EDUCATORS PERCEPTIONS ON PERFORMANCE OF SECONDARY SCHOOL LEARNERS IN MATHEMATICS AND SCIENCE IN THE MAFIKENG DISTRICT OF THE NORTH WEST PROVINCE.

BY

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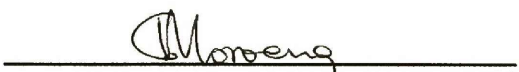
DECLARATION

I, CONSTANCE DIKELEDI MOROENG hereby declare that the dissertation for the degree of Master of Business Administration (MBA) with the University of North West is submitted, has not previously been submitted by me for any degree at this or any other University, that it is my own work in design and execution and all the materials contained in this research has been acknowledged.



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ABSTRACT

The purpose of the study is to determine the perception or views of mathematics and science educators on performance of grade 12 learners in Mafikeng district. Little has been written about secondary school educators' views with regard to performance of learners in Mathematics and Science in developing countries like South Africa.

The survey method was used to gather data. A 31 item questionnaire was used to evaluate perception of educators in the areas of: Support for educators, Educator involvement, Conditions for teaching and Educators' perception on how educational change affects performance of learners in Mathematics and Science.

The subjects of the study were 89 Mathematics and Science educators in the Mafikeng district. The sample was selected from the 31 high schools including senior secondary schools in the district. The empirical investigation conducted revealed that parental involvement in their children's studies is a serious problem that needs immediate attention, in addition to educator qualifications and lack of learning support materials. The study also revealed that improving performance of learners, responsibility and involvement of educators, learners, parents, government and community is essential.

The conclusions drawn from the study show that educators' perceptions on performance of learners in Mathematics and Science entail cooperative and supportive structure, regular communication among staff and monitoring of school work for both educators and learners is very important. It is also important that the findings of the research be implemented to improve learner performance.

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LIST OF ABBREVIATIONS

SAQA	-	South African Qualifications Authority
NWDE	-	North West Department of Education
TIMSS	-	Third International Mathematics and Science Study
CASS	-	Continuous Assessment
DoE	-	Department of Education
OBE	-	Outcome Based Education
NCS	-	National Curriculum Statement
GETC	-	General Education Training Certificate
FETC	-	Further Education Training Certificate
NGO	-	Non-Governmental Organisation
CEM	-	Council of Education Ministers
RSA	-	Republic of South Africa
LSM	-	Learning Support Material
IRT	-	Item Respond Theory
LAEP	-	Los Angeles Educational Partnership
SMART	-	Science and Mathematics Advancement and Resources for Teachers
NASDC	-	New American Schools Development Corp
QLP	-	Quality Learning Programme
UCLA	-	University of California, Los Angeles
IEA	-	International Association for Evaluation of Educational Achievement

CHAPTER 1: ORIENTATION

1.1 INTRODUCTION

Poor performance of Grade 12 learners in Mathematics and Science in South African Secondary Schools, especially in the Mafikeng District of the North West Province, has shown evidence of constant recurrence. An analysis of Grade 12 Mathematics and Science results show that average percentages of learners in Mafikeng District has ranged from 40% in 1997 to 50% in 2002.

The implicit notion that a high degree of performance in Mathematics, Science and Technology is paralleled by economic prosperity, guarantees a strong interest in Mathematics, Science and Technology education among almost all policy makers in the educational arena. Overall performance of Grade 12 Mathematics and Science learners is poor and this is also shown by less number of learners taking Science oriented subjects. Most schools enrol learners for humanity subjects than for science oriented curricula. It is therefore essential to conduct studies in the view of educators towards performance of learners in Mathematics and Science in Grade 12.

This chapter focuses on the statement of the problem in order to facilitate understanding of the problem under investigation. Thereafter, the aims and research design are given and the terms relevant to the study are defined.

1.2 STATEMENT OF PROBLEM

In South Africa, Grade 12 is a yardstick for entrance into tertiary education. However, the failure rate in Grade 12 is alarming.

The post 1994 education system for blacks is often blamed for poor examination results and the legacy of apartheid education is currently blamed for poor results. Learners' poor results were and still are, common in Mathematics and Science subjects. However, abilities in scientific thinking are essential. In fact, it is these abilities that are generally regarded as being vital in the development of nations (Sibaya and Sibaya, 1997:9).

Poor performance in Mathematics and Science by black learners is a drawback to the nation, which needs scientists in both organic and inorganic sciences. To overcome this problem, much emphasis is needed in our society on the value of Technology and Science.

While learners from all racial groups in the Republic of South Africa may encounter problems regarding the teaching and learning of mathematics, such problems occur to a much greater extent among black learners than among learners from other racial groups. Learners' poor performance in Mathematics can be attributed to the lack of relationship between the subject content and learners' cosmos. The variables include understanding mathematical and scientific concepts. There is a concern on the poor performance of the Grade 12 learners and there is a need to know the role played by assessment to improve the situation (Barry, 1998:14).

According to Sutherland (1998:100), learning is so driven by assessment that the form and nature of assessment often swamp the effects of any other aspect of the curriculum. Furthermore, is it important to note that if assessment is used as a tool for learning, it can impact positively on learners' performance.

In addition, there is a paradigm shift towards integrating assessment with learning, continuous assessment using learners' regular work rather than formal examinations, records of achievement, portfolio, school based assessment and lastly using results as feedback to help define objectives and encourage learners to take responsibility of their own learning.

In order for the new paradigm of assessment, as espoused by the South African Qualifications Authority (SAQA), to be successful, educators will also need to inculcate a culture of assessment where not all that is assessed is for grading purposes. In keeping with curriculum 2005, the South African Qualifications Authority (SAQA) and UMALUSI (South African Examining Authority) have suggested continuous assessment (CASS).

Asmal (2001), states that a review of Curriculum 2005 was based on simplifying the language in order to make it more accessible to teachers and learners in schools. It also recommended relaxing implementation timeframes. The significance of education in the South African society cannot be underestimated. The curriculum is the place where a society expresses its goals, visions and expectations of how it will create and develop the kind of citizens who will embody its ideals (NWDE Report, 2000).

Even though much attention is placed on the expectations of Grade 12 learners' performance in Mathematics and Science, by policy makers, improving assessment processes, it is essential to investigate the causes that may lead to poor performance. These causes, according to the North West Department of Education (NWDE) provincial report examination results, may vary from lack of human and physical resources to human resources include departmental problems such as (NWDE Report, 2000): -

- Demotivated educators as a result of redeployment and right sizing;

- Inexperienced, incompetent and non-committed and poor work ethic prevalent in schools;
- Inability of learners to comply with examination instructions;
- Lack of discipline by learners, coupled with poor school attendance;
- Large number of unqualified and under qualified Mathematics and Science educators in schools; and
- Insufficient continuous in-service training for training of educators as a result of too many projects being introduced at the same time.

The school system lays foundation for the country's work force and it determines whether that work force will be competent, productive and competitive and subsequently whether the country will be prosperous.

The International Association for the Evaluation of Educational Achievement (IEA) is a programme facilitated by the Third International Mathematics and Science Study (TIMSS) and it is based in Netherlands. It is a comparative study of educational achievement and meant for measuring scientific abilities of learners from different countries.

The aim is to get an in-depth understanding of the effects of policies and practices within and across systems of education. According to Gray, (1997), evaluation of national curricula and achievement in Mathematics and Science inform governments, policy-makers and educators about the Mathematics Science proficiency of their learners. It was undertaken among more than 60 countries across the world. The following are the preliminary findings of the IEA in the achievement tests (Gray, 1997:16): -

- South Africa's scores were very low in comparison with those of other participating countries.

- South African science curricula were not in line with those of other participating countries.
- South African learners generally seemed to possess inadequate problem solving techniques.
- South African learners generally had difficulty constructing their own answers.
- In top-performing countries classroom size did not appear to affect achievement negatively. In Korea 89% of learners were in classes with more than 40 learners, while Japan and Singapore 90% of learners were in classes of more than 30 learners.
- There is a strong link between home environment and achievement.
- South African learners had less learning time in classrooms than those in the top performing countries and again, the learners have low level of general numerate and scientific understanding and skills.

The above findings imply that the numbers of young people who qualify to enter institutions of higher learning are low. But more importantly, this paucity of high school graduates in Mathematics and Science means that the country's ability to train enough young people in medical sciences, engineering sciences and high calibre information technology is reduced.

De Cenzo et al., (1998), view high performance as resulting from appropriate human resource planning which is clear and objective enough to be understood and measured.

The following questions guide the study: -

- Is the performance of learners in Mathematics and Science satisfactory?
- How do Mathematics and Science educators view or perceive learners' performance?

- What should be done to improve performance of learners in Mathematics and Science?

1.3 AIMS OF THE STUDY

- To determine from the literature, the nature and scope of learners performance in Mathematics and Science.

- To investigate empirically, the views of Mathematics and Science educators with regard to the factors causing poor performance of learners in Mathematics and Science.

1.4 RESEARCH METHODS

1.4.1 The Questionnaire

The primary instrument in this study was questionnaire which was developed and presented to Mathematics and Science educators. The questionnaire consisted of both open and closed ended types of questions.

1.4.2 Population Sampling

There are 31 high schools (Grade 10 – 12) out of which there are 4 senior secondary schools (Grade 8 – 12) in the Mafikeng district. The district consists of 6 circuits. Five (5) questionnaires were distributed to each school to Mathematics and Science educators (n = 150) from a total number of Mathematics and Science educators (N = 200) in the district.

Questionnaires were distributed to all high schools in the Mafikeng district to answer, specifically all educators teaching Mathematics and Science.

This is a typical purposive sampling as questions were directed to Mathematics and Science educators.

1.5 ANALYSIS OF RESULTS

The analysis of the research results was done using a computer aided statistical tool (SPSS), with the help of statistical consultants of University of North West. The computation of frequencies (*f*), percentages , means and standard deviation were conducted.

1.6 DEFINITION OF TERMS

Learner refers to any person receiving education or is obliged to receive education in a particular school (South African School Act 1996) Again a learner can be referred to as a person acquiring knowledge or skill by studying.

Learner Performance refers to the process of carrying out a learner's achievement under test conditions. Learners' achievement is usually measured by their response with regard to tests, classwork and home work. Such evaluation is reflected on CASS assessment reports (Sutherland et al., 1998).

Grade 12 refers to the last stage of formal school education as used interchangeably with the concept of matriculation. The completion of this grade render the learners a chance of being given a certificate which enables them to continue with tertiary education.

Educator refers to anybody employed by the Department of Education in a school setting with full qualifications, as desired by the department, National education policy Act 27 of 1996.

Secondary school refers to a school providing education following primary education. In this study more emphasis was based on senior secondary school's (grades 8 – 12) and high schools (grades 10 – 12).

District refers to a demarcated area used by the education department for the control of schools that are found in that area.

A parent, the South African School Act of 1996, defines a parent as a guardian or a person legally entitled to the custody of a learner; or a person who undertakes to fulfil the obligations of a person referred to as a learner.

1.7 CHAPTER HEADINGS

The study is divided into the following five chapters:-

1. Orientation
2. Literature review
3. Research methodology
4. Data analysis
5. Summary, recommendations and conclusion

1.8 SUMMARY

In this introductory chapter, the statement of the problem, the aims of the study and brief orientation were provided. The main aim of the study was to find out from Mathematics and Science educators, their views pertaining to learners' performance. The following chapter reflects the literature reviewed for this study.

CHAPTER 2: NATURE AND SCOPE ON PERFORMANCE OF GRADE 12 LEARNERS IN MATHEMATICS AND SCIENCE

2.1 INTRODUCTION

This chapter gives a brief review of the literature on performance of Grade 12 learners in Mathematics and Science. The review focused on the state of learners' performance, the role of different stakeholders (government, parents, educators and learners) in the history of performance and the status and challenges met in improving the performance in the said subjects.

There is a growing need for systematic monitoring of Grade 12 learners' performance in Mathematics and Science, because the degree of performance enhances economic prosperity and again, since the world is filled with products of scientific inquiry, scientific literacy is therefore important to the nation as a whole. There is a need to be able to engage intelligently in public discourse and debate about important issues that involve Science and Technology. Citizens deserve to share in the excitement and personal fulfilment that can come from understanding and learning about the natural world (National Science Education Standards, 2002).

Democratisation of education system in South Africa has brought changes and challenges in school situation, which to a certain extent has greater impact on Grade 12 learners' performance in Mathematics and Science. Therefore monitoring learner performance will guide the policy makers, curriculum developers and educators to implement new teaching and assessing strategies with a positive attitude, with the main aim of improving learner performance.

Apartheid education, which deemed Mathematics irrelevant to blacks, bears much of the blame. Under apartheid, there was vast expansion of black schooling while spending was contained. South Africa was left with a mass education system staffed with inadequately trained educators (Sibaya and Sibaya, 1997). As a result performance in Mathematics and Science in schools designated for African children was negatively affected.

According to Legotlo et. al. (1997), a trend of declining pass rate, from an already unacceptably low level, has made Physical Science an unpopular choice with matriculation learners. Observation made of the poor performance at these schools for black learners, revealed that they rarely, if ever, did the required practical work. Another problem is realised in disadvantaged schools, where there is lack of guidance educators to inform learners about career choices, and the significance of Mathematics and Science subjects.

2.2 THE CONCEPTS OF POOR PERFORMANCE

The following discussion will focus on concepts of poor performance and the latter part will concentrate on characteristics of performance models. A great deal of confusion has been generated in the past when discussing poor performance. As a result, because of lack of clear definition for the term used in this discussion, emphasis will be made on factors involved in analysing poor performance. Such factors include among others, assessment, expected standard and educator qualifications.

2.2.1 Further definition of terms

Within this section, the terms performance, poor performance and expected standard of performance are elaborated.

Performance is defined in the Oxford Dictionary, as execution or fulfilment of a duty or a person's achievement under test conditions.

In the case of performance of Grade 12 learners in Mathematics and Science, the test condition or the tool used to measure achievement is assessment standards that are developed to ensure integration of concepts, skills and values. Learners should be equipped with knowledge and skills that will help them to compete in a global economy and allow them to lead lives of satisfaction and integrity, both as individuals and as citizens. Performance – based assessment requires that the learner complete, demonstrate, or perform the actual behaviour of interest (Baron et. al., 1996).

Practical competence is the ability to consider a range of possibilities for action, make considered decisions about which possibility to follow, and to perform the chosen action. Problem solving is a multi faceted cognitive activity in which, when engaged and confronted with a task in which routine action or normal thinking does not allow one to go from the given existing situation to the desired goal situation, but rather there are resources to some form of critical thinking. Such critical thinking has the task of devising some action, which may overcome the perceived barrier between the existing and the goal situations (Singh, 2002).

Poor performance on the other hand is a result of underachievement, in this case Mathematics and Science. This is a situation where learners' output in Mathematics and Science does not match or fit the expected set standards or performance. Several factors that contribute to poor performance include poor communication and coordination between the professional support system and administrators in educational system. Learners' poor performance can be attributed to the lack of relationship between the subject content and the learners' cosmos (Sibaya and Sibaya, 1997:10).

Other factors, which contribute to poor performance, are lack of resources, qualified and committed educators and also dedicated learners.

2.2.2 Background information

Performance is related to cognitive abilities of learners and other factors such as background, environment and assessment. Stoll et al. (1996: 46), postulates a dynamic situation brought about by the move to full democracy within South Africa. As a result the structure and institutions that existed prior to change are re-evaluated and programmes re-designed. Further, educational change is an innovation that is used in school systems because of new legislation (policy) or because stakeholders (school staff, parents, community) felt a need to implement new innovation in the school. It is identified in three ways (Mokgosi, 1999: 11):-

- Possible use of teaching approaches (e.g. new teaching strategies or activities);
- Possible alteration of beliefs (pedagogical assumptions and theories underlying particular educational goal or set of goals);
- Possible use of new or revised material (direct instructional resources such as curriculum materials or technologies).

Most organisations like schools face a dynamic and changing environment that in turn require these organisations to adapt. The only prediction that can be made about education is that change is inevitable. According to the Department of Education, Physical Science curriculum (DoE 2002(a)), The Constitution of the Republic of South Africa (Act 108 of 1996) forms a basis for social transformation in a post-apartheid society.

The imperative to transform South African society through various transformation tools stems from a need to address the legacy of apartheid in all areas of human activity, and in education in particular. Social transformation in education was aimed at ensuring that the educational imbalances of the past are addressed, and that equal educational opportunities are provided for all sections of the country's population. Major emphasis is placed on Mathematics and Science curriculum and the following discussion proceed with their focuses on the intentions of these two areas of study.

2.2.2.1 Intentions of the Physical Science curriculum

The use of Physical Science has profound worldwide impacts on economic, environmental, ethical and technological issues. An understanding of scientific perspectives will enhance participation by citizens when they are called upon to exercise their rights in deciding on and responding to the directions of science and technology (DoE, 2002(a)). However, it should be acknowledged that science could be used in responsible and or irresponsible ways.

South Africa has come from a past in which the poor quality or lack of education resulted in limited access to scientific knowledge and the devaluing of indigenous scientific knowledge (Legotlo et al. 1997, Sibaya and Sibaya, 1997). Therefore the Physical Science curriculum must ensure increased access to scientific knowledge and scientific literacy.

The study of science contributes to the holistic development of learners in the following ways (DoE, 2002 (a)):-

- Giving the learners the ability to work in scientific ways, such as using scientific inquiry and problem solving, which has proved effective in

understanding and dealing with the natural and physical world they live in;

- Developing useful skills and attitudes that will prepare them for various situation in life, like self-employment;
- Enhancing understanding that the technological applications of sciences should be used responsibly towards social, human, environmental and economic development in South Africa and globally.

The document for this outlines the focus of the study of Science thus (DoE, 2002(a)):-

- Scientific enquiry and problem solving in a variety of scientific, technological, socio-economic and environmental context;
- The construction and application of scientific and technological knowledge; and
- The impact on the quality of sustainable socio-economic and human development with reference to the society, ethics and the environment.

According to the DoE, 2002 (a),Learning Outcomes of science aim to develop the abilities of knowing (knowledge), doing (skills), applying and constructing knowledge and being (values and attitude):

- Learning outcome 1:

Scientific inquiry problem-solving skills, entails the ability of the learner to use process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts.

- Learning outcome 2:

Constructing applying scientific knowledge, entails the ability of the learner to explain, interpret and evaluate scientific and technological facts, concepts, principles, models and laws and can apply them in everyday contexts.

- Learning outcome 3 :

Nature of scientific knowledge entails the ability of the learner to be able to identify the sources of scientific knowledge and to evaluate knowledge claims, taking cultural and historical context into consideration.

- Learning outcome 4;

Science, Technology, Society and the Environment, entail the ability of the learner to indicate the impact of Science on the quality of sustainable socio-economic and human development by critically evaluating the interrelationships between Physical Science, Technology, ethics and the environment.

The four learning outcomes and assessment standards are of equal importance.

Learning outcomes 1 and 2 have four assessment standards each while learning outcomes 3 and 4 have only three assessment standards each. This implies that different outcomes will require different prominence with regard to teaching and assessment time.

2.2.2.2 *Intentions of the Mathematics curriculum*

An appreciation of the manner in which Mathematics has developed over time establishes its origins in culture and the needs of society. Mathematics has an important role in the economic, management, and social sciences. Furthermore, maths is an important tool for creating, exploring and expressing theoretical and applied aspects of the sciences. Therefore, the Department of Education (Mathematics curriculum) DoE, 2002(b), recognises that the study of Mathematics contributes to personal development through an enjoyment experienced in a deeper understanding and successful application of its knowledge and skills, while maintaining appropriate values and attitudes.

According to DoE, (2002 (b)), the learning outcomes for Mathematics include:-

- Learning outcome 1:

Number Relationships, entails the ability of the learner to recognise, describe, represent and work with numbers and their relationships to estimate, calculate and check with confidence in solving problems.

- Learning outcome 2 :

Patterns, Functions and Algebra, entail the ability of the learner to investigate, analyse, describe and represent a wide range of functions and solve related problems.

- Learning outcome 3:

Shape, Space and Measurement, entail the ability of the learner to describe, represent and explain properties of shapes in two and three dimensional space with justification.

- Learning outcome 4:

Data handling and probability, entail the ability of the learner to collect and use data to establish statistical and probability models to solve related problems.

Mathematics requires understanding before competence in the learning outcomes can be achieved. Since Mathematics is a cognitive science, its mastery depends to a large extent on mathematical processes such as investigating patterns, formulating links across the domains of Mathematics to enable lateral thinking.

2.2.2.3 Assessment

Assessment is a critical element of any curriculum as it entails collecting and interpreting evidence in order to make judgement on a learner's competence. DoE2002 (b), states that evidence can be collected at different times and places and with the use of various methods, instruments, modes and media. It is important that the assessments of Mathematics and Science learning measure the knowledge and skills that are being taught in the curriculum. In addition, the future and current educators need training to use instructional strategies recommended in various standard documents, such as inquiry and cooperative learning (Stoll, 1996:46).

The Department of Education (2001), further looked into improving learner achievement and equipping educators currently in the system. Programmes such as in-service training and educator empowerment projects, should develop educators' preparation, strengthening both subject matter expertise and pedagogical mastery.

Implementing the National Science Education Standards is a large and significant process that will extend over many years (Meier, 2002:12). But through the combined and continued support of all, it can be achieved. Change will occur locally, as will differences in individuals, schools, and different pathways to reform and different rates of progress. Nevertheless, with the common vision of the Standards, deliberate over time can be expected, leading to reform that is permanent (National Science Education Standards, 2002).

In addition, helping educators in their daily practices, the New Science Literacy addresses more widespread concerns among current science educators, including the following needs (Norman et al., 2002):-

- To reassert the rightful place of science in a basic curriculum;
- To strengthen teaching skills and strategies among elementary educators unsure of science content and /or the teaching of language skills;
- To help middle and high school science educators raise learners achievement in science by using language as an essential element of their science programs;
- To enhance the movement for accountability, standards and educational improvement.

Furthermore, it should be noted that assessment is a vital element in education, as its implications are well known. This includes implementation of Curriculum 2005 and Outcome Based Education (OBE) in the South African education system. According to Barnard, (1998:28), assessment is integral in education, hence without it, goals and objectives in education cannot be evaluated. OBE forms the foundation for the curriculum in South Africa.

Assessment strives to enable all learners to reach their maximum learning potential. It does this by setting the outcomes to be achieved at the end of the process. The outcomes encourage a learner-centred and activity-based approach to education. The National Curriculum Statement (NCS) builds its learning outcomes for Grades 10-12 (schools) on the critical and developmental outcomes inspired by the Constitution developed in a democratic process (DoE,2002(a)).

According to Norman et al. (2002), culture awareness brings to light differences in languages, values, socio-economic status, gender and behaviours. Meeting the science content needs of predominantly Hispanic learners challenges educators to develop greater cultural awareness. Cultural awareness is raised through the School District Partnership programme, relating and integrating the Hispanic culture into science accomplished by(Norman et al., 2002) :-

- Teaching educators to pay attention to cultural differences;
- Making educators aware of differences in values;
- Including role models as science reinforcement to cultural differences; and
- Socialising parents to expectations in science.

The processes by which these objectives are met in this programme include several components of cultural awareness through science curriculum development in science education, parental involvement and the inclusion of role models in programme activities.

According to the National Science Education Standards (2002), good educators have continually expanded theoretical and practical knowledge about science learning and teaching. Educators use assessments of learners and of their own teaching to plan and conduct their teaching. They build strong, sustained relationships with learners that are grounded in their knowledge of learner's similarities and differences. In addition, they are active as members of science-learning communities.

In South Africa, assessment is synonymous with measurement of product. School leaving examinations played a major role in maintaining education that was unequal in the sense that deprived educational opportunities had lowered the marks (Barry, 1998). Further emphasis on performance in Mathematics and Science is shown by analysis of performance of grade 12 learners in Mathematics and Science for the previous four years, that is from 1999 to 2002 as reflected on Table 2.1

Table 2.1 Number of learners enrolling for Mathematics and Science from 1999 to 2002 Grade 12 examinations

Total number of Students written	**GRADE HG/SG**	**1999**	**2000**	**2001**	**2002**
Mathematics	HG	Wrote-2561 Passed 935.0 36.5%	Wrote-1880 Passed-1041 55.4%	Wrote-1607 Passed-987.6 53.2%	Wrote-1537 Passed-1004 47.8%
Mathematics	SG	Wrote-17789 Passed-4736 26.6%	Wrote-20716 Passed-5935 28.7%	Wrote-19070 Passed-6235 27.9%	Wrote-18638 Passed-7119 28.7%
Physical Science	HG	Wrote-6099 Passed-1429 23.43%	Wrote-4887 Passed-1200 24.6%	Wrote-3998 Passed-1302 27.3%	Wrote-3193 Passed-1433 39.33%
Physical Science	SG	Wrote-5607 Passed-2358 42.1%	Wrote-8336 Passed-3826 45.9%	Wrote-7989 Passed-2997 40.4%	Wrote-9049 Passed-4562 33.7%

(NWDE, 2003, Grade 12 examination results, Report).

2.3 ISSUES AND CHALLENGES FACING EDUCATIONAL CHANGE

Since performance of learners in Mathematics and Science in this era of transformation in South Africa, both learners and educators encounter challenges that may delay the process of learning. Factors that delay learning process include among others, learner assessment, educator assessment, language, curriculum content, learning environment, writing to learn and gender.

For educators to design and implement new ways of teaching and learning science, the practices, policies and overall culture of most schools must change. It should be taken into cognisance that such reform cannot be accomplished overnight. Again it is important that educators be provided with the necessary resources, time, materials and support from the educational system to achieve the objectives.

It is reported in the National Science Education Standards, (2002), that reforming science education requires substantive changes in how science is taught, which requires equally substantive change in professional development practices at all levels. Prospective and practising educators need opportunities to become both sources of their own growth and supporters of the growth of others. National Science Education Standards, (2002), further states that educators should be provided with opportunities to develop theoretical and practical understanding and ability, not just technical proficiencies. Professional development activities need to be clearly and appropriately connected to educators' work in the context of the school. In this way, educators gain the knowledge, understanding and ability to implement the standards (standards is a term that embodies both excellence and equity).

According to Stoll et al. (1996: 15), the majority of schools in Southern Africa is characterised by a shortage of well qualified Mathematics and Science educators, many of whom have to teach beyond their level of competence, in poorly equipped schools with large classes of learners who are no all up to the standards they are said to be on paper and who all aspire to pass the final examinations one way or the other. The environment, in which educators work, therefore, is not conducive to a quiet and analytical reflection on the conceptual understanding of learners in relation to the teaching strategy developed by the educators. Many secondary schools are unable to contribute adequately and effectively towards the professional development of science due to poor management of existing materials and equipment as well as lack of creativity of science educators.

2.3.1 Learner assessment

Learner assessment is a vital component in an education system as it provides educators with feedback on how well their learners are learning or meeting the expectations. The primary role of assessment is to provide feedback to school districts on the effectiveness of their educators and programmes and policy makers with feedback on how well policies are working. It is essential to consider alternative approaches to assessing learner performance, since there are various functions served by assessment (DoE, 2002 (a)).

Before an educator assesses learners, it is crucial that the purposes of the assessment be clearly and unambiguously established. Some reasons on learners' performance assessment include monitoring progress, diagnosing or remediation barriers to learning, selection, guidance, supporting learning, certification, and for promotion (Stoll et al., 1996).

It is reported in the DoE 2002 (b), that learning and assessment are inextricably linked. Educators' assessment of learners' performances must have a great degree of reliability. Since each assessment cannot be totally valid or reliable by itself, decision on learner progress must be based on more than one assessment. This is the principle behind Continuous assessment (CASS).

According to Sutherland et al. (1998), CASS is an assessment strategy that bases decisions about learning on a range of different assessment activities and events that happen at different times throughout the learning process. It involves assessment activities that are spread throughout the year, using various kinds of assessment methods such as tests, examinations, projects and assignments. Oral, written and performance methods are included in CASS.

Assessment helps learners to gauge the value of their learning. It gives learners information about their own progress and enables them to take control of their abilities and to make decisions about their learning. Assessment also helps in the planning of activities and in learning programme development. As a result, assessment should be transparent, democratic, clearly focused and flexible, integrated with teaching and learning and allow for expanded opportunities for learners.

Methods of assessment have become more sophisticated and varied as they focused on higher-order skills. Rather than simply checking whether students have memorised certain items of information, new assessment methods probe for learners' understanding, reasoning and use of the knowledge, that is, the skills that are developed through inquiry. A particular challenge to educators is to communicate to parents and policy makers the advantages of new ways of assessment (DoE, 2001).

Assessment can be done in many ways, besides conventional paper and pen tests (standardised testing), class exercises, it might include performances, portfolios and interviews, investigation reports or written essays (assignments). It refer to such techniques as systematic educator observation and 'authentic' assessment, in which the tasks assessed more closely parallel the learning activities and outcomes that are desirable in the (Science) classroom (National Science Education standards, 2002).

The need to measure the opportunity of learners to learn science should always be taken into consideration. Hence, assessment might measure educators' professional knowledge, the time available to teach science, and the resources available to learners. According to Mettler, (2002), South Africa is still experiencing a legacy of inequality in key fields of study including Mathematics and Science and this in turn limits the potential of participants in the education system.

2.3.2 Educator assessment

In any system of education, assessment should entail the performance of both learners and educators as part of performance indicators. Due to constant change in scientific knowledge, educators require periodic updating of scientific knowledge and opportunities to learn about new methods of teaching science.

According to Van der Westhuizen, (1996), class visits were in the post 1994 education system, conducted by principals or school inspectors with the aim of evaluating fellow educators in schools.
The disadvantage of class visits is that principals or inspectors are not directly involved in classroom practice thus they might not know the latest development in educational methodology and subject approaches.

A similar problem is prevalent with the implementation of Whole School Evaluation programme. The Education Labour Relations Council (Resolution No. 4 of 1998) developed the appraisal system for educators so as to have balance between developmental formative appraisal and judgement (summative) appraisal. Appraisal system also intended to entrench educators with strength, develop their potential and overcome their weaknesses. However, the monitoring of this programme is not effective.

2.3.3 Language

Language plays an important role in the performance of learners since learning Mathematics and Science involves usage of language (medium of instruction). Gray, (1997:7), states that South African learners who wrote Third International Mathematics and Science Study (TIMSS), had difficulty in constructing sentences and interpreting questions because the tests were written in a language which was not their mother tongue.

According to Cherian, (2002:24) and the Human Sciences Research Council (2002), the official policy ensured development and use of dominant languages. For example, English and Afrikaans were used at the expense of other languages. As a result of this policy, the majority of South African learners learned through a medium of instruction that was not their mother tongue. This has critical consequences for educational performance of learners especially, black learners.

According to Mettler (2002), the strengthening of the teaching of English as a second language is important since it is the medium of instruction in most historical disadvantaged schools. Carin (1997:238), argues that Science and language are both process-oriented, that is, both integrate and use all related abilities and skills.

Again, learners should be provided with opportunities to practise receptive language skills (listening and reading) therefore, be able to use language skills in conjunction with science concepts to explore their innovation skills and yield their scientific literacy.

2.3.4 Curriculum content

The curriculum is usually seen as part and parcel of the schooling process, as are teaching and learning styles and methods. To produce competent Mathematics and Science learners, it is thus important to consider curriculum content and compare it with that of other countries. Sheppard, (1997:14), states that internationally there is growing interest in comparing curricula to see where different countries put the emphasis in teaching and learning content. The author further says that conceptual framework of TIMSS is centred around the intended, implemented and attained curriculum. The results of TIMSS revealed that South African science curricula were not in line with those of other participating countries.

In line with the policy of apartheid, different curricula were provided for different racially based departments of education. Under-resourced black schools with unbalanced educator-pupil ratio and limited facilities tended to offer learners a very narrow range of subjects (Stoll et al, 1996). Many schools designated for African children did not offer Mathematics and Science. In cases where these subjects were offered, very few learners took them and resources such as laboratories and qualified educators were limited. Nevertheless, a transition has taken place from separate education to multicultural education where educational opportunities were broadened in the spirit of democracy.

There has been a shift from an input-based, norm-referenced and summative assessment model to an outcome-based, criterion-referenced and formative assessment model (Stoll et al, 1996).

2.3.5 Learning environment

Learning environment is one of the factors that play a vital role in performance of learners. A conducive teaching and learning environment may improve performance. Learning environments however, are impoverished by factors such as classroom disruptions, under qualified educators, inadequate textbooks, high pupil-ratio, shortage of educators and physical facilities.

Haasbroek (1998:15), argues that effective leadership and management styles and the presence of team spirit among staff members are essential elements in bringing about positive change in schools. Poor performance emanates from badly managed schools, thus it is essential that school management be taken into cognisance when evaluating performance. Educators should hold a positive belief about learners' capability and success by creating an environment in which there is a sense of order accompanied by sense of engagement. Such educators remind learners that they are capable and create learning situation in which learners have an opportunity to succeed.

According to Rice et al. 2001), the degree to which members of the school community feel safe is one indicator of the quality of interaction in the school. A healthy school climate is reflected by high achievable standards for learner performance, friendly and supportive relations, hard work towards shared academic goals, serious and orderly learning environment (Haasbroek, 1998:13).

Teu (1997:15), cites that parental support and involvement as essential for adequate performance of learners. A school-wide programme of academic success includes publicly honouring academic achievement. A principal and a school governing body should provide motivational devices and reward systems that support an academic orientation.

2.3.6 Writing to learn

Writing enhances learner's conceptual knowledge, develop scientific literacy, familiarises learners with expectations, conventions and reasoning skills required of scientific writing (Hand et al., 2002).

The writing to learn approach is a resource for thinking and learning, an interim process or clearing house by which learners clarify and consolidate conceptual knowledge. The main goals of this approach is to encourage learners to see writing in science as a resource for communication and clarification of viewpoint. Furthermore such approach serve as a tool for displaying knowledge that promotes learners' science literacy by developing their interest in a capacity to apply scientific thinking to social issues for the purpose of informed action. New computer-based programmes for learning Mathematics and Science should be considered (Hand et al, 2002:737 & Von Secker 2002:159).

2.3.7 Educator qualifications

The qualifications of educators are an important factor in determining performance, because the nation's prosperity to a certain extent depends on the educators' competence, productivity and competitiveness (Sheppard, 1997:13). Hence, adequate supply of qualified and competent Mathematics and Science educators as well as the upgrading of under-qualified educators

is essential. Incentives for attracting learners to train as educators in Mathematics and Science through the provision of bursaries also enhances educator quality. Recruiting Mathematics and Science educator trainers from abroad to complement the current educator corps, could be used as a temporary measure to overcome current problems.

2.3.8 Gender

Science has long been seen as a 'masculine' domain that did little to motivate girls to excel in it and the ease with which they were allowed to give up science at an early age merely confirmed that science was for boys. According to Masters (2002), when analysing results from Third International Mathematics and Science Study (TIMSS), gender differences in achievement were common throughout the participating countries, particularly in Mathematics and Science, the scale tipped towards male learners.

It is critical to mobilise broader support (parents, educators, volunteers) around the need and urgency to improve participation and performance by historically disadvantaged schools in grade 12 Mathematics and Science (Mettler, 2002). The strategy of addressing gender equity in science oriented careers, aims to increase the number of female learners taking Mathematics and Science. Currently in South Africa, Eskom parastatal is offering bursaries to girls taking Science. Traditionally fewer female than male learners studied in science related fields such as engineering and this has to be addressed. The establishment of girls' schools or classes for Mathematics and Science should be considered.

2.4 IMPROVING PERFORMANCE OF GRADE 12 LEARNERS IN MATHEMATICS AND SCIENCE

The nation's economy or prosperity is somehow dependent on its citizens' competitiveness, productivity and skills with regard to the gradually changing scientific and technological needs globally. This dramatic shift or change affects schooling systems too and subsequently learners' performance. This brings about a critical issue of improving learners' performance in Mathematics and Science so as to prepare learners to be scientifically and technologically competent. In South Africa the national department of education has taken this matter seriously, hence there are projects put in place with the main aim of improving performance in Mathematics and Science of grade 12 learners. Other regional projects include: SEDIBA; EXPO FOR YOUNG SCIENTISTS (EXPO); PROTEC AND QUALITY LEARNING PROJECT (QLP).One of the projects in place is the DINALEDI (Sesotho for "stars") project.

Activities to be implemented in relation to the project are outlined as (Mettler, 2002):-

- Provision of Satelite dishes to schools by multichoice. Lesson material will be transmitted to schools via internet for utilisation in schools and cluster of schools;
- The provision of computers, Televisions and Video recorders to schools;
- Training of selected educators in basic computer literacy;
- The preparation of video material for educators. This aims to improve their teaching methodology and knowledge of subject content;

- The provision and distribution of learning Channel material for learners by the Northern Cape Department of Education;
- Conducting an Autumn clinic for all of 102 Dinaledi Schools in Midrand;
- Conducting of a national common examination for grades 10 and 11 learners November 2002 as well as grade 12 learners September 2002 in Mathematics and Science;
- Conducting of educator development sessions for educators of Mathematics and Science. Physical Science educators from Dinaledi Schools in the Northern Cape will receive training on the uses of Science;
- Conducting winter schools for learners of Dinaledi Schools.

According to Callaghan (2002), the Dinaledi project aims to boost pupils' performance in Mathematics and Science. It is being piloted from 2001,in 102 selected schools in the country. The Department of Education is trying to remedy the problem of lack of hands-on experience by supplying each school with basic science kits with assistance from Somerset a non-government organisation. In addition, the Department of Education has initiated, such as Quality Learning Project, Sediba project and Intel in schools so as to improve learners' performance at the same time empowering educators.

2.4.1 Strategies

The improvement of learner achievement is largely dependent on a competent teaching corps of Mathematics and Science educators. This concept addresses both the ongoing professional development of educators already in the classroom and the preparations of new educators.

According to Carin (1997:52) scientists and educators generally agree that although science learning takes place in a variety of ways, one of the best ways is through an active approach that involves students in observing, measuring, predicting, inferring, investigating and explaining the world in ways that parallel the methods of scientists. This approach brought about the discovery of constructivist strategy, which entails a hands-on, minds-on approach. The approach incorporates Piagetian-Cognitive learning theories, students' learning styles and interests and the goals of an active science education programme.

According to the National Science Education Standards (2002), standards refer to excellence and equity to all learners and rest on the premise that science is an active process. Learning science is a 'hands-on' and a 'minds-on' process. This system brings coordination, consistency and coherence to the improvement of science education. Policies and procedures within the system support people improving science education. It further takes science education beyond the constraints of the present towards a shared vision of the future.

The National Science Education Standards (2002), further, presents a vision of a scientifically literate populace. The document outlines what learners need to know, understand and be able to do to be scientifically literate at different grade levels. The description of an education system entail:-

- all learners demonstrate high levels of performance;
- educators are empowered to make the decisions essential for effective learning;
- interlocking communities of educators and learners are focused on learning science; and

- supportive education programmes and systems nurture achievement.

Standards point towards a future that is challenging but attainable, which is why concepts are written in the present tense.
The above notion is supported by Von Secker (2002:152), when he states that educators need to be encouraged to replace traditional educator-centred instructional practises such as emphasis on textbooks with inquiry-oriented approaches that provide opportunities for learners to use appropriate laboratory techniques to collect evidence. There is a need to develop strategies for attracting, recruiting and selecting learners who obtain good marks in Mathematics and Science to train them as educators at institutions of higher education.

Programmes that can help equip educators with competences to teach at all levels of the schooling system will be appreciated. Higher education institutions (with assistance from the government) will have to play an active role in improving the knowledge and skills of educators currently in the system, as well as those of future trainees. These institutions should develop rigorous new programmes for educator preparation, strengthening both subject matter expertise and pedagogical mastery. The quality and relevance of the training programmes should be reviewed to ensure that when trainees complete their training, they are competent in subject content, knowledge and teaching skills. This includes strategies for teaching specific mathematical and scientific concepts and principles to young people at different stages of development (DoE, 2001).

Currently there are talented and dedicated educators who are teaching Mathematics, Science and Technology in schools in South Africa. Some of these educators are either under-qualified or unqualified. In order to ensure

that every classroom has a competent and qualified educator, the strategy must first and foremost upgrade the knowledge, competence and skills of under-qualified educators already in the system.

One way of attracting learners to train as Mathematics and Science educators is to provide them with bursaries to enter higher education. A contractual agreement would be entered into between government and prospective trainees on matters such as where to teach after graduation and for how many years (Mettler, 2002). There are good Mathematics and Science educators who have either retired or have taken voluntary severance packages. A concerted effort should be made to persuade them to return to teaching and to be deployed in areas of need.

Professional organisations have played a critical role in supporting educators to improve learner achievement. The support and participation of mathematical, scientific and technical communities will continue to be crucial in the realisation of the country's objectives. In the past the private sector has demonstrated a willingness to support the improvement of learner participation and performance in Mathematics and Science. Private sector contributions have come in the form of bursaries and the supply of learning support materials (including equipment). This support must be encouraged and channelled towards targeted institutions that can demonstrate success such as Telkom, the Sowetan and Makwetla Associates who sponsor a programme of Mathematics and Science Teacher of the Year Award.

In addition, visible national and local activities such as 'Science Week' to engage and arouse public interest in Mathematics and Science should be put in place. Through this strategy, public, private and professional organisations would be brought together to develop a strong network of local partnerships aimed at improving learner attainment. The national Strategy for Mathematics,

Science and Technology Education revolves around three thrusts (DoE, 2001):-

- To raise participation and performance by historically disadvantaged learners in Senior Certificate Mathematics and Physical Science;
- To provide high-quality Mathematics, Science and Technology education for all learners taking the first General Education and Training Certificate and Further Education and Training Certificate; and
- To increase and enhance the human resource capacity to deliver quality Mathematics, Science and Technology education.

The policy of specialisation in Mathematics and Science is crucial to address the current low levels of achievement and output of especially historically disadvantaged learners in the system. Such policy is driven by the following reasons (DoE, 2001 and Callaghan, 2002):-

- Firstly, good Mathematics and Science teaching is expensive and the necessary resources (qualified and competent educators, well-resourced laboratories and libraries) are scarce;
- Secondly, an adequate supply of Grade 12 graduates with Mathematics and Science is needed to enter higher education. This could be better assured by focusing on Mathematics and Science learners with potential in dedicated schools, rather than through a dilution of effort across the whole schooling system;
- Thirdly, dedicated schools may have policies to increase the participation of disadvantaged learners in Science and Technology-based education; and
- Fourthly, these schools will promote innovative learning and teaching strategies for Mathematics and Science that are usually not found in mainstream schools.

The policy of dedicated schools is therefore the most cost effective way of deploying scarce resources in the teaching of Mathematics and Science subjects. In the context of competing priorities and limited resources, it is therefore better to at least in the short term provide sufficient and adequate learning and teaching facilities to fewer schools with the aim of going full scale over a longer period of time (DoE, 2001 and Callaghan, 2002).

This policy will respond better to a range of abilities and interests that learners display. It will allow those with the ability to study intensively and learner preference in Mathematics and Science to be catered for. In pursuit of this policy as argued by the DoE, (2001), the Council of Education Ministers (CEM) has approved the establishment of a hundred dedicated high schools for Mathematics and Science. These schools would be distributed pro rata across the nine provinces and would be clustered mainly in districts for easy co-ordination, connectivity and sharing.

The choice of dedicated schools entails (DoE, 2001and Callaghan, 2002): -

- Under resourced, well-performing schools (schools should have competent educators in both Mathematics and Science, display basic levels of functionality. The schools should be situated in presidential nodal areas, and already offer the said subjects in the higher grade); and
- Those with potential to improve participation and performance in mathematics and science (such schools should already offer Mathematics and Science at least at standard grade level, situated in presidential nodal areas, have the potential to improve both participation and performance in grade 12 Mathematics and Physical Science)

Such schools after being provided with equipment and facilities are expected to serve their communities by developing other schools, learners and or educators in their areas. These schools are given cross-curricular support and should be encouraged to excel in extramural activities. There is a well-established connection between learner achievement and the availability of quality learning support materials (LSMs). The strategy will support the Tirisano programme on LSM procurement, delivery and retrieval to ensure the following (DoE, 2001): -

- Availability of quality and relevant learning and teaching materials;
- The existence of a range of learning materials, from textbooks to internet-based sources and information; and
- The cost of learning materials at a level that ensures access by historically disadvantaged learners.

According to Barnard (1999:29), Item Respond Theory (IRT) is a statistical theory consisting of a mathematical model expressing the probability of a particular response to an item as a function of the ability of the testee and of certain characteristics of the item. The theory postulates two things, the performance of a testee can be predicted or explained by a set of factors (abilities), secondly, the relationship between the non-observable traits and the observable can be described in terms of a monotonic increasing function.

Barnard (1999), further states that this function, refers to as item response function, specifies that testees with higher scores regarding the traits have a higher expected probability of answering an item correctly than testees with lower scores in respect of the traits. The advantage of IRT is in its claim to offer person-free measures of item characteristics and item-free measures of person abilities.

2.5 RESEARCH FINDINGS FROM DIFFERENT COUNTRIES

In this section, examples from different countries are cited to see how they deal with the problem of inadequate Mathematics and Science education. The countries considered are USA, Asia and South Africa. Mathematics and Science are the key subjects to empower individual towards profitable involvement in the economy of the country.

According to Gray (1997:15), a comparison study TIMSS was carried out in different countries, with the aim of getting an in-depth understanding of the effects of policies and practices within and across systems of education. There was further assessment of national curricula, schools and social environment, achievement in Mathematics and Science so as to inform governments, policy-makers and educators about Mathematics and Science proficiency of their learners.

2.5.1 The United States of America

Science and Mathematics Advancement and Resources for Teachers (SMART) is a program implemented by the Los Angeles local government through which the Los Angeles Educational Partnership (LAEP) convened a coalition with the purpose of developing a workable solution to the problems of inadequate mathematics and science education as well as technological illiteracy (Smart Objectives, 2002)

The Coalition subsequently formed a working group of scientists, engineers, principals, school administrators, union representatives, and technical experts from higher education and industry to design a strategic approach to the problems.

After two years of study and research, the coalition defined five strategic goals to improve learner performance in Mathematics and Science (Smart Objectives, 2002):-

- To motivate learners to excel in Mathematics and Science;
- Recruit, develop and maintain effective Mathematics and Science educators;
- Implement effective and relevant Mathematics and Science curricula;
- Build awareness and provide public support for Mathematics and Science education in Los Angeles; and
- Create effective methods of assessment, and hold all constituencies accountable.

To achieve these goals by the year 2005, the Coalition issued in 1992 the Los Angeles science and Mathematics Advancement and Resources for Teachers (SMART) Action Plan, which established an integrated program of ten action steps to jump-start the work needed to make a difference in Mathematics and Science education in local public schools.

The coalition advocates the use of performance-based indicators to measure learner improvement and performance, as it believes these types of indicators most accurately measure and promote the critical-thinking and analytical skills that learners need to keep pace in today's society. However, appropriate performance-based indicators are still being developed in collaboration with the New American Schools Development Corp, (NASDC) and the University of California, Los Angeles (UCLA's) evaluation unit (Smart Objectives, 2002).

Yielding learner performance and encouraging completion of advancement Mathematics and Science courses is taken into consideration as outlined by the following (Smart Objectives, 2002):-

- By the 2005, double the number of Los Angeles County high school learners completing Algebra 2;
- By the year 2005, double the number of Los Angeles County high school learners completing a Chemistry course;
- By the year 2005, increase by 50% the proportion of Los Angeles County high school learners completing Calculus;
- By the year 2005, increase by 50% the proportion of Los Angeles County high schools learners completing a physics course.;
- INDICATOR: Using 1991 as the baseline year, increase the number of underrepresented learners completing advanced mathematics and science courses; and
- By the year 2005, increase the number of African-American, Latino, Native American, and other under-represented learners completing advanced mathematics and science courses such that the proportion of each under-represented group competing advanced mathematics and science coursework is equivalent to the proportion of all learners completing such coursework.

Although the coalition was meant to supplement these more traditional indicators with appropriate performance-based measures in the next three years (2003, 2004 and 2005), progress would continue to be measured against these indicators through the year 2005 to provide some long-term continuity. Baseline data would be collected on each school as it begins participation in the Coalition's effort, data on each school would then be collected and assessed on an annual basis thereafter. However, it must be emphasised that changes in learner performance cannot be expected 'overnight' and significant improvements, as measured by the traditional indicators, are not anticipated for several years (Smart Objectives, 2002).

Since measurable changes in learner performance would not be evident in the short-term, the Coalition also proposes to establish secondary indicators of success in the areas of educator empowerment, parent and community involvement, and corporate involvement. These secondary indicators will help the Coalition assess success in implementing the action plan and engaging the various constituencies in reforming maths and science education in Los Angeles over the next few years. The Coalition proposes to establish these secondary indicators for success in future (Smart Objectives, 2002).

It is essential to take into consideration that to improve learner performance motivation is vital. The best way to motivate learners is to provide them with adequately trained, qualified and effective educators, empowered with the resources and training to teach Mathematics and Science to a diverse learner population. According to Norman et al. (2002), the University of Texas at Brownsville and the Brownsville District Collaborative Partnership for Science and Mathematics agreed upon mutual goals, activities and responsibilities. This partnership was officially established in 1993 and is a fundamental component of the missions of both the university and the school district.
The goals for this partnership that emphasise science education include the following (Norman et al, 2002):-

- To support training and research that promotes the teaching of Science and Mathematics in elementary grades;
- To provide educators with the knowledge and resources that integrate Mathematics, Science language and other elementary disciplines so that learners are provided experiences that promote scientific literacy;
- To develop a positive attitude in educators toward Science and Mathematics which can be, in turn reflected in learner enrolment in quantitative Mathematics and Science courses;

- To reach the underlying problems facing the teaching of Science and Mathematics at every level of elementary education;
- To increase the academic performance of learners enrolled in middle school Science and Mathematics coursework with respect to classroom and state performance measures; and
- To provide knowledge and resource activities during intercessions to ensure that learners having difficulty or needing enrichment can successfully complete middle school Science and Mathematics coursework.

A sampling of cooperative activities that emphasise Science and Science teaching are outlined below (Norman et al, 2002):-

- Science and Mathematics coursework and field experiences;
- Research investigations for middle and high school learners; and
- High school coordinated thematic science coursework and field experiences.

According to Haney (2002:783) the National Science Education Standards (USA, NRC 1996) outlines goals for professional development of both practising and prospective science educators. These goals suggest that the preparation of science educators should include frequent inquiry based and constructivist experiences that allow learners to gain both content knowledge and pedagogical skills. These experiences should enhance science educator abilities to provide similar experience in their own classroom. Prospective educators often lack sufficient professional classroom experience to 'play out ' their developing belief about constructivist teaching.

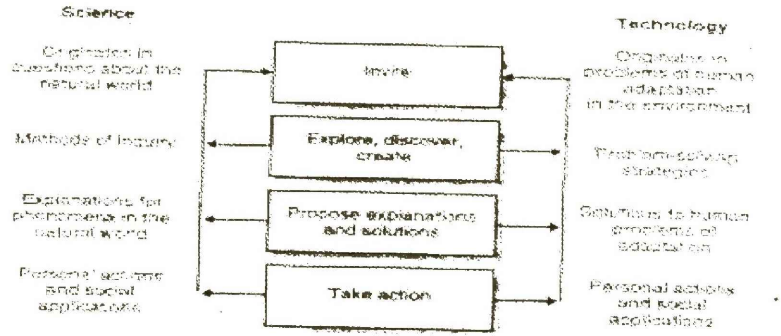
A social-constructivist classroom is one in which learners are viewed as partners in the learning process. According to the author, learning is a filter by

which each learner creates personal meaning through peer negotiation of sensory experiences that are provided. An educator's role in these types of classroom changes from someone who typically provides information on certain topic to someone who orchestrates the environment and provides opportunities for learners to create meaning through active and relevant experiences (Haney, 2002:784).

In constructivist classroom, Haney (2002 : 785),further argues that learners' questions and inputs are highly valued and encouraged as opposed to a more traditional classroom where the existing curriculum (often science textbooks) dictates learners learning. In addition, learners of constructivist classrooms are viewed as thinkers, with emerging theories about the world and they primarily work in groups. Their assessment is interwoven with teaching and occurs through educator observation of learners at work and through learners' exhibition and portfolios.

However traditional learners primarily work alone and are viewed as 'blank slates' onto which information is sketched by educators. Their assessment is viewed as separate from teaching and occurs almost entirely through testing. Traditional educators behave in a didactic manner, disseminating information to learners and seeking correct answers to validate learners' learning. Constructivist educators behave in an interactive manner, mediating the environment for learners, seeking learners' points of view in order to understand their present conception for use in subsequent lessons (Haney, 2002).

Figure 2.1 illustrates a constructivist-oriented instructional model to guide learning.



Source : Carin, (1997:74).

The goals and testing policies of science education must reflect the socially and culturally mediated dynamic and non-objective nature of what and how learners come to know. Adequate communication is critically needed to harmonise educators' beliefs and existing curriculum.

Importantly it will be extremely difficult and unlikely for educators to align these seemingly opposing beliefs unless testing policies reflected both what learners need to know as well as how they come to know it. Only then will constructivist practices in the classroom be prevalent (Carin, 1997:74).

According to Hoff (2002), since the first result from the 1996 TIMSS were released, American educators have started to purchase Singaporean mathematics programmes for both public and privates schools. Singapore performed excellently in Mathematics in the 1996 TIMSS. Again American schools excel at hands-on science activities in which learners see scientific principles at work especially in the early grades.

2.5.2 Asia

Compared to the nation as a whole, the performance of Hawaii's public school system is by no means seriously inadequate. While Hawaii learner performance may be about average by national standards, by international performance standards, both Hawaii and the U.S. learners fall well down on the list. This is a message from the recent Third International Mathematics and Science (TIMSS) testing conducted (Woessmann, 2002).

2.5.3 South Africa

South Africa was rated last in TIMSS. The grade 12 (matric) learners performed worst among 22 countries. Learners were tested for their general mathematical and scientific knowledge and in particular, for their reasoning and problem-solving skills (Human Sciences Research council, 2002).

Highlights of the results for South African Grade 12 learners include the following (Woessmann, 2002, Gray 1997:15):-

- Their overall score were significantly lower than those of learners in other countries, suggesting that South African learners have a low level of general mathematical and scientific understanding and skills;
- They did not perform well in any area of the Science and Mathematics literacy test. In many of the individual test items, South Africa performed the worst;
- South African learners appeared to have difficulty with problems that involved graphic interpretation. It would appear that South African learners generally had difficulty in constructing their own answers as

they performed very poorly in items that required responses to be creatively generated;

- The vast majority of South African learners wrote the Mathematics and Science literacy test in a language that was not their mother tongue. It is possible that the language factor had a negative impact on achievement;
- Learners with Afrikaans and English as a home language performed significantly better than those learners with other languages. The underachievement in Mathematics and Science is common among black learners. (TIMSS test was conducted in English and Afrikaans);
- South Africa was the only country with no significant difference between the performance of boys and girls in either Mathematics or Science. In numerous other countries, boys performed better than girls; and
- South African learners performed marginally better in Mathematics than in Science.

The TIMSS is the largest and most ambitious study of Mathematics and Science ever undertaken. The aim of the study is to assess the national curricula, school and social environment, and the achievement in Mathematics and Science in participating countries across the world. The TIMSS tests were designed to measure Mathematics and Science achievement so as to help inform governments, policy makers and educators about the proficiency of their learners at key points in the education process. The majority of South African learners wrote Mathematics and Science literacy test in a second or third language.

The TIMSS report reflected that the highest educational level attained by either parent was primary school and the parents of more than half of the

respondents had a secondary school qualification at most (Woessmann, 2002).

Science educators are confronted with three problems as realised from a study conducted on Northern Sotho-speaking (Sepedi) Grade 12 pupils in South Africa. The problems include (Cherian, 2002:23):-

- Renewal of current science curriculum on order to meet needs of modern society as expressed in the scientific literacy movement;
- Decline of learners' interest in science and corresponding swing away from science as soon as learners have a choice as revealed by international reviews; and
- Disappointing low academic achievement of learners.

School environment has an impact on performance of learners in Mathematics and Science, these encapsulate the social climate of learning that exists in schools, interaction among learners, educators, peers and the curriculum.

2.6 SUMMARY

This chapter examined issues and challenges pertaining to performance of Grade 12 learners in Mathematics and Science. From literature review, factors influencing the process of improving performance, models and guidelines are cited.

Particular attention in developed countries was paid to performance in countries participating in Third International Mathematics and Science Study (TIMSS). The countries include among others, United States of America, Asia and South Africa.

Research reviewed in this chapter indicates that to improve performance, involvement of all stakeholders is essential. Major findings are :-

- Learners are continuously assessed.
- Even though some means are made to empower and encourage science educators, like implementation of Science and Mathematics educator of the year award some science educators remain unemployed.
- Stakeholders, including government and NGO's need to realise the importance and significance of scientific knowledge and well-empowered science educators.
- Introducing new techniques of teaching and assessing Science and Mathematics subjects, like tactile strategy (hands-on and minds-on) or constructivist programmes will make teaching and learning active and enjoyable to all stakeholders.

- New materials and prior knowledge are related however, it should be noted that the process of improving learner performance takes time and should not be rushed. The following chapter will focus on the research design of the study.

CHAPTER 3 RESEARCH DESIGN

3.1 INTRODUCTION

This chapter outlines a description of the empirical research, which was undertaken to investigate the performance of grade 12 learners in Mathematics and Science. An exposition of the rationale behind improving results, the standard of teaching and the method thereof were investigated. Some steps were followed in the design of data collecting instrument as an attempt to validate the research study.

3.2 RESEARCH TOOL

3.2.1 Questionnaire

According to Molale, (1999:81) research tools are the means by which different approaches to research are operationalised. In this investigation, the hand-delivered questionnaire was employed as a means of data collection. The essence of a questionnaire is that it is in the hands of the respondent, and is completed by him or her, usually not under the supervision of the researcher.

3.2.1.1 Advantages of using the questionnaires

In comparison with the use of an interview procedure, the questionnaire has the following advantages (Babbie, 1983):-

- Distribution of questionnaires is cost-effective in terms of time, money and travelling;
- A broader sample of people can be reached, in a way ensuring an extensive spectrum of views, thus maximising generalisation of the study;

- Standardised instructions are given to all respondents and the appearance and mode of conduct of the investigator do not influence the result;
- Confidentiality of information given can be maintained since in the questionnaire, the identity of the respondent is anonymous.

3.2.1.2 Disadvantages of the questionnaire

Since questionnaires are commonly used in research currently, some respondents could have a negative attitude towards them, thus contributing to a high rate of non-response.

The following disadvantages of using a questionnaire have been identified as (Legotlo,1996 : 30) :-

- Respondents may not respond to important points or emphasised aspects which are of importance to the investigator;
- The danger of misinterpretation of questionnaire exist as it is very difficult to formulate questions which convey almost the same meaning to all respondents.

According to Borg and Gall, (1989:430), researchers have identified a number of factors and several aspects of design and layout in securing a good response rate to questionnaires. The factors include:-

- Contents of the questionnaire should be arranged in a way that it will maximise co-operation from the respondents;
- The language must be accessible and clear, bearing in mind that what may be clear to a researcher may be jargon to another person;

- The way the questionnaire appears is visually important, it has to look easy to answer.

3.2.2 Questionnaire construction

3.2.2.1 Development of Questionnaire items

According to Molale, (1999:83), an ideal questionnaire possesses the same properties as a good law. It is clear, unambiguous and uniformly workable. Legotlo (1996), also states that the questionnaire as a measuring instrument used to collect data has the greatest influence on the reliability of the collected data. It is of significance that care must be taken when designing a questionnaire because questionnaires that are not properly constructed can lead to respondents missing questions and confusing them. The implication here therefore, is that design must minimise potential errors from respondents. A well-designed questionnaire boosts the reliability and validity of the data to an acceptable level of tolerance (Borg and Gall,1989).

Borg and Gall (1989:430-431), outline some basic rules for constructing a questionnaire as follows:-

- Biased questionnaires are to be avoided;
- Questionnaires must be brief;
- Negative items should be avoided;
- Clarity is important, that is, items should mean the same to all respondents.

Moroane (2000), further identifies some important steps in constructing a questionnaire:-

- Deciding what the problem really is and what information is required to provide answers;
- Writing a first draft of the questionnaire;
- Piloting the draft questionnaire with a sample of respondents;
- Revising the questionnaire on the basis of criticism;
- Administering the questionnaire;
- Analysing and interpreting the returned questionnaire and ;
- Writing the final report of the inquiry.

Moroane, (2000), cites pitfalls that need to be considered in the construction of a questionnaire. These are:-

- Questions ought to be clearly worded and in simple language;
- Ensure that questions are important and that the respondents possess the knowledge to give answers;
- Ensure that the items follow a natural logic order.

3.2.2.2 Format and content of the questionnaire

The questionnaire used in this study consisted of three sections, namely Section A (Questions 1-9); Section B (Questions 10-13) and Section C (Question 14). The purpose of the questions in Section A was to gather biographical and demographic information about each respondent. The information was essential in understanding the background of the respondents.

The objective of the questions in Section B, was to assess Grade 12 learners performance as perceived by educators, using 20 items. For each item the respondents were asked to reflect, on a four point scale, their opinion about

performance of Grade 12 learners in Mathematics and Science (1 = strongly disagree ; 2 = disagree ; 3 = agree ; 4 = strongly agree).

Analysing the performance of Grade 12 learners in Mathematics and Science was undertaken to evaluate educators' perception of success in the areas of :-

- Support for educators;
- Educator involvement;
- Conditions for teaching; and
- Educator perception.

The objective of the question asked in Section C was to determine the effectiveness of projects initiated by the Department in various schools. A space was provided for respondents to identify and comment about the effectiveness of projects implemented in their respective schools.

3.2.2.3 Pre-testing of the Questionnaire

Even though much care is taken into consideration when designing a data collection instrument (the questionnaire in this particular case), there is always a possibility of error. It is therefore, imperative to avoid making mistakes, such as an ambiguous question, or one that respondents cannot answer, and consequently there is a need to pre-test the questionnaire in full and or in part (Babbie, 1983:159).

According to Teu, (2002:54), a pilot study is a small-scale preliminary investigation designed to acquaint the researcher with the flaws and problems that need attention before the major study. It offers the researcher an opportunity to pre-test the instrument. The primary purpose of a pilot-study is

to detect the problems that must be solved before the major study is conducted.

With the view to determining any flaws, problems and ambiguity, the questionnaire was pre-tested using a sample of six Mathematics and Science educators. Respondents were asked to complete the questionnaire and to indicate items or points that might need to be considered to improve the instrument (Teu, 2002:54).

The pre-test results were checked and the suggestions made by respondents were taken into consideration to improve the questionnaire.

3.2.3 Final Questionnaire

The final questionnaire was administered to 150 Mathematics and Science educators in various schools in the Mafikeng district.

3.2.4 Covering Letter

The covering letter is a tool employed to introduce the questionnaire to the respondents. This letter should be carefully and thoughtfully structured and it should also address the concerns of the receiver of the letter. Cohen and Manion, (1985: 110) suggest that the letter should indicate the aim of survey in order to convey its importance to the respondents, assure them of the confidentiality of their responses and encourage their participation.

3.3 ADMINISTRATIVE PROCEDURES

Permission for access to schools was first secured from the Mafikeng district manager. A list of all high schools in the district was obtained from the district office.

From the information provided about the location of schools the researcher then delivered the questionnaires to the schools. Access to individual schools was readily achieved.

3.4 POPULATION SAMPLING

A list of all high schools in the Mafikeng district (31 high schools and 200 Mathematics and Science educators) was obtained from the district office of the Department of Education. With consideration of the characteristics of the study being undertaken, a purposive sampling was used. This entailed, distributing a total of 150 questionnaires to Mathematics and Science educators, at a rate of at least five questionnaires per school.

This sampling method is based on the judgement of a researcher regarding the characteristics of a representative sample. As an example of non-probability sampling, the strategy is to select units that are judged to be typical of the population under investigation.

In this particular case, the population selected were Mathematics and Science educators in all (31) high schools including four senior secondary schools in the Mafikeng district. The advantage of this method is that in this particular study, perception, involvement and support of Mathematics and Science educators was the imperative information required.

3.5 STATISTICAL TECHNIQUES

Computer-aided statistical analysis was employed to compute the descriptive data for each respondent in the study. The SPSS programme included the following tools of analysis; frequency distribution, percentages, mean and standard deviation.

3.6 SUMMARY

In summary, the questionnaire was used as a main tool for collection of data for this study. Assistance to analyse data was received from UNIWEST statistics department, a statistical tool SPSS 9for performing frequency, percentage and graphical representation, mean and standard deviation) was used carefully to determine the results of the study. Descriptive statistics was employed to verify issues and challenges encountered by Mathematics and Science educators in improving learners' performance.

The following chapter reflects analysis and interpretation of data collected, using statistical tool SPSS.

CHAPTER 4: DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

This chapter outlines the results of the empirical investigation conducted to determine the inadequate performance of grade 12 learners in Mathematics and Science in the Mafikeng district of the North West province and educators' views on how to improve learner performance. The quantitative and qualitative data that was collected through the inquiry are summarised, analysed and discussed.

4.2 REVIEW OF THE RESPONDENTS

Of the total subjects 150, 89 respondents returned the questionnaire.

4.3 BIOGRAPHICAL DATA

The biographical data and background information reflected in Table 4.1 was drawn up to gain a picture and profile of the respondents. This information was elicited from the participants to have insight into the location of the schools, the age of educators, their qualifications and the number of learners doing Mathematics and Science.

4.3.1 Educators' Age

Most respondents were found to be of the age group 31 – 39 and these were 55 (72.4%), for age group of 34 and below these were 15 (19.7%), for age group 50 and above these were 6 (7.9%) as reflected in Table 4.1. This shows that the majority of the respondents were not close to retiring age.

Table 4.1 Biographical data of the respondents

Variable	Categories	frequency	%
Age of the educator	30 and under	22	24.7
	31 – 39	43	48.3
	40 – 49	19	21.3
	50 and over	4	4.5
	No Response	1	1.1
	TOTAL	89	100.0
Gender	Male	42	47.2
	Female	47	52.8
	TOTAL	89	100.0
Highest Qualifications	Matriculation and Diploma	41	46.1
	Bachelors	31	34.8
	Honours	12	13.5
	Masters	4	4.5
	Other	1	1.1
	TOTAL	89	100.0
Subject(s)	Mathematics	39	43.8
	Science	25	28.1
	Mathematics and Science	21	23.6
	No Response	4	4.5
	TOTAL	89	100.0
Learners Doing Maths	Less than 50	13	14.6
	50 – 100	15	16.9
	101 – 200	22	24.7
	201 and more	29	32.6
	No Response	10	11.2
	TOTAL	89	100.0
Learners doing Science	Less than 50	16	18.0
	51 – 100	19	21.3
	101 – 200	20	22.5
	201 and more	19	21.3
	No Response	15	16.9
	TOTAL	89	100.0
Location of the School	Urban	39	43.8
	Rural	50	56.2
	TOTAL	89	100.0

This also suggests that due to changes in the education system and management, most old Mathematics and Science educators took voluntary severance packages which was made available through redeployment and severance package policies of the National Department of Education.

4.3.2 Gender

The data presented in Table 4.1 show that 42 (47.2%) respondents were male and 47 (52.8%) were female educators offering Mathematics and Science. This seems to suggest that Mathematics and Science subjects which used to be dominated by male, educators has had a dramatic shift as more females are now entering these fields, the pattern is gradually changing male dominance.

The data demonstrate a positive scenario in the application of gender equity in the Mathematics and Science fields, as outlined by affirmative action and gender equity policy of 1996 Republic of South Africa (Act 28 of 1996). The implementation of the correct policies will ensure representation of women in the field of Science and Technology. The recognition of the above fact will be imperative in the promotion of the Bill of Human rights as articulated in the Constitution of the Republic of South Africa (Act 108 of 1996: 6).

The fact that female respondents outnumbered male participants in this study, suggests that the current debates about women under-representation in many spheres of life is receiving attention. However the problem is still prevalent as few female learners had taken Mathematics and Science and their performance is still below compared to the male learners, according to this study.

4.3.3 Educator Qualifications

Participants were asked to state their academic qualifications. Table 4.1.revealed that 41(46%) of respondents had matric and diploma as the highest qualification. Most respondents, 31(35%) held a university degree as the highest academic qualification, while 17(19%) held a post graduate degree. The highest academic qualification of the respondents has a bearing on performance of learners in Mathematics and Science. Science educators possess low academic training which is totally inadequate for acquisition and cultivation of further scientific literacy and attitude, as informed by this study.

There is a relationship between educator qualification and educator competency which relates to the quality of education in initial and continuing educator education. A shortage of Mathematics and Science educators remains a problem, because educators tend to follow less demanding, not scientifically accurate subjects with the aim of avoiding Mathematics and Science. However, the department has initiated several projects to increase educator interest in maths and science, such as the Sediba project which empowers educators in Mathematics and Science, both subject matter and teaching strategies.

4.3.4 Subjects presently taught

Most respondents 39(46%), indicated that they were teaching Mathematics only, while 25(29%) indicated that they were teaching Science only and only 21(25%) showed that they were teaching both Mathematics and Science. Lack of Science educators is still prevalent, as there are more Mathematics educators than Science educators. Some schools offer Mathematics as one of the compulsory subjects as a result Mathematics outnumbered Science in the number of both learners and educators. Some of the educators had majored

in both subjects thus there are educators teaching both Mathematics and Science, as reflected from the study.

This implies that there is a need for Science educators who are competent so as to attract and encourage more learners to take Science as one of their subjects or even make Science compulsory.

4.3.5 and 4.3.6 Number of learner taking Mathematics and Science as subjects in their learning area

Most respondents indicated that they had most learners, 51(65%) above 100 taking Mathematics as one of the subjects studied, while 28 (36%) were learners below 100. The implication is that most learners take Mathematics. On the other hand, 39 (52%) above 100 take Science as one of the subjects studied while indication of learners below 100 is shown as 35(48%). The significance of such findings is that there are more learners taking Mathematics as compared to learners taking Science. This implies that the number of learners taking Science should be taken into consideration. Ways of encouraging learners to take Science should be looked at and be given a serious consideration by schools.

A joint effort of the government and non-government organisations (NGO) to encourage and attract learners to study Mathematics and Science should be seriously considered. This could be done by offering learners bursaries to continue their studies in science and technological related fields. Mathematics is a subject for all learners and should be taught by linking it to practical examples instead of expecting learners to memorise theories and formulae that do not make sense in their lives.

4.3.7 Location of the school

In the North West Province, both rural and urban schools offer Mathematics and Science. Most respondents 50 (56%), indicated that they were teaching in rural schools and 39 (44%) were teaching in urban schools. Rural schools find it difficult to recruit and hold educators in the subjects such as Mathematics and Science because these educators are sought after by urban schools with the obvious advantages of urban life.

4.3.8 Highest Qualifications on the subject

The data presented in Table 4.2 indicate the highest qualifications obtained by educators with regard to the subject presently teaching. A qualified and competent educator is a necessity to improve learners' performance and expose their scientific innovative ideas or skills.

Table 4.2. Highest qualifications on the subject presently teaching

LEVEL	MATHS	%	CHEM	%	PHYSICS	%
1	13	20.6	2	4.8	4	13.8
2	4	6.3	6	14.3	12	41.4
3	32	50.8	15	35.7	9	31.0
4	14	22.2	18	42.9	2	6.9
5			1	2.4	2	6.9
6						
7						
Totals	**63**	**100.0**	**42**	**100.0**	**29**	100.0

Most respondents (63%) possessed Mathematics qualification of at least up to fourth year level, while 42% have Chemistry up to fourth year level and only 29% have Physics up to fourth year level. Within all these findings, however the majority were found to be in possession of the subjects at third year level

which is equivalent to diploma. As discussed above, most educators possessed matriculation and diploma.

4.3.9 Grade presently teaching

Table 4.3 indicates different grades presently taught by the respondents. Since the study was carried out at high schools, the majority of the participants were teaching grades 10, 11 and 12. Only 16 (14%) respondents taught grades 7, 8 and 9 because of the 31 high schools in Mafikeng, four are secondary schools.

Table 4.3 Indication of grades presently teaching

GRADE	Number	%
Grade 12	7	6.0
Grade 11	9	7.8
Grade 10	23	19.8
Grade 12 & 11	36	31.0
Grade 12 & 10	16	13.8
Grade 11 & 10	9	7.8
Grade 9	7	6.0
Grade 8	7	6.0
Grade 7	2	1.7
Totals	**116**	**100.0**

Table 4.3 reflects that most participants 107(87%) teach Mathematics and Science from grade 10 to grade 12. Most of respondents taught more than one grade as illustrated in the Table that 36 (31%) taught Mathematics and Science in grades 11 and 12. The implication of this is that most educators have studied both subjects at tertiary institutions.

4.4 DESCRIPTIVE ANALYSIS

Section B of the questionnaire was intended to reveal whether Mathematics and Science educators agree with literature on the issues that were found to be important in improving performance of learners in those subjects. The respondents were asked to reveal to what extent they agree or disagree with literature on issues important in improving performance of grade 12 learners in Mathematics and Science. The four skills used were:-

- ***Kind of support needed by educators;***
- ***Educator involvement in the teaching process;***
- ***Conditions for teaching; and***
- ***Educators' perception on how educational change would affect Mathematics and Science learners' performance.***

These skills were given in a four-point scale, which gave the respondents a direction: -

4 – Strongly agree,
3 – Agree,
2 – Disagree and
1 – Strongly disagree.

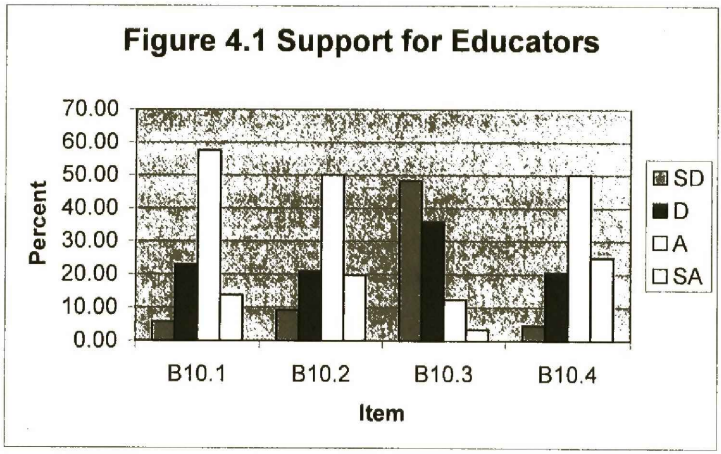
4.4.1 Kind of support needed by educators

Table (4.4) reflects the kind of support needed by Mathematics and Science educators is reflected. The frequency for each item is of outmost importance because the degree of how the educators agree or disagree with what literature stated with respect to the items on this section would be determined.

Table 4.4 Kind of support needed by educators

ITEM	NR		SD		D		A		SA		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
10.1 The Department supports educators empowerment, by upgrading educators	2	2.2%	5	5.6%	20	22.5%	50	56.2%	12	13%	89	100.0%
10.2 The principal motivates educators to improve teaching maths and science	3	3.4%	8	9.0%	18	20.2%	43	48.3%	17	19%	89	100.0%
10.3 Parents are involved in their children's learning, thus making educators work easier and meaningful	-	-	43	48.3%	32	36.0%	11	12.4%	3	3.4%	89	100.0%
10.4 Educators attend workshops regularly	1	1.1%	4	4.5%	18	20.2%	44	49.4%	22	25%	89	100.0%

NR = No Response, SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree



Item 10.1 The Department supports educators empowerment, by upgrading educators

Most of the respondents on this item 62 (71%), strongly agreed and agreed that the department supports educator empowerment. Only 25 (29%) respondents disagree to the statement of departmental support to educators. Based on the results, it suggests that all projects initiated by the department to upgrade educators like the Sediba project and workshops are to a certain extent effective as reflected by the response of educators.

Item 10.2 The principal motivate educators to improve teaching and performance of maths and science.

Many respondents about 60 (70%) agreed and strongly agreed that principals motivated educators to improve teaching and performance in Mathematics and Science. Only 26 (30%) did not agree with the statement.

A possible explanation for the high percentage of agreement could be ascribed to the fact that principals are aware of the need for science and technology skills. Principals are often regarded as the departments' mouthpiece as they implement and monitor government initiated projects.

Item 10.3 Parents are involved in their children's learning, thus making educators work easier and meaningful.

Only 14 (16%) of the respondents agreed that parents were involved in their children's learning while over half of the respondents, about 75 (84%) did not agree with the statement. The implication of this is that parental involvement is essential and contemplates a positive contribution to learner performance (cf 2.3.5 and 2.5.1).

To resolve this non-participation of parents on their children's' education, the government has initiated several projects to familiarise Mathematics, Science and Technology to communities. Through extra curricular activities, such as Science and Technology awareness week, Science fairs and Mathematics Olympiads, schools attempt to enhance awareness in communities. Schools arrange parents meetings with the help of school governing bodies (SGBs), to create a joint effort in monitoring and helping learners to learn.

Item 10.4 Educators attend workshops regularly.

The majority of respondents, 66 (75%) agreed to the statement that workshops were regularly attended. Only 22 (25%) did not agree with the statement which could possibly mean that the department's effort to empower educators is effective. The processes of empowering educators also include workshops which are usually conducted by subjects specialists.

Workshops entail demonstration of use of more advanced equipment, how to conduct experiments (using micro-science kits supplied by Somerset) improvise and allow active participation by learners during the exercise. Scientific knowledge is constantly changing and expanding while concepts and skills are more enduring. Therefore educators require frequent periodic updating of scientific knowledge and opportunities to learn about new methods of teaching Mathematics and Science.

4.4.2 Educator involvement

In this item of the study, the respondents revealed their involvement in the planning and teaching processes. Table 4.5 indicates the response of educators regarding their involvement and willingness in the process of teaching and learning.

Item 11.1 Teaching technique / skills predict effective learning.

Most respondents, 74 (89%), agreed that teaching techniques and skills predict effective learning. Only 9 (10%) did not agree with the statement. A possible explanation for this finding could be ascribed to the fact that both educators and learners should be equipped with knowledge and skills that will help them to compete in a global economy and allow them to lead lives of satisfaction and integrity, both as individuals and as citizens (cf 2.2.1).

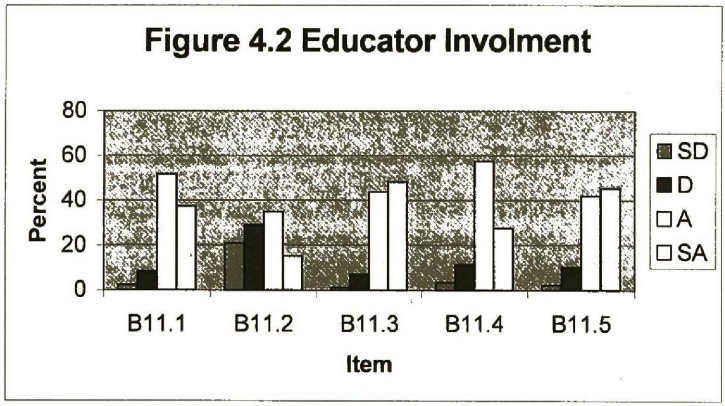
There is a need to develop useful skills and attitudes that will prepare learners for various situations in life and to enhance understanding that the technological applications of sciences should be used responsibly towards social, human and economic development in the country and globally (cf 2.2.2.1).

Table 4.5. Educator involvement in teaching process

Table 4.5 Educator involvement

ITEM	NR		SD		D		A		SA		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
11.1 Teaching technique / skills predict effective learning	6	6.7%	2	2.2%	7	7.9%	43	48.3%	31	34.8%	89	100.0%
11.2 Educators are involved in curriculum planning	3	3.4%	18	20.2%	25	28.1%	30	33.7%	13	14.6%	89	100.0%
11.3 Willingness to go an extra mile to improve learners' performance	2	2.2%	1	1.1%	6	6.7%	38	42.7%	42	47.2%	89	100.0%
11.4 CASS is useful to improve maths and science	2	2.2%	3	3.4%	10	11.2%	50	56.2%	24	27.0%	89	100.0%
11.5 It is important to reduce educator dominance thus changing learners' passiveness	1	1.1%	2	2.2%	9	10.1%	37	41.6%	40	44.9%	89	100.0%

NR = No Response, SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree



Item 11.2 Educators are involved in curriculum planning.

About half of respondents, 43 (50%) agreed and strongly agreed to the statement that educators were involved in curriculum whereas 43 (50%) did not agree with the statement. This then implies that prior to transition, educators were not involved in curriculum planning however, transition has taken place from separate education to unified system of education where educational opportunities were broadened in the spirit of democracy. There is a shift from an input-based and summative assessment model to an outcome-based, criterion-referenced and formative assessment model (cf. 2.3.4).

Educators' associations play an important role in improving the working environment for educators through acting as a representative of educators view to curriculum developers, teaching facilities and materials. Policy makers, curriculum developers, learner representative are also included in the parties participating in curriculum planning.

Item 11.3 Willingness to go an extra mile to improve learners' performance.

Majority of respondents,80 (92%), agreed and strongly agreed that they were willing to go an extra mile and only 7 (8)% did not agree with the statement. Due to motivation and support from the department and principal, educators are willing to go an extra mile to improve performance of learners. Some schools in the Mafikeng district have adopted the strategy of offering extra lessons on Saturdays, and re-opening schools prior to the said date (NWDE,2002).

Item 11.4 CASS is useful to improve maths and science.

Most respondents, 74 (85%) agreed and strongly agreed that CASS is useful to improve learner performance in Mathematics and Science. Only 13 (14%) did not agree with the statement. CASS involves assessment activities that are spread throughout the year, using various kinds of assessment methods such as tests, examinations, projects and assignments. These include oral, written and performance methods (cf. 2.3.1). Since the strategy is flexible and probe for learners' understanding, reasoning, knowledge application and skills that are developed through inquiry, learners are able to fit into the world filled with the products of scientific literacy (cf. 2.1.)

Item 11.5 It is important to reduce educator dominance thus changing learners' passiveness.

Most respondents 77 (87%), agreed and strongly agreed that it was important to reduce educator dominance thus changing learners' passiveness. Only 11 (12%) did not agree with the statement. The educational change that includes new assessment, teaching and learning methods takes place in a variety of

ways. One of the best way is through an active approach that involves learners in observing, predicting, investigating and explaining the world in ways that parallel the methods of scientists. The constructivists' strategy entails a hands-on, minds-on approach. The system brings coordination and coherence to the improvement of science education. (cf. 2.5.2.)

Learners must be provided with an environment in which they are able to construct knowledge for themselves and take charge of their own learning experience. Again, to facilitate learner-centered and resource-based learning practices, thinking skills must become an explicit component of the curriculum.

4.4.3 Conditions for teaching

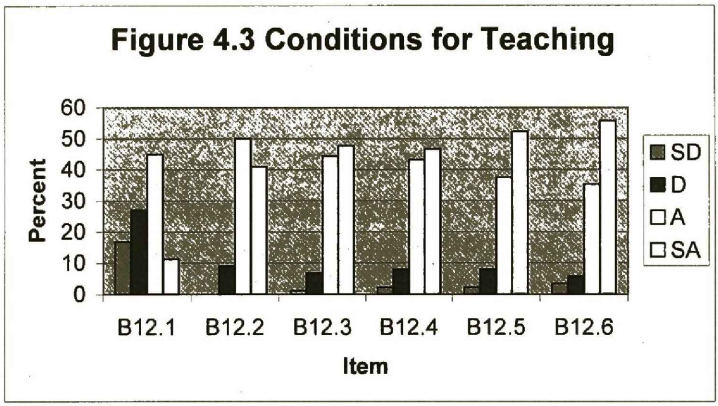
This item determines effective conditions for teaching and learning process. The main aim was to find out from the educator's whether the conditions for teaching Mathematics and Science were conducive and the resources which make teaching effective were sufficient. Table 4.6 reflects participants' view with regard to the conditions of teaching and how the situation affected learners' performance.

Table 4.6 Conditions for teaching

Table 4.6 Conditions for Teaching

ITEM	NR		SD		D		A		SA		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
12.1 The prevailing environment is conducive to improve teaching and learning process	-	-	15	16.9%	24	27.0%	40	44.9%	10	11.2%	89	100.0%
12.2 Availability of learning support materials improves performance of learners	1	1.1%	-	-	8	9.0%	44	49.4%	36	40.4%	89	100.0%
12.3 Availability of learning support materials motivates educators to actively participate in the process	1	1.1%	1	1.1%	6	6.7%	39	43.8%	42	47.2%	89	100.0%
12.4 Availability of learning support materials motivate learners to actively participate in the process	1	1.1%	2	2.2%	7	7.9%	38	42.7%	41	46.1%	89	100.0%
12.5 Availability of maths and science equipments improve performance of learners	1	1.1%	2	2.2%	7	7.9%	33	37.1%	46	51.7%	89	100.0%
12.6 Availability of maths and science equipments motivates both educators and learners to actively participate in the process	1	1.1%	3	3.4%	5	5.6%	31	34.8%	49	55.1%	89	100.0%

NR = No Response, SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree



Item 12.1. The prevailing environment is conducive to improve teaching and learning

About 50 (56%) of the respondents agreed and strongly agreed that teaching and learning environment were conducive to improve performance. While 39 (44%) of respondents did not agree with the statement. A possible explanation to this finding could be ascribed to the fact that the learning environment is essential to the performance of learners. Educators should hold a positive belief about learners' capability and success by creating an environment in which there is a sense of order accompanied by a sense of engagement. Such educators remind learners that they are capable and create learning situation in which learners have opportunity to succeed (cf. 2.3.5).

It is necessary to help schools become better places in order to promote learning and professional development of educators. Furthermore, it is vital to promote equity in distribution of science educator quality and to improve the supply of learning materials and teaching equipment.

Item 12.2, 12.5, and 12.6 Availability of learning support materials, Mathematics and Science equipments will improve performance and motivate both learners and educators to actively participate in the process.

The majority of respondents 80 (91%) agreed and strongly agreed that availability of learning support materials and Mathematics and Science equipments would improve and motivate both learners and educators to actively participate in learning and teaching. Only 8 (9%) did not agree with the statement. Communication between educators and learners will be enhanced, while active participation of learners and educators will be improved and maximized by the availability of learning support materials and equipments

Private sector contributions have come in the form of bursaries and the supply of learning support materials (including equipment). This support must be encouraged and channeled towards targeted institutions that can demonstrate success. Furthermore, there is a well-established connection between learner achievement and the availability of quality learning support materials (LSMs). The strategy will support the Tirisano programme on LSM procurement, delivery and retrieval to ensure the existence of a range of learning materials, from textbooks to internet-based sources and information (cf. 2.4).

Item 12.3 and 12.4. Availability of materials will motivate both educators and learners to actively participate in the process.

Most respondents 79 (90%) agreed and strongly agreed that availability of materials would motivate both educators and learners to actively participate in the process. Only 9 (10%) of the respondents did not agree with the statement.

Both learners and educators will be motivated by the availability of materials in the process. This will also enhance hands-on, minds-on approach, within which there will be active participation by both parties.

The approach incorporates Piagetian-Cognitive learning theories, learners' learning styles and interests and the goals of an active science education programme (cf. 2.4.1).

4.4.4 Educators' perception on how educational change affects performance of learners in Mathematics and Science

The item deals with the educators' perception when dealing with issues related to ways of improving performance of Mathematics and learners. These issues like confidence; ability to make the subject enjoyable to learners, empowerment and supervision are of importance since the department judges the level of competency of the educators by some of these issues. These experiences will be briefly discussed below. Table 4.7 indicates how educators perceive certain aspects that attribute to improvement of learners' performance.

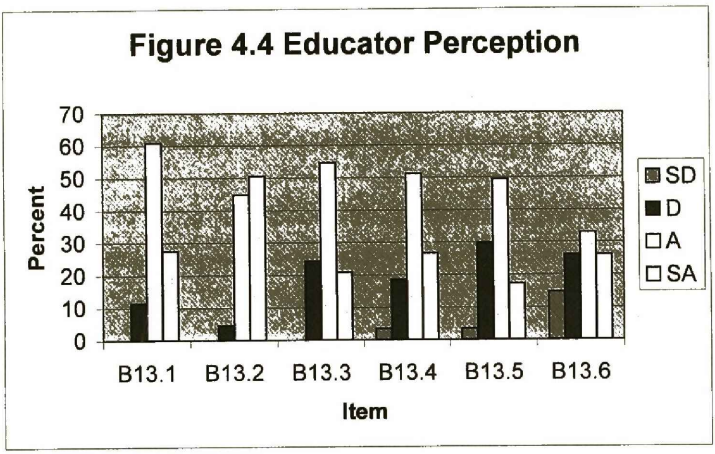
Item 13.1. Educators are able to relate Science topics to everyday life so as to make the subject enjoyable to learners.

Most respondents, 77 (89%) agreed and strongly agreed that they were able to relate science topics to everyday life so as to make the subject enjoyable to learners. Only 10 (11%) did not agree with the statement. Constructing and applying scientific knowledge entails the ability of the learner to explain, interpret and evaluate scientific and technological concepts, principles, models and laws, and apply them in everyday contexts (cf 2.2.2.2).

Table 4.7 Educator Perception

ITEM	NR		SD		D		A		SA		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
13.1 Educators are able to relate science topics to everyday life so as to make the subject enjoyable to learners	2	2%	-	-	10	11%	53	60%	24	27%	89	100%
13.2 Teaching and learning science and maths enhance the productive capacity of the economy	2	2%	-	-	4	4.5%	39	44%	44	49%	89	100%
13.3 Educators practice learner guidance daily	3	3%			21	24%	47	53%	18	20%	89	100%
13.4 Educators' attitude towards new assessment procedure encourages learners to learn and enjoy science and maths	3	3%	3	3.4%	16	18%	44	49%	23	26%	89	100%
13.5 Projects to entice young people to the sciences are being devised and are effective	2	2%	3	3.4%	26	29%	43	48%	15	17%	89	100%
13.6 Using English as a medium of instruction makes it difficult on learner's comprehension	1	1%	13	15%	23	26%	29	33%	23	26%	89	100%

NR = No Response, SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree



Item 13.2. Teaching and learning Mathematics and Science enhance the productive capacity of the economy.

The majority of respondents 83 (96%) agreed and strongly agreed that teaching and learning science enhanced the productive capacity of the economy. Only 4 (5%) did not agree with the statement. Mathematics has an important role in the economic, management and social sciences. It is an important tool for creating; exploring and expressing theoretical and applied aspects of the sciences (cf. 2.2.2.1).

Item 13.3, Educators practice learner guidance daily

Most respondents, 65 (76%) agreed and strongly agreed that educators practiced learner guidance daily. Only 21 (24 %) did not agree with the statement. With the help of new assessment methods educators are able to identify and encourage learners potential in many different ways. Learners'

innovation is encouraged and skills are depicted during presentations or when conducting experiments.

Item 13.4. Educator's attitude towards new assessment procedure encourages learners to learn and enjoy maths and science.

The majority of the respondents 60 (70%) agreed and strongly agreed that educator attitude towards new assessment procedures encouraged learners to learn and enjoy Mathematics and Science. Only 3 (3%) did not agree with the statement.

Assessment is done in many ways, which include, class work, assignments, portfolio, projects and practical reports. This is a challenge for educators as they do not check whether learners have memorised certain items of information, but reasoning, understanding and innovation of learners is also taken into cognisance.

Item 13.5. Projects to entice young people to the Sciences are being devised and are effective.

Most respondents 58 (66%) agreed and strongly agreed that projects to entice young people are devised and were effective. Only 29 (33%) did not agree with the statement. Projects like Mathematics and Science Olympiads, science fairs (expo), Mathematics and Science awareness week do have a positive impact on the learners' attitude and are effective. Learners are willing to explore their creativity and potential during science fairs. This is shown by their participation rate and this takes the researcher back to the educators' role of encouraging learners to participate and reveal their scientific knowledge.

Item 13.6. Using English as a medium of instruction makes it difficult on learner's comprehension of concepts.

More than half of the respondents 52 (59%) agreed and strongly agreed that using English as a medium of instruction made it difficult for learners' to comprehend concepts. Only 36 (41%) did not agree with the statement.

The TIMSS project revealed that South African learners, who participated in the test, wrote Mathematics and Science in a language that was not their mother tongue, and this yielded a negative impact on achievement. Learners had a difficulty of interpretation. The findings reflected better performance by learners whose home language was English or Afrikaans compared to different home languages. Language is a significant aspect in learners' performance as it affects learner performance (cf. 2.5.3).

4.4.5 Correlation and Mean scores

Correlation indicates aspects or items that are relatively reliable to be given immediate attention, the objective being to improve learners' performance. The exercise measures total scores against group scores to reveal their reliability. Mean scores on the other hand reveal items that are rated highest with regard to improving performance of learners.

4.4.5.1 Mean scores

An attempt was made to rank the mean scores of items in Section B of the questionnaire, scored high by respondents. Table 4.8 gives the first five highest rated items, on factors contributing to improving performance of learners as viewed by educators.

Table 4.8 Mean scores

Item no.	ITEM	X	SD
1.	Teaching and learning Science and Mathematics enhance the productive capacity of the economy.	3.46	0.59
2.	Availability of Mathematics and Science equipments motivates both educators and learners to actively participate in the process.	3.43	0.76
3.	Availability of Mathematics and Science equipments improves performance of learners.	3.40	0.74
4.	Availability of learning support materials motivates educators to actively participate in the process.	3.39	0.67
5.	Educators are willing to go an extra mile to improve learners' performance.	3.39	0.67

Table 4.8 displays the mean scores arranged in order of five most important statement which the respondents strongly agreed that they contributed positively towards improving performance of learners in Mathematics and Science. It is important to note that all items of educators' responses with regard to learners' performance are rated above 3.35. The implication is that all factors contribute to the improvement of learners' performance.

The five most important statements listed in Table 4.8 were ranked as the most important features for improvement of learners' performance. The first item teaching and learning Science and Mathematics enhance the productive capacity of the economy, was ranked the highest. The finding implies that the implicit notion that a high degree of performance in science is parallel by economy prosperity, guarantees a strong interest in science education amongst all policy makers in the educational arena. In addition, the belief that science and technology play a critical role in socio- economic development

has compelled most countries including South Africa to promote science education in schools (cf 1.1).

Items 12.6, 12.5, and 12.4 put more emphasis on the availability of learning support materials and equipment. The provision of a sound scientific and technological base is crucial in addressing existing skills in the region, especially in secondary schools. Such a function enhances innovation amongst educators and learners and also entails improved communication and competency.

The fifth item in the mean ranking emphasises the educators' role and morale. Educators' morale has improved as shown by their efforts of conducting after-school lessons, winter school and Saturday lessons. The improved morale is as a result of the support from the principals and subject specialist, projects initiated to empower educators and provision of Science kits, even though the supply is not sufficient.

From Table 4.8 it can be concluded that these findings stress the importance of availability of learning support materials and equipment. Again awareness of the importance of scientific literacy to the country's economy is taken into consideration. More emphasis is revealed by literature reviewed in Chapter 2 (cf. 2.2.2 and 2.4.1). It should be noted that all other features are also important since their mean scores are above 2.

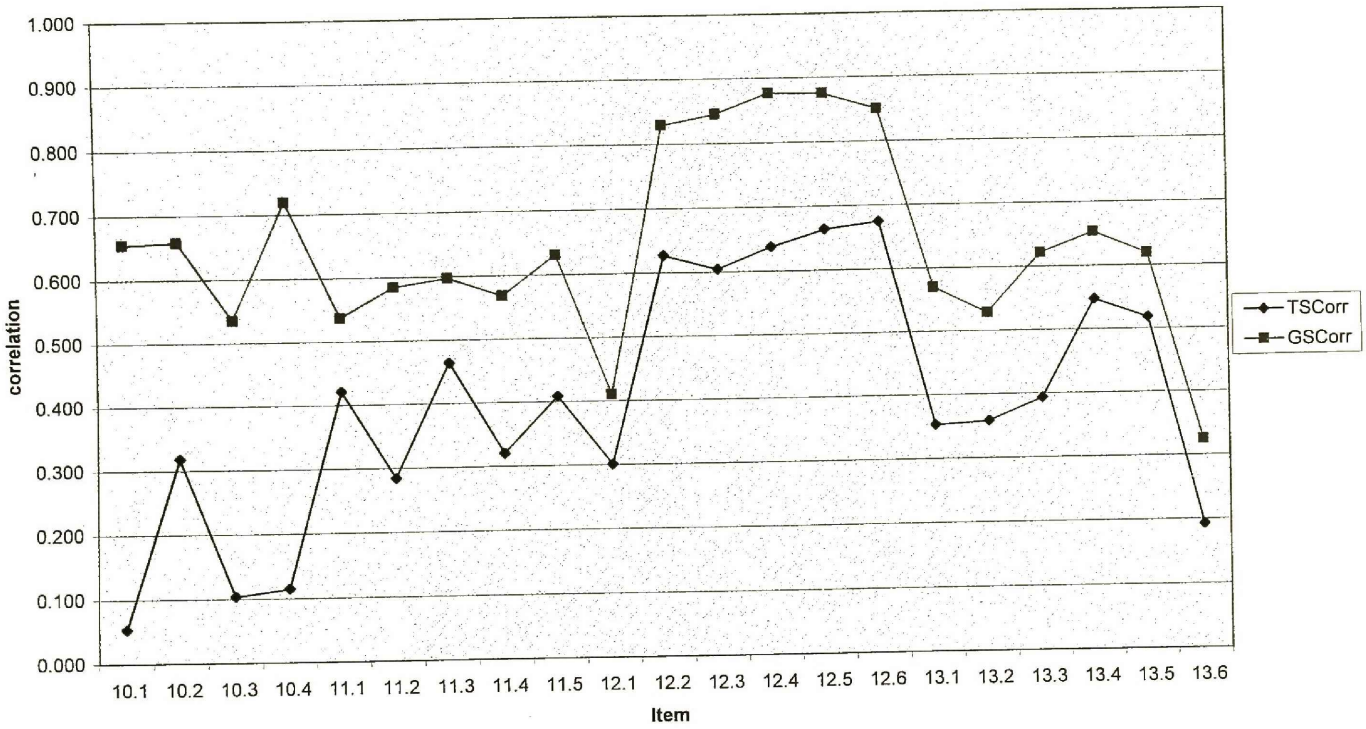
4.4.5.2 Correlation

The purpose of correlation study is used to detect the existence of relationship between variables. Correlation allows for an evaluation or measurement of the importance of the relationship. A strong relationship implies a more reliable concept. In this study Figure 4.5 reflects that total scores or individual items

showed less reliability as compared to when grouped. The grouped items are relatively reliable as reflected in the graph.

The group which is more reliable is 12.2 to 12.6. Only 12.1 fell out of the group score, the implication is that conducive environment is a vital aspect that needs a serious attention to improve learner performance. Both total score and group score revealed positive attribution of availability of LSM to improve learner performance in Mathematics and Science

Figure 4.5 Correlation of Total Score(TS) and Group Score(GS)



4.4.6 Specific project the school is engaged in

Section C of the questionnaire had an open-ended question, in which information regarding projects initiated by the department in schools was required, the question was also aimed at finding out whether the said projects were effective, accessible and known to all educators.

The following details about the identified projects and their effectiveness were revealed from the responses :-

- SEDIBA	3 (60%)
- QUALITY LEARNING PROJECT	22 (55%)
- PROTEC	6 (30%)
- EXPO (SCIENCE FAIR)	1 (25%)
- DINALEDI	4 (19%)

The indication is that the majority (60%), of the schools were engaged with SEDIBA project, which implies that educators are empowered and upgraded. Further explanation to the response is that the respondents 3 (60%) were aware and benefit from the project. 22 (55%) respondents feel that the Quality Learning Project (QLP), was also effective this means that most schools were engaged and implemented the quality of learning, and most educators as revealed by the frequency, participated in the project. About 3 (25%) respondents indicted that their schools were engaged in science fairs or Expo.

The responses revealed that most schools did not participate in the science fairs project, therefore it is essential that the department take the matter into consideration as it is one of the objective to create interest and awareness of Mathematics and Science to learners in many ways among which include

projects such as Expo Such projects enhance learners' innovation and creativity, scientific reasoning and thinking. Only 4 (19%) respondents stated the DINALEDI project effective in their schools. Majority of educators are not familiar with DINALEDI because the project was implemented only to the chosen 102 schools in the country and there is only one school chosen in the Mafikeng district.

The following are respondents' views:-

- Monitoring of DINALEDI should ensure that the neighbouring schools benefited
- All the projects initiated should be monitored and implemented as written, and these projects should not be paper work only.
- Projects should ensure that academic skills help learners to be ready to survive in life;

4.5 SUMMARY

This chapter outlines the findings on challenges and issues encountered by the educator offering Mathematics and Science in the Mafikeng district. From the findings educator qualification and lack equipment are amongst problems encountered by respondents. Hence participants agreed that the availability of equipment would improve learners' performance and at the same time motivate educators. However, there was no statistical significant difference obtained from all variables discussed, such as:-

- Location of the school;
- Subjects presently teaching;
- Educator qualification; and
- Gender

The findings of this study revealed that performance of learners is a dependent feature which relies on the intertwined responsibility of learners, government, community, parents and educators. In addition, the availability of qualified educators and learning support materials could serve as a catalyst to improve learning and teaching. Cooperative and supportive organisational structure, regular communication among staff and monitoring of school work (for both educators and learners) is very important.

The following chapter focuses on summary, recommendations and conclusion.

CHAPTER 5: SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

The purpose of this chapter is to give a summary of the study, to recommend suggestion on some of the issues and to come to a conclusion. An area of further research is also highlighted.

5.2 SUMMARY OF THE STUDY

This study focused on the challenges and issues of educators on improving performance of learners in Mathematics and Science.

Chapter 1 outlines the statement of the problem and the rationale behind the study. In an attempt to search for ways of improving performance, attention should be focused on factors causing poor performance and guidelines on how to improve performance.

Chapter 2 highlights the nature and scope of Mathematics and Science. Further definition of the concept and the theoretical framework was also outlined. Focus was also directed to issues and challenges as encountered within the transformation of education arena. Amongst the problems that the department of education is faced with are:-

- The poor output of Mathematics and Science graduates in grade 12;
- Lack of adequate facilities;
- Dedicated Mathematics and Science schools; and
- Vicious supply of unqualified Mathematics and Science educators.

The learners taking Mathematics outnumbered those taking science because in some schools Mathematics is compulsory and there are more educators qualified to teach Mathematics than Science, although most educators have matriculation and diploma (three years training). This situation of limited numbers of learners and educators in Science has a negative impact in the performance of learners thus poor output in grade 12. The situation is then related to the research question, 'Is the performance of learners satisfactory?'

Improved output of grade 12 learners is at a certain extent dependent not only on educator qualifications, but also on the availability of learning support materials and facilities. Conducive learning environment enhances better communication amongst educators and learners.

Even though, English has long been used as a medium of instruction in teaching Mathematics and Science, it has been found that South African learners whose mother tongue is neither English nor Afrikaans encountered problems in interpreting questions and constructing their own answers during the participation in the TIMSS test. The other problem revealed, was curriculum content. South African Science curricula were not in line with those of participating countries (cf. 2.5.3). Further revelation on the challenges of education transformation, was involvement of all stakeholders in the process (planning, implementation and ways of improving). Joint effort of parents, learners, educators and Non-government organisations is essential.

Most problems encountered in the process are receiving attention hence ways and strategies of improving Mathematics and Science in developed countries was emphasised (cf. 2.5). The Education system in South Africa is transformed from traditional approach to constructivist-approach that entails minds-on and hands-on approaches. The models put more emphasis on learners' innovation; critical scientific thinking, skills and reasoning (cf. 2.5.1).

Different projects initiated by the national Department of Education are implemented in most schools, although monitoring is not effective. Such projects include, DINALEDI, EXPO, SEDIBA, PROTEC and the QUALITY LEARNING PROJECT (cf. 2.4). Transformation of education entails raised participation and performance by historically disadvantaged learners in Senior Certificate Mathematics and Science and also to enhance the human resource capacity to deliver quality Mathematics and Science education.

The chapter was then concluded with findings such as-

- Learners are continuously assessed;
- Involvement of all stakeholder in planning, implementing and improving the process is vital;
- Introduction of new techniques should be parallel with provision and proper maintenance of facilities; and
- Educator empowerment will enhance competency, creativity, scientific thinking and increase communication amongst learners and educators.

Chapter 3 discusses the development of the questionnaires for educators, which were pre-tested. A total of 150 questionnaire was distributed to all high schools in the Mafikeng district of the North West Province. From the total number the researcher distributed 89 copies of questionnaire were returned.

Chapter 4 deals with the interpretation and analysis of data. The chapter also highlights the discussions and interpretations of the findings from the empirical investigations. The respondents were concerned about availability of Learning Support Material (LSM) and equipment so as to improve performance (cf.2.4.1).

From the responses, effective educator empowerment and provision of LSM were found to be the key issues that need attention. In addition, conducive learning environment, educator qualifications and parental involvement also needed to be addressed.

5.3 RESEARCH FINDINGS

In order to address the main aims of the study, the findings discussed in conjunction with the aims of the study in chapter 1 were highlighted. Thus this section will discuss each of the findings for all the mentioned aims.

5.3.1 Findings on aim 1:

- To determine the nature and scope of learners performance in Mathematics and Science. The literature revealed that the nature and scope of learners' performance involves its issues and challenges of performance in Mathematics and Science.

There are factors which bring a delay in the transformation education in South Africa, which amongst others include:- Language, gender, curriculum content, learning environment, assessment, writing to learn and educator qualification are identified. The findings revealed that learners were still experiencing difficulty with question interpretation especially those whose mother tongue was not English. Therefore educator empowerment is required that enables educators to encourage and derive interest from learners on the bases of using English as a medium of instruction. Educators are encouraged to raise learners' achievement in science by using language as an essential element of their science programmes (cf. 2.3.3).

Transition has taken place in which education opportunities have broadened in the spirit of democracy. Aspects that are affected by transformation include curriculum content, assessment and gender. The Outcome Based Education in line with the new assessment programme, CASS enhances learners' creativity, competency, awareness of the changes of scientific and technological concepts and principles. The objective is to enable learners to reach their maximum learning potential (cf. 2.2.2.3).

Female respondents outnumbered males, however that does not truly reflect the prevalent situation as there are still less females enrolled to study Mathematics and Science and their pass rates are lower than males(DoE, 2002 : 19). A solution to the prevailing problem of less females taking Science oriented subjects is addressed by Eskom, by attracting females to the science fields by way of issuing bursaries to female learners to pursue science related careers. Overall concern is that female learners need to be encouraged to take Mathematics and Science and to perform well in these subjects. Balancing the gender ratio within the subjects is important (cf. 2.3.8).

5.3.2 Findings on aim 2:

Regarding aim 2, namely; to determine empirically perception or views of Mathematics and Science educators regarding the causes of poor performance by the learners.

In order to improve performance of learners, all stakeholders should be involved as shown by the responses of the participants. Again, policy makers should ensure that stakeholders participate in planning and implementation of changes in education programmes. Parental involvement was seen as one of the aspects that needed to be considered. It is important that parents participate in their children's learning (cf. 4.4.1).

Availability of learning support materials contributes positively to performance as both educators and learners will participate actively in the act. The supply of learning support materials should reach all schools and effective use of the materials should be monitored (cf. 4.4.3). Since the country's prosperity depends on the growing scientific and technological skills, the national department of Education initiated several projects to improve performance of learners. The process is appreciated but emphasis was made to the effect that all projects should be made known to educators and implementation be monitored (cf. 4.4.6).

An appreciation of the manner in which Mathematics and Science have developed over time established their origin in culture and the needs of society. The new assessment policy in place as appreciated by educators enables learners to reach their maximum learning potential, explores their capabilities, knowledge and scientific thinking (cf. 4.4.4). Mathematics and science have an important role in the economic, management and social sciences.

5.4 RECOMMENDATIONS:

5.4.1 Recommendation 1

Consultation and involvement of stakeholders should not be ignored.

Motivation

All stakeholders, educators, parents, learners and the national department of Education should be involved in all aspects of learners' education which entail curriculum planning, teaching and learning requirements which should suit the country's economic needs. Empowered educators, learners and communities

make appropriate decisions essential for effective learning in which interlocking communities are focused and supportive education programmes and systems nurture achievement.

Stakeholders should be encouraged to take part in the implementation of changes pertaining to teaching and learning activities so as to assume responsibility for children's education. Furthermore, parents should develop interest in their children's education. Regular and consistent communication with parents increases awareness of the community services available to reinforce and extend learners' academic programmes.

5.4.2 Recommendation 2

Attention should be paid to implementation process of change

Motivation

The Department of Education should design clear structures to implement and monitor periodically, the projects initiated. The exercise will enable the schools to be aware of the need of such projects and to assist in implementation and to focus on making the projects efficient, while working with monitoring committees for the relevant project.

5.4.3 Recommendation 3

More attention should be paid on implementation of effective Mathematics and Science projects in schools

Motivation

The Department of Education has initiated and implemented projects like Sediba, Protec and Dinaledi but not all schools are involved. Even if some of these projects have their own strategy for choosing participating schools, at least information regarding the projects should be made available to all schools. All Mathematics and Science educators should be aware of the projects.

Neighbouring schools are supposed to benefit from the chosen Dinaledi schools, but because not all schools are aware of the projects, their effectiveness is questionable. Each project initiated should have an effective committee to monitor progress and to give report to the department and schools involved in such projects.

5.4.4 Recommendation 4

Establishment of training centres for Mathematics and Science educators.

Motivation

The findings indicate that professional development enhances educators' knowledge and ability to implement excellence and equity.

The prevailing situation is shown that the majority of educators have grade 12 and diploma as their highest qualification although they teach beyond their level of competency in poorly equipped schools with large number of learners in classrooms.

Since most of the educators had 0 – 6 years of teaching experience, there is a need for continued and persistent training and support in teaching methodologies, assessment techniques and content, especially during a period of transformation in the education sector.

The Department of Education should establish effective in-service training centres for Mathematics and Science educators. For example, the Sediba project, which is based in Potchefstroom, is not accessible to all schools and not all Mathematics and Science educators are aware of this project, especially educators in the rural areas. It is therefore important that similar projects be initiated regionally. Mathematics and Science educators require the relevant skills to keep abreast with technological changes, hence continuous in-service training will enable educators to be innovative, improvise and allow learners to use new learning and appropriate strategies.

The Association of Mathematics Educators of South Africa (Amesa) work in conjunction with the education authorities to conduct workshop for educators and to expose them to innovative ways of teaching Mathematics. Since the organisation aims at increasing the human resources in Mathematics, Science and technology needed in this country, it is vital to spread the programme to all schools and to ensure that information reaches all educators.

5.5 CONCLUSION

In conclusion, performance of learners in Mathematics and Science can not be improved unless parents, learners, educators are fully involved and have a positive attitude towards improving performance.

With the implementation of the Outcome Based Education (OBE) and Continuous Assessment (CASS), learners will be equipped with knowledge,

competency and orientation needed to improve the country's economy. The increasing demand for scientific literacy is the main aspect which needs serious consideration.

Another key aspect is the need for learning support materials and equipment, which will serve as a catalyst to the implementation of new teaching methodologies, which entails hands-on and minds-on approaches. Professional organisations play a critical role in supporting educators to improve learner achievement. The support and participation of mathematical, scientific and technical communities will continue to be crucial in the realisation of the government's objectives. It is therefore suggested that for further research provision of learning support materials and monitoring of initiated projects be considered and to determine how these factors contribute to learners' performance.

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QUESTIONNAIRE

CARD NO: [ ]

The aim of this questionnaire is to learn about the background and experiences of mathematics and science educators. The survey is sent to secondary schools in the Central region of North West Province. The results of the survey will be summarised. The study is to be used in improving learner performance in Mathematics and Science subjects.

All the information will be treated confidentially and no direct references will be made to you or your school.

SECTION A: BIOGRAPHICAL

Kindly answer the following questions by crossing (X) on the appropriate box.

1. **Age of the educator**

1.1	30 years and under	**1**
1.2	31 – 39	**2**
1.3	40 – 49	**3**
1.4	50 years and over	**4**

2. **Gender**

2.1	Male	**1**
2.2	Female	**2**

3. **Highest Qualifications**

3.1	Matric + Diploma	1
3.2	Bachelors degree + Type of Degree (B Sc Ed, B.A Ed, etc) Specify :	2
3.3	Honours Degree Specify	3
3.4	Masters Degree	4
3.5	Other (specify)	5

4. Subject(s) presently teaching

4.1	Mathematics	1
4.2	Science	2
4.3	Both Mathematics and Science	3

5. What is your highest qualification on the subject you are teaching?
(E.g. Maths 1 or Chemistry 2)

.....

.....

.....

6. Which Grade(s) are you offering presently?

.....

.....

7. Number of learners doing maths

7.1	Less than 50	1
7.2	51-100	2
7.3	101-200	3
7.4	200 and more	4

8. Number of learners doing science

8.1	Less than 50	1
8.2	51-100	2
8.3	101-200	3
8.4	200 and more	4

9. Location of the school

9.1	Urban	**1**
9.2	Rural	**2**

SECTION B: DESCRIPTIVE DATA

To what extent do you agree with the following statements with reference to your school? Please read through the list, cross with an (X) the block that expresses your view in each item. And use the following rating scale.

Key:

SA – Strongly Agree

A -- Agree

D -- Disagree

SD – Strongly disagree

10. SUPPORT FOR EDUCATORS

	ITEM	SA	A	D	SD
10.1	The department support educator empowerment, by upgrading science educators.	4	3	2	1
10.2	The principal motivate educators to improve teaching and performance of maths and science.	4	3	2	1
10.3	Parents are involved in their children's learning, thus making educators work easier and meaningful.	4	3	2	1
10.4	Educators attend workshops regularly .	4	3	2	1

11. EDUCATOR INVOLVEMENT

	ITEM	SA	A	D	SD
11.1	Teaching technique / skills predict effective learning.	4	3	2	1
11.2	Educators are involved in curriculum planning .	4	3	2	1
11.3	Willingness to go an extra mile to improve learners' performance.	4	3	2	1
11.4	CASS is useful to improve maths and science.	4	3	2	1
11.5	It is important to reduce educator dominance thus changing learners' passiveness.	4	3	2	1

12. CONDITIONS FOR TEACHING

	ITEM	SA	A	D	SD
12.1	The prevailing environment is conducive to improve teaching and learning process.	4	3	2	1
12.2	Availability of learning support materials will improve performance of learners.	4	3	2	1
12.3	Availability of learning support materials will motivate both educators to actively participate in the process.	4	3	2	1
12.4	Availability of learning support materials motivates learners to actively participate in the process.	4	3	2	1
12.5	Availability of maths and science equipments improve performance of learners.	4	3	2	1
12.6	Availability of maths and science equipments motivates both educators and learners to actively participate in the process.	4	3	2	1

13. EDUCATOR PERCEPTION

	ITEM	SA	A	D	SD
13.1	Educators are able to relate science topics to everyday life so as to make the subject enjoyable to learners.	4	3	2	1
13.2	Teaching and learning science and maths enhance the productive capacity of the economy	4	3	2	1
13.3	Educators practice learner guidance daily.	4	3	2	1
13.4	Educators' attitude towards new assessment procedure encourages learners to learn and enjoy science and maths	4	3	2	1
13.5	Projects to entice young people to the sciences are being devised and are effective.	4	3	2	1
13.6	Using English as a medium of instruction makes it difficult on learner's comprehension of concepts.	4	3	2	1

14. Name and comment on the effectiveness of the Departmental initiative projects, your school is engaged in with the aim of improving the standard of maths and science, such as (DINALEDI, QUALITY LEARNING PROJECT, PROTEC etc).

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR TIME AND CO-OPERATION.

GRADUATE SCHOOL University of North-West
OF BUSINESS & GOVERNMENT LEADERSHIP

MBA/MPA
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The District Manager
Department of Education
Mafikeng

Dear Sir/ Madam

RE: PERMISSION TO CONDUCT RESEARCH

This letter serves to request that Mrs. C. Moroeng, a registered student in the MBA/MPA programme at the Graduate School of the University of North-West, be afforded the full cooperation of the Department of Education in the completion of her research project.

Mrs. Moroeng's research project is a partial requirement for the fulfilment of her Masters Degree in Business Administration, and his field of study is concerned with the support given to school principles by the district offices.

Mrs. Moroeng requires permission to distribute research questionnaires to various high schools throughout the district, and your assistance in this regard will contribute to the successful completion of her project.

Please forward your written responses directly to Mrs. Moroeng, in order to aid her logistical planning.

Your cooperation is highly appreciated.

Regards

Dan Setsetse
Programme Director

MAFIKENG DISTRICT OFFICE
(EDUCATION)
DISTRICT MANAGER / STREEKBESTUURDER
2003 -05- 2 8
Private Bag / Privaatsak
Mmabatho
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Permission granted.
28/05/03