ENHANCEMENT OF LEARNERS' PERFORMANCE IN GEOMETRY AT SECONDARY SCHOOLS IN THE VHEMBE DISTRICT OF THE LIMPOPO PROVINCE

by

NTSHENGEDZENI REANETH MAMALI

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SUPERVISOR: Prof RJ Monobe
CO-SUPERVISOR: Dr MP Mulaudzi

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DECLARATION

I, **NTSHENGEDZENI REANETH MAMALI,** declare that:

Enhancement of Learners' Performance in Geometry at Secondary Schools in the Vhembe District of the Limpopo Province

…is my own work and has not been previously submitted in any form whatsoever, by myself or anyone else, to this university or any other educational institution for any degree or examination purposes. All resources that I have used or quoted have been indicated and duly acknowledged by means complete references.

…….. ……

NTSHENGEDZENI REANETH MAMALI **DATE**

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ABSTRACT

Learning Geometry has been identified as an area of Mathematics that poses various problems for many secondary school learners'. Many learners' fail to develop an adequate understanding of geometrical concepts and to demonstrate good reasoning and problem solving skills. Poor performance of learners' in Euclidian Geometry has been a concern to Mathematics teachers, parents and government. The purpose of this study was to enhance learners' performance in Euclidian Geometry as a branch of Mathematics in the FET band of secondary schools. The research question was: What factors facilitate the enhancement of learners' performance in Euclidian Geometry in the FET band of secondary schools? The study adopted the mixed methods design. The population were all the FET band learners who chose Mathematics as a field of study at secondary schools in Nzhelele East Circuit. Purposive sampling was used to select participants who contributed to qualitative data. For quantitative data, clusters and random sampling methods were used to select learners who participated in the study. The sample consisted of 6 school principals, 6 heads of departments and 6 teachers. These groups of people participated in the interviews. Nine schools were sampled from the population and questionnaires were administered to 405 learners of which 45 were randomly selected from each school and 15 learners were randomly selected from each grade level. Thematic analysis was used to analyze qualitative data and the SPSS Version 22 was employed to analyze quantitative data. The data collected revealed the causes of poor performance in Geometry at Grades 10-12. The results of this study described how learners in Grades 10-12 could improve their performance in Geometry.

Keywords: Mathematics, Geometry, teaching, learning, learner performance

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TABLE OF CONTENTS

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Creating Future Leaders

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Creating Future Leaders

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LIST OF TABLES

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CHAPTER 1

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 INTRODUCTION

This chapter consists of the background of the study, statement of the problem, purpose of the study, followed by the research questions that guided this study and the definition of terms. It further highlights the significance, delimitations, and the outline of the study. It then ends with conclusion.

Learning Geometry has been identified as an area of Mathematics that poses various problems for many secondary school learners' (Binti, Tay & Lian,. 2003:165). Many learners' fail to develop an adequate understanding of geometrical concepts, and to demonstrate reasoning and problem solving skills (Khoo & Clements, 2001:213). Since my employment as a Mathematics teacher in 1995, my experience has not been different from these authors with regard to learners'' performance in Euclidean Geometry.

The problem of learners'' performance in Mathematics cannot be isolated from how teachers interact with learners' in the learning of the subject. Despite the relative importance of Mathematics, it is disappointing to note that learners'' performance in the subject has remained consistently poor. Teachers have put up noble and spirited efforts aimed at identifying major problems associated with the teaching and learning of Mathematics in the nation's schools. Despite all these noble efforts, the problem of poor performance in Mathematics has continued to rear its head in the nation's public examinations. Mass failure in Mathematics examinations is real and the trend of learners'' performance has been on the decline (Adolphus, 2011:144).

According to Adolphus (2011:144), Euclidian Geometry is the most problematic area to teach and learn. Euclidian Geometry is a field of Mathematics, which deals with the study of different shapes. These shapes may be plane or solid. A plane shape is a geometrical form such that the straight line that joins any two points on it wholly lies on the surface.

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Binti, Tay and Lian (2003:168) identified the problems of teaching and learning Geometry as a language, visualisation and instruction. These problems are discussed below:

1.1.1 Geometry Language

One of the problems with many geometry learners' is their weakness in the language of Geometry. The vocabulary in Geometry is specific and carries meaning, descriptions and even properties. Knowing geometric names like "triangles" and "squares" may not imply learners' understand their exact meanings or properties involving angle sums, perimeter or area. Learners' are unable to explain simple terms like "perimeter" and "triangle". Words like "area, isosceles, scalene, and equilateral" give rise to much confusion among their sample subjects. Evidently, the Geometry language, especially in the comprehension of Geometry terms, plays a very important role in learning and understanding of geometric concepts (Khoo & Clements, 2001:213).

1.1.2 Visualization

Another problem in Geometry learning involves the ability to visualize. Many concepts in Geometry require learners' to visually perceive objects and identify their properties by comparing them with their previous experiences involving similar objects. These geometrical concepts also require visual interpretations, as many Geometry problems are presented in a two-dimensional format on paper. Thus, learners' who are unable to extract geometric information about three-dimensional solid objects drawn on paper will have some difficulties in interpreting questions involving solid Geometry. Some Mathematics teachers recommend more visual activities in the classroom to help learners' understand geometric concepts (Guzman, 2008:5). It would therefore seem helpful for learners' if geometry lessons could be carried out with hands-on activities. By being able to "touch-see-and-do" and interacting with the objects of their learning, learners' can learn geometry in a more imaginative and successful way (Tay, 2003:1).

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1.1.3 Geometry Instruction

In the past, Geometry lessons were pictured as learners' were copying diagrams and properties of figures and shapes from blackboards and doing repetitive exercises to calculate angles, lengths, and areas of geometric figures. This approach posed problems for both teachers and learners', and both groups began to dread Geometry. Teachers became frustrated because their poor conceptual understanding led to poor Geometry achievement. This problem persists in many Geometry classrooms today. Teachers introduce learners' to facts about Euclidean Geometry and then drill them on concepts through deductive reasoning. Learners' are seldom given the opportunity to discover and conceptualize Geometry on their own (Mullis, 2000:1).

Geometry is recognised as not only one of the most important components of the school Mathematics curriculum, but also- alongside Algebra as one of the most important elements of Mathematics itself. The reasons for including Geometry in the school Mathematics curriculum are myriad and encompass providing opportunities for learners'', not only to develop spatial awareness, geometrical intuition and the ability to visualize, but also to develop knowledge and understanding of, and the ability to use, geometrical properties and theorems (Jones, 2002:121). This being the case, it can be argued that teaching approaches need to encompass the encouragement of the development and use of conjecturing, deductive reasoning and proof, as well as develop skills of applying Geometry through modelling and problem- solving in a range of contexts (including real world ones), and an awareness of the historical and cultural heritage of Geometry in society, and of the contemporary applications of Geometry. All these considerations tend to make Geometry a demanding element of Mathematics to teach effectively, especially when other topics in Mathematics curriculum (such as Numeracy and Algebra) can dominate curricula considerations (Jones, Fujita & Ding, 2005:89).

For a topic like Geometry, which is the bedrock of engineering and technological development, the issue of adequate physical facilities cannot be over- emphasized. The physical facilities such as models will help grasp the idea of Geometry, which seems to be abstract. The facilities in terms of infrastructure, equipment and

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materials afford the learners' the opportunity to acquire the necessary knowledge (Adolphus, 2011:145). He further indicated that such a situation, where teachers are forced to discuss, practical aspects of the subject theoretically, is not good enough.

It was against this background that I intended to undertake this study of enhancing learners' performance in Euclidian Geometry at secondary schools.

1.2 STATEMENT OF THE PROBLEM

Poor performance of learners' in Euclidian Geometry has been a concern to Mathematics teachers, parents and government (Adolphus, 2011:145). The chief examiner's annual reports in Mathematics in the National Senior Certificate (NCS) Examinations diagnostic report are good testimonies of those facts (DoE, 2011:120). Mathematics teachers have put in efforts aimed at identifying the major problems associated with secondary school Mathematics. Despite all these noble efforts, the problem of poor performance in Mathematics has persisted. It was based on these facts that this research identified Geometry as a difficult area, where learners'' performance has consistently been low (Adolphus, 2011:145).

Geometry plays an important role in primary and secondary school Mathematics. It provides a rich source of visualization for understanding arithmetical, algebraic, and statistical concepts (Binti, et al., 2003:165). These authors contend that Geometry provides a more complete appreciation of the world we live in. For example, Geometry appears naturally in the structure of the solar system, in geological information, rocks and crystals, plants and flowers and even in animals. Geometry learners learn to analyse characters and properties of two and three-dimensional Geometric shape and develop mathematical arguments about geometric relationships; specify location and describe spatial relationships using coordinate Geometry and other representational systems; apply transformations and use symmetry to analyse mathematical situations; use visualization, spatial reasoning, and geometric modelling to solve problems.

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In a study of Problems of Teaching and Learning of Geometry conducted in Secondary Schools in River State of Nigeria, Adolphus (2011:157) made the following startling discoveries:

- The foundation of most Mathematics teachers in geometry is poor.
- The learners' have poor foundation in Mathematics, as such cannot solve problem even when similar examples are given.
- Attitude of learners' towards learning is very poor. They lack the willingness and readiness to learn.
- The teachers lack commitment due to lack of motivation.
- It was also found that if the necessary provisions are made and proper monitoring is made on the learners' and teachers, these problems were eradicated.

The intention of this study was to investigate how learners' performance in Euclidian Geometry at secondary school can be enhanced.

1.3 PURPOSE OF THE STUDY

The purpose of this study was to investigate how learners perform in Euclidian Geometry as a branch of Mathematics in the Further Education and Training (FET) band of secondary schools. In order to achieve this purpose the following objectives were developed:

- To identify the factors that contributes to the learners' performance in Geometry as a branch of Mathematics.
- To determine the strategies that can be used to teach Geometry that are easy for learners to understand.

1.4 RESEARCH QUESTIONS

The main research question was: How do learners' perform in Euclidian Geometry as a branch of Mathematics in the FET band of secondary schools?

In order to answer this question, the following subsidiary questions were developed:

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- What are the factors that contribute to learners' performance in Euclidian Geometry as a branch of Mathematics?
- How can geometry be taught to learners in terms that are easy to understand?

1.5 DEFINITION OF TERMS

This section defines key terms used in this study.

1.5.1 Learner Performance

According to Bell (2004:199), learners' performance refers to how well the learner meets standards set by teachers. Learners' performance refers to the ability of a learner to demonstrate knowledge by participating in class work and homework, writing test, making presentation and participating in discussion (Wesslen & Maria, 2005:27). In this study, learner performance means a concept in learning closely-related to that of academic performance. For instance, doing homework, coming prepared for classes, regular attendance and not skipping classes reflect learners' engagement and motivation.

1.5.2 Geometry

Royal Society (2001:11) defines Geometry as a science of physical space. In other words, the study of the real physical space around the learner and the concrete objects constitute Geometry. He further argues that Geometry does not start from formulating definitions and theorems, but it starts from organising spatial experiences that lead to the formulation of definition and theorems. The meaning of Geometry is not as straightforward as one may think (Royal Society, 2001:11). Originally, the Greek called it 'earth measure', the science of measuring land. In this study, I have defined Geometry as the branch of Mathematics concerned with the properties and relations of point, lines, surface and solid or the shape and relative arrangement of the parts of something and also involves the study of position of objects, movement of objects and the space around the objects improve learners' spatial imagination.

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1.5.3 Mathematics

In DoE CAPS document, (2011: 8) Mathematics is defined as a language that makes use of symbols and notations for describing numerical, geometric and graphical relationships. According to Elaine (2014:1), Mathematics is the science that deals with logic of shape, quantity and arrangement. In this study, Mathematics is defined as an important subject of which learners must acquire all the skills, knowledge and understanding that will help them in the real world and as an abstract science of numbers, quantity, space, change and other properties.

1.5.4 Learning

According to De Houwer (2009:20), learning is the act, process or experience of gaining knowledge or skills and can be done in different ways for example, a learner may learn in groups, by doing simulation and presenting, also regarded as a process of getting knowledge and finding out about something. Learning is the lifelong process of transforming information and experience into knowledge, skill, behaviors and attitude Cobb (2009:99). In this study, learning can be done in different ways, for example, cooperatively and through mediating with peers.

1.5.5 Teaching

Carter (2003:3) defines teaching as the practice of experienced teachers passing expertise and wisdom to learners faced with many challenges. According to O'Neil, (2012:4) teaching involves professionally supporting and guiding a learner who is less experienced or struggling. Teaching in this study is considered as a strategy that is used by a qualified, experienced teacher to guide, coach, counsel, and support a learner who is undergoing learning.

1.5.6 Learner

According to Maree (1997:3), learner is preferred to the term student although the two are regarded as synonyms. Since the one should guard against the use of so-called buzzwords, the trend is to use the word learner instead of student within the

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contest of the study. The word learner can have the following meanings: person who learn; person preparing for a particular subject; person who have the following attitudes: curiosity, perseverance initiative, originality, creativity and integrity. For the purpose of this study learner refers to a person who are scholars or are engaged in some or other form of high school Geometry study.

1.6 RESEARCH DESIGN AND METHODOLOGY

Creswell (2009:107) defines the research design as a set of guidelines and instruments to be followed in addressing the research problem. The research design summaries the model which was used in the study. Research methodology refers to the different techniques, methods and procedures that were used in the process of implementing research design or research methods (Creswell, 2009:18).

The qualitative data was collected through interviews. According to Creswell (2009:16), the purpose of qualitative research is to try to gather full information in a real setting, in order to develop understanding of everything being answered by participants and observation by the researcher. The quantitative data was collected through questionnaires. A questionnaire is a set of carefully designed questions given in exactly the same form to a group of people in order to collect data about some topic in which the researcher is interested (Jupp, 2006:252). This is detailed in chapter three, which outlines the research methodology used in this study. It describes the research design and the research methods – quantitative and qualitative methods. It also describes the population, sampling procedures, sample, data collection procedures, and research instruments.

1.7 TRUSTWORTHINESS

Trustworthiness seeks to establish the credibility of the research. This study used multi-methods of both qualitative (interviews) and quantitative (questionnaires) approaches. A combination of these methods is referred to as triangulation, which is understood as a validation strategy. In this case data drawn from different participants (principals, heads of departments, teachers and learners) and at different times and in different schools was triangulated (Juppe, 2006:305).

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1.7.1 Credibility

Credibility in qualitative research is defined as, the extent to which the data and data analysis are believable and trusted. Credibility is analogous to internal validity, that is, how research findings match reality. However, according to the philosophy underlying qualitative research, reality is relative to the meaning that people construct within social contexts (Shenton, 2004:71). The researcher interviewed some of the respondents and others completed the questionnaires. This was done to avoid inaccurate and misleading conclusions.

1.7.2 Transferability

Research findings are transferable or generalizable only if they fit into new contexts outside the actual study context. Transferability is analogous to the external validity, that is, the extent to which findings can be generalized (Shenton, 2004:69).

1.7.3 Conformability

Shenton (2004:72) avers that conformability is the qualitative investigator's comparable concern to objectivity. Shenton cautions that steps must be taken to help ensure as far as possible that the work's findings are the result of the experiences and ideas of the research participants, rather than the characteristics and preferences of the researcher. The researcher ensured that sample size, respondents and similar research instruments were used.

1.7.4 Dependability

Dependability is analogous to reliability; that is, the consistency of observing the same finding under similar circumstances. According to Merriam (1998:205), it refers to the extent to which research findings can be replicated with similar subjects in a similar context. It emphasises the importance of the researcher accounting for, or describing the changing contexts and circumstances that are fundamental to consistency of the research outcome. Evidence of the field research in the form of

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research instruments used to draw the findings, conclusions and recommendations, in order to ensure research dependability.

1.8 DATA ANALYSIS

Data analysis is the process of reducing accumulated data to a manageable size, developing summaries, looking patterns and performing statistical analyses (Tavakoli, 2012:144). Two types of data were analyzed; namely, qualitative and quantitative data. Qualitative data was analyzed through thematic analysis and quantitative data was analyzed using the Statistical Package for Social Sciences (SPSS) Version 22.

1.9 SIGNIFICANCE OF THE STUDY

The core purpose of teaching Mathematics is that Mathematics is the foundation of all subjects. Learners' who do well in Mathematics have a better chance of doing well in their future careers. It is therefore necessary that learners must perform well in all sections, with a number of tertiary institutions demanding a pass in Mathematics. Thus, learners should perform well in Geometry in order for them to pass Mathematics.

1.10 DELIMITATION OF THE STUDY

This study was conducted in the Nzhelele East Circuit in the Vhembe District in the Limpopo Province (South Africa).

1.11 ETHICAL CONSIDERATIONS

The study participants were kept anonymous. All the participants were treated with respect. Each one was asked to sign a consent form, which explained the purpose of the study, and their rights such as withdrawal from participation if they wanted to do so, without being compelled to give an explanation.

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1.12 OUTLINE OF THE STUDY

This study is divided into five chapters. Chapter One presents the background of the study,statement of the problem, purpose, research questions, definition of terms and significance of the study. Chapter Two presents the review of related literature on learners' performance. Chapter Three deals with the research design and methodology used. This includes the population, sampling procedures, sample , data collection procedures and research instruments. Chapter Four presents the data and anlysis thereof. Chapter Five presents the findings, conclusion and recommendations.

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CHAPTER 2

LITERATURE REVIEW: ENHANCEMENT OF LEARNER PERFORMANCE IN GEOMETRY AT SECONDARY SCHOOLS

2.1 ffINTRODUCTION

This chapter reviews literature on the enhancement of learners' performance in Geometry at secondary schools. The review of the literature included a theoretical framework, enhancement of learners' performance, factors that affect learners, performance, strategies that can be used to teach and learn Geometry in an effective and understandable way .

2.1.1 Theoretical Framework: Social Constructivism

This section discuses social constructivism.

The review of literature in this study formed the methodological basis of the study, which assisted the researcher in the construction of the research instruments. The social constructivist theory is based on the idea that the learner builds new knowledge upon the foundation of previously acquired knowledge. Learners should be given the foundation of knowledge needed by teachers so that they may use the knowledge to develop themselves academically.

Kim (2012:1) reveals that social constructivism is based on the argument that reality is constructed through human activity and that people construct their own understanding and knowledge of the world through experience. New knowledge should be built on the knowledge learners already have. This can happen if learners are part of the process of developing knowledge. What is crucial in learning is the ability for one to think. The teacher can either do the process of knowledge development jointly with the learners, where the teacher plays the leading role of posing problems or learners working in groups to solve the problems posed. Knowledge in the former will be generated through learners applying their minds, whereas in the latter learners have to discuss ideas among themselves. In both

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cases, it is not only effective learning that takes place but learners also attach ownership to the knowledge they helped construct. This study will hopefully facilitating the quest to improve achievement in Geometry at secondary schools and establish what schools can learn from one another.

Kanselaar (2002:1) says social constructivism is a process that allows learners to experience an environment first-hand, so that they can gain reliable and trust- worthy knowledge. Thus, the nature of activities that happen during the lesson have a bearing on the overall enjoyment of the subject. If there are exciting and fascinating activities during the lesson, learners may tend to associate that with the subject. It is therefore incumbent upon teachers to formulate activity-oriented exercises that are both suitable and of interest to learners.

According to Singh, Granville & Dika. (2002:323), many of these variables are home-related and family-related, and as such are difficult to change and beyond the control of teachers. Such factors alone cannot account for the poor Geometry performance and persistent difficulties among secondary learners. In particular, these explanations fail to account for intra-group performance differences and the success of South Africa secondary learners comes from the same communities and share similar socio-economic backgrounds, schools and classrooms.

According to Kutama (2002:2) teachers tend to give low priority to Geometry compared to algebra. He further stresses that if Geometry is to be taught at all, only theorems should be drilled into the minds of learners with little understanding of them. This is a typical situation in most South African Mathematics classrooms today, whereby learners are taught mainly algebra, and during the last few weeks of the year, teachers teach them Geometry. He also states that the root cause of poor Geometry teaching lies in the mismatch between the teacher -education courses and the needs of the learners in the school. This shows that the teachers have not been trained to be innovative in their teaching of Geometry. In other words, the curricula for colleges do not adequately prepare student teachers for challenges at the school. Eventually, the teachers find themselves poorly- prepared to teach Euclidean Geometry. It is important that teachers use teaching methods that take the learners' level of understanding Geometry into account. They should encourage learners to

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reason. The choice of Geometry content depends on what we want to do with it in real life situations.

According to Hughes (1999:47), the most important conclusions from qualitative research on factors related to enhancement of geometry in secondary schools are that teachers are critical resources; the composition of student body matters; schools make a difference, and physical facilities, class size, curriculum, instructional strategies and other resources influence student learning indirectly through their effect on their behavior of teachers and learners'. In an effort to identify the causes for low performance in Geometry, some researchers such as Brodie (2004:65), Attwood (2001:42), Malcom (2000:1), Murray, (1997:376), Maree (1997:1) and Moyana *et al.*, (1996:1) suggest that improvement in Geometry in secondary schools is influenced by a number of variables. These variables include learners' abilities, attitude and perception, family and socio- economic status, parent and peer influence, school- related variables such as poor learning environment, learning cultures, past racial discrimination and low expectations by principals and teachers.

The United States of America (USA) Mathematics curriculum places emphasis on the learners' knowing and being able to apply Mathematics (National Council of Teachers of Mathematics (NCTM), 2000:4). The importance of Geometry in the USA is set to achieve the following objectives:

- Learners should be geometrical literate in order to cope with everyday life.
- Geometry should empower learners to solve problems at workplace.
- Mathematics should prepare the most able learners to be mathematicians, scientist, statistician and engineers.
- Geometry should be viewed and taught as part of culture.

In the USA, Geometry is taught from pre-primary school to Grade 12 (National Council of Teachers of Mathematics (NCTM), 2000:4). The primary school Geometry curriculum involves the study of two- and three-dimensional shape (National Council of Teachers of Mathematics (NCTM), 2000:48). Reasoning and proof receive the utmost important at all levels (National Council of Teachers of Mathematics (NCTM), 2000:55). Reasoning cannot be developed through Geometry

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alone. However, it should be developed through all disciplines of Mathematics in variety of context at all grades.

It was shown that the USA Mathematics curriculum places emphasis on teaching Geometry through the inductive approach from primary level through to Grade 8. Reasoning and proof are also taught inductively (National Council of Teachers of Mathematics (NCTM), 2000:112).

Developed countries such as England and Germany have their own way of teaching Geometry. In order to improve the learners' performance in Geometry, these countries focus on designing appropriate and relevant procedures for assessment and recording of learners' progress and attainment. Teachers use these new concepts strategies and methodology in a dynamic creative learning environment in the teaching of Geometry (Jayaprakash, 2005:98).

In Japan and China, the opportunity to focus is useful as there are interesting similarities and contrasts. For example, both countries have National Curricular for Mathematics that covers Geometry, among other mathematical topics Japan Society of Mathematics Education (JSME), 2000:7). Yet, for teachers in the two countries there are different traditions and ways in which they respond to international development over the years (Jones, Fujita & Ding, 2005:89).

A recent UK study of Geometry teaching (Royal Society, 2001:19) concluded that the most significant contribution to improvement in Geometry teaching will be made by the development of good models of pedagogy, supported by carefully- designed activities and resources. The analysis of lesson given by Mathematics teachers in countries such as China and Japan might inform the development of new pedagogical approaches to teaching Geometry.

While the training curriculum specified in the UK for initial training of both primary and secondary teachers contains very little in the way of Geometry and how it should be taught, the complexity of the issue means that there is a lack of consensus about what Geometry can and should contain within such courses
(Royal Society, 2001:19).

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Learners' fail to understand the basic Geometry concepts and fail to develop adequate problem solving skills. The place of Mathematics in the life of any nation cannot be overemphasized because it is linked with the place of development of Nations (Betiku, 2001:1). According to Deppe, Sonderegger, Stice, Clark &Streuling (1991:257) some of the problems encountered in the developed countries that were being addressed were:

- Learners did not explore the conceptual foundation and real-world relevance of Geometry information;
- Teachers encourage writing skills in Geometry; but not with oral communication skills;
- Learners did not participate in extensive group work in most classes; and
- There was a lack of program continuity; Geometry was treated as a subject with no integration with other learning areas.
- Failure of Mathematics to relate to the child's environment and thus the child cannot see the importance and immediate application of Mathematics, particular geometry in his day-to-day living.
- Each new curriculum has always taken teachers unaware because they had never been involved in the development of the curriculum.
- Non–availability of instructional material such as textbooks, workbook, slides and other media to meet the pedagogical demand of new curriculum imposed on teachers.

According to Steen (1998:19), Geometry does not empower people with the capacity to control their lives but also provides a firm foundation for effective theories, and also guarantees society a vigorous economy. At its most basic level, geometry is a requirement for science, computer technology and engineering courses. Throughout the world, a major difference between the advanced and the underdeveloped countries of today has been noted in their level of development in modern science and technology. There is thus a compelling need for South Africa as a developing country to keep up with new and emerging technologies.

Several studies conducted locally as well as internationally highlight certain shortcomings in the Geometry in Mathematics performance of South African learners. In the (Third International Mathematics and Science Study (TIMSS),

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2007:25) seventh grade and eight grade learners in South Africa were ranked last in Mathematics out 41 participating countries. Furthermore, in a joint survey conducted by the Foundation for Research and Development and the Human Sciences Research Council, it was stated that South Africans ranked 18th out of 20 World Nations on Natural and Environmental Sciences (TIMSS, 2007:25).

Regarding the performance of learners in South African Grade 12 examinations, the Limpopo Province (where this study was conducted) produced the poorest or second poorest matriculation Mathematics and Science results out of the nine provinces for the past consecutive years (Strauss, Plekker & Van der Linde, 1999:19).

According to DOE, (2012:120), diagnostic report on learner performance in Mathematics states that number of learners passing Mathematics since 2009-2012 were increasing at a low rate; for example in 2000; 2009; 2011; 2012 percentage was 47,4%; 46,0%; 46,3% and 54,0% respectively for those who achieved 30% and above. For those who achieved 40% and above since 2009-2012 it was 29, 4%; 30, 9%; 30, 1%; and 35, 7%, respectively. This trend indicates that learners do not perform well in Mathematics nationally. This also shows that the numbers of graduates in science, engineering, and technology are low in South Africa. The (National Commission on Higher Education (NCHE), 1996:1) further indicated that South African blacks are underrepresented in the scientific, engineering and mathematical professions.

In South Africa, the performance of learners in Geometry is associated with lack of learning materials, poverty, lack of poor learners motivation, teachers' relationships, under prepared teachers, lack of parental support, lack of clearly defined learner support systems, and serious lack of discipline in many schools (Van der Westhuizen, Mosoge, Nieuwoundt, & Steyn, 2002:114).

In an effort to identify the cause for performance in Geometry, some researchers Brodie (2004:22), Attwood (2001:42), Maree et al. (1997:1) have suggested that the enhancement in Geometry at secondary school is influenced by a number of variables. The variables include learners' abilities, attitudes and perception, parent and peer influences, school-related variables such as poor learning environment and

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learning culture. In particular, these explanations fail to account for inter-group achievement difference and the success of some South African secondary learners in spite of these background factors.

In secondary schools, let alone in Grade 12 classes, learning difficulties in Geometry could originate from the learners' under-preparedness, the teacher's presentation of the subject matter and difficulties in the classroom situation and mathematical language.

2.1.2 Conceptualising Enhancement of Learners' Performance

The Human Research Council (HSRC) in partnership with Stanford University (2008:1), indicates that enhancement of learner performance refers to how well the learner accomplishes his or her task and studies; however, there are a number of factors that contribute to the learners' enhancement performance.

While the process of enhancing can be effective and good quality teachers may be produced if it is well implemented, the process has a number of challenges that have been noted. According to Castling (1996:95), the following are some of the challenges:

- Expertise may be intimidating. If the teacher is viewed as an expert, the learner may feel insecure due to teacher's expertise. The learner may not feel free to teach in the presence of the teacher due to fear of displaying his or her ignorance in front of the teacher and this may negatively affect the performance of the learner.
- The teacher may be impatient with the learner. Some teachers may feel that learners waste their time if they continuously seek for assistance. Some teachers may not assist learners effectively.
- Teachers may have an inflexible approach. At times, teachers may not want to change their ways of doing things, which may cause problems for learners who are expected to follow a given way of doing things.
- Since learners are from senior phase, the teacher may take it for granted that the learners know what should be done when in fact learners need guidance

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from teachers. Learners need to fit in the society in which they work so that they can be relevant and this may be achieved through the assistance of the teachers.

Wragg (1998:11) argues that, there is no systematic training for teachers such that it may be difficult to be aware of what one is expected to do, reflecting that at times the teachers may not be aware of the role that they are supposed to play in the process of teaching. Teachers may not be aware because they are neither trained nor inducted on teaching. Wragg (1998:11) adds another dimension when he says that teaching will not be systematic due to lack of knowledge on the part of the teachers this may affect the performance of learners. Wragg (1998:11) points out that not all those selected to be teachers have interpersonal skills; hence, this can lead to conflict and unhappiness. Once there are conflicts, unhappiness between the teacher and the learner, standards are likely to be compromised, and the purpose of teaching may be defeated.

Parental influence can also have a negative influence or positive influence on academic performance of learners because most learners are from poor homes, with little or no educational learning materials at homes (Kirk & Johnson, 2000:2). This implies that learners who receive parental support perform better in their studies. It also means that learners with illiterate parents will come to school with a low intellectual ability and poor attitude to academic work. Parents and teachers play an important role in shaping the academic performance of learners.

The school environment, such as infrastructure and physical structures, can also influence learner performance. It is impossible for good teaching and learning to take place in such conditions. This means that the issue of poor schools may make the learner uninterested in the performance. The school environment can also determine teacher effectiveness in the classroom (Kirk & Johnson, 2000:2).

Teaching methodology, styles of assessment and lack of background knowledge have a strong influence in the performance of learners in Geometry. The level of teaching and quality of learning activities given to learners has a negative impact on the performance of learners. The quality task for learners, test scores, intellectual

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attitude of the learners, previous in structural quality, prior knowledge, parental influence and the environment at home can influence the learners' performance (Dhigra & Manhas, 2009:59).

2.2 FACTORS THAT FACILITATE LEARNERS' PERFORMANCE

In investigating factors that facilitate performance in Geometry, variables related to school, learners and teachers would be reviewed. In this regard, Malcolm et al. (2000:1) suggest that when investigating factors that facilitate performance in Geometry, a more extensive investigation should consider learner, teacher and school variables.

2.2.1 School-Related Variables

Several studies have shown a positive correlation between secondary school environment and learner achievement at school. For example, in the Western and Northern Cape provinces, which have a large white population and well-endowed communities and schools, learners lead in pass rates in Grade 12 examinations, whereas those in Limpopo Province, with its black population majority, rank last in this regard (Murray,1997:376). A comprehensive study on the status of Mathematics teachers in South Africa found that black learners were underprovided for and performed worse than their white peer group in this subject (Arnott et al., 1997:1). Although the above findings show in general that disadvantaged learners tend to perform worse than other learners, some studies indicate that some underprivileged learners perform better than privileged learners.

a. Learning Environment

According to Tsanwani (2009:19), a learning environment comprises teachers, existing curriculum, instructional equipment as well as the institutional and larger learner community. The school environment, such as infrastructure and physical structures as well as facilities, can also influence poor academic performance. For example, classrooms in rural schools are often in a poor state. It becomes impossible for good teaching and learning to take place in such conditions. The

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school environment can determine a teachers' effectiveness in the classroom (Dhigra & Manhas, 2009:59). One can therefore state that learners who attend under- resourced South African schools have been educationally disadvantaged through a lack of opportunities to access quality educational service.

b. School and Class Size

School and class sizes have been shown to have an impact on learners' success. Lee, Smith & Croninger (1997:128) observed that larger schools have a negative influence on academic achievement in secondary school Mathematics. In contrast, Leithwood (2004:59) found no relationship between the size of the school and scholastic achievement; effective school can be very small, very large or somewhat in between. Leithwood (2004:59) further observes that the relationship between the size and the learners' achievement is not well- defined for classes with 20 to 40 learners. Class sizes of below 20 learners have been found to be advantageous for disadvantaged learners. In this respect, Leithwood (2004:59) argued that small school sizes facilitate interaction and inhibit teacher specialization.

c. Curriculum

Many concerns have been emphasized in the literature about the existing Geometry curricula. The concerns here are not that learners' should never learn to compute, but that learners' must learn how to critically analyse geometrical problems and produce effective solutions. This requires them to learn, how to make sense of complex Mathematics emotions concepts and how to think geometrically (Cobb, Yakkel & Wood, 2009:99). Many geometry curricula overemphasize memorization of facts and underemphasize understanding and application of these facts to discover, make connections, and test Geometry concepts. Memorization must be raised to conceptualization, application and problem solving for learners' to successfully apply what they learn. An impressive body of research suggests that curriculum that considers learners' incapable of meta-cognitive actions for example, complex reasoning should be replaced with the one that sees learners' who are capable of higher-order thinking and reasoning when supported with necessary and relevant knowledge and activities (Tsanwani 2009:20). Research has also revealed evidence

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that curricula in which learners'' knowledge and skills grow, is significantly connected to their learning, and therefore their achievement (Lehren & Chazan, 1998:1).

d. Culture

South Africa is a country of diverse culture, as manifested by the notion of "rainbow nation". Barnett and Pierce (1999:615) point out that culture is the aggregate of attitudes tradition, and ethical codes peculiar to the particularly society. Internationally much has been written about the relationship between culture, Geometry learning and teaching. The topics range from cultural bases for Geometry, geometric development from different cultures, the effect of culture on geometry learning and political effects of societies on Mathematics. Maree (1997:145) states that people's cultural background can influence aspects of geometry that different cultures may stress. Research in Geometry education has sought to understand how cultural differences affect learners' performance in Mathematics (Maree, 1997:145). Analyses of studies on culture and Geometry of the following reveal some general factors that affect geometry performance:

- Societal influence;
- Parental attitudes, values and beliefs;
- Teachers attitude, values and beliefs;
- Learners' perception and beliefs; and
- Language.

Tsanwani (2009:23) states that blacks in the United States of America underachieve greatly in geometry and blames this on cultural-related factors such as:

- inability to see the usefulness of Geometry to their lives, both present and future;
- lack of success in previous Geometry courses;
- failure to receive positive career counselling;
- absence of role model;
- lack of significant others, such as parent, who shows an interest in Geometry achievements; and

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- view of Mathematics as a subject appropriate for white males only (Maree, 1997:145)

2.2.2 Learner-Related Variables

Learners themselves contribute to the high failure rates in Geometry because of negative attitude towards the section. As a Mathematics teacher, I found that learners hate this section. The mixing of circles and lines when proving theorems frustrates them.

The learner- related variables are as follows:

a. Attitudes and Beliefs

The positive attitudes learners in Geometry have in South Africa will be enable the country to produce the required number of engineers, technologists and scientists. If the attitude of the learners towards this section of Geometry is positive, the learners will perform well. According to McLeod (1992:575) factors such as attitudes and beliefs play an important role in Geometry achievement.

Stuart (2000:330) argues that, peer and family attitudes toward geometry either may positively or negatively influence learners' confidence in Geometry. The findings are that learners who have positive attitudes towards their teachers have high achievement levels. Newman & Schwager (1993:3) found that in all grades a sense of personal relatedness with the teacher is important in determining a learners' frequency in seeking help from the teacher.

Girls and boys in middle school tend to have different attitudes towards Geometry. Studies have shown that more boys than girls have positive attitudes at the middle school and high school levels (Fennema & Romberg, 1999:126). Furthermore, (Fennema & Romberg, 1999:126) emphasize that for both males and females ability and achievement in Geometry results in positive attitudes to Geometry. The perceived usefulness of Mathematics for educational and career goals, and the positive influence of key reference groups, such as parents, teachers, counsellors,

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and peers, was found to be particularly important in forming positive attitudes to Geometry.

Most of the studies focus on the relationship between the learners'' Mathematics achievement and learners'' attitude towards Mathematics. In Turkey, Aksu (1991:185) focused on the effects of gender on learners'' attitude towards Mathematics. Although their subjects were from different grade levels (secondary school and university), they reported that there is no significant mean difference between attitude scores of girls and boys.

At the same time, in Turkey, only one study dedicated to possible effects of learners'' attitudes towards Geometry on their Geometry achievement was found. Bulut (2002:126) has developed an attitude scale to measure learners'' attitudes toward Geometry. It is widely believed that a teacher's attitude towards Geometry affects learners'' attitude. A study conducted by Bayram (2004:46) established that prospective teachers for the lower grade levels (Grade 1 to Grade 9) have less favourable attitudes towards Mathematics than prospective high school Mathematics teachers. Since learners' tend to form lasting attitudes towards Mathematics during their middle school years Bayram (2004:46), it is essential that their teachers have a positive attitude towards Mathematics. When concrete materials are used in Geometry lessons, both teachers and learners' report that they enjoy Geometry lesson learning more (Bayram, 2004:46). This is only one of the many ways that teachers can create a positive attitude in the maths classroom. Because Geometry achievement is closely linked to the attitude, improving achievement necessarily improves the attitude (Bulut, 2002:126).

b. Peer Pressure

Peer pressure in geometry affects all learners, successful ones as well as those who are less successful. The effect of negative peer pressure has been recorded in numerous articles (Stuart, 2000:330). In this regard Stuart, (2000:330) argues that peer and family attitudes towards geometry either may positively or negatively influence learners' confidence in the subject. Accordingly, Reynolds and Walberg (1992:306) identified peer attitude as one of the most influential factors in learners'

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geometrical achievements. According to Harris (1995:17) learners are ridiculed by their peers for taking challenging Geometry while others are encouraged by their peers to pursue academic excellence in Geometry.

c. Enjoyment and Ability

Learners who enjoyed and have ability in Geometry perform better than those who hate it. Ma (1997:17) observed that in the case of trigonometry learners, the attitude that Geometry was important and enjoyable was significantly associated with achievement in Mathematics. According to Ma (1997:17), learners who have more enjoyable experiences while learning Geometry achieve higher scores. In a study of Grade 10 to 11 Geometry classes, Klemm, (2007:3) explores aspects of the relationship between learners' beliefs about geometry, their sense of geometry as a discipline and their relationship with it, and their geometry performance. Klemm, (2007:3) found the following: Learners who think less of their Geometry ability tend to attribute their geometrical success more to luck and their failures to lack of ability, whereas those who consider themselves good at Geometry attribute their success to their ability.

Learners studied by the researcher made a distinction between the Geometry they know and experience in the classrooms and abstract geometry, the discipline of creativity, problem solving, and discovery, about which they are told but have not yet experienced (Klemm, 2007: 3). Learners tend to think of classroom Mathematics as requiring memorization of equations and formulas and knowing the rules (Klemm, 2007: 3).

2.2.3 Teacher-related variables

Teacher's knowledge and command of the subject are important in the performance of the learner. Most teachers do not enjoy teaching Geometry so they do not spend more time in this section. Meyer and Kloehler (1990:60) state that one of the most important factors in developing learners' Geometry ability is the attitude of their teacher of Geometry. According to Meyer and Kloehler (1990:60) knowledge of the

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learners thinking is important while teachers 'knowledge of Geometry content and pedagogy is also critical to the culture of the learning environment.

a. Attitude of Teachers Towards Geometry

In geometry research, one area of focus has been on teachers' belief and attitudes towards Geometry. Ernest (1999:67) observed that the practice of teaching Geometry depends on a number of key elements, such as the teachers' mental contents and schemes, particularly the system of beliefs concerning Geometry and its teaching and learning; the social context of the teaching situation, particularly the constraints and opportunities it provides and teachers' level of thought process of reflection.

b. Attitude of Teachers towards Learners in Geometry

Research related to the issue of attitude toward learners in Geometry is extensive. One of the most important factors in developing learners' Geometry ability is the attitude of the teacher towards learners. Fennma and Romberg (1999:1) state that it is not only the teachers' beliefs about geometry and its usefulness that are important, but also that the teachers' beliefs about their learners' ability to do Geometry have an influence on how they teach and subsequently on how learners learn.

c. Teacher Quality

Sarason (1993:1) maintains that if one wants to change the education of learners, one needs to first change the education of the teachers. According to Sarason (1993:1), it is necessary to prepare teachers for what life is like in classroom, school, school systems and society. The preserve and continuing education of teachers of Geometry should provide them with the opportunity to examine and revise their assumptions about how Geometry should be taught, and how learners learn geometry (National Council Teachers of Mathematics, 1989:160).

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2.2 CHALLENGES RELATED TO LEARNERS IMPROVEMENT IN GEOMETRY AT SECONDARY SCHOOL

During the fifteen years that I was a teacher of Mathematics in Grades 8–12, I learnt that learners' who are entering senior secondary school education have many problems with Geometry. One of the aspects I have experienced for example was that, even if the learners' know the names of the geometric figures/shapes, they are not familiar with their properties, and are not always able to point out specific differences expressed in the definitions. Clements & Battista (1995:48), who emphasise the difficulty of the passage from middle school to high school in USA support this experience. They hold that the major focus of standard elementary and middle school curricula is only on recognising and naming geometric shapes, writing the proper symbolism for simple Geometric concepts, developing skills with measurement and construction tools such as a compass and protractor, and using formulas in geometric measurement. Clements & Battista (1995:45) further explain that the said curricula consist of a number of things mixed together in no particular order of unrelated concepts with any systematic progression to higher levels of thought, levels that are required for sophisticated concept development and substantive geometric problem solving. Primary school teachers generally tend to spend the minimum amount of instruction time on the teaching of Geometry (King, 2002:178). When the subject is taught, it is usually done using the traditional transmission model. As a result, learners' have problems with conceptual understanding in the higher standards or grades where deeper knowledge of geometric concepts is expected or presupposed (King, 2002:178).

In my view, learners' do not receive adequate and age-appropriate, high quality/proficient teaching from teachers at the primary phase. This is largely because teachers do not have the necessary knowledge of Mathematics. For example, Thekwane (2001:1) points out that the majority of teachers have weak backgrounds in the subject matter of Mathematics. As a result, they commonly express a fear of or anxiety about Mathematics. Teaching Geometry therefore remains problematic because it requires knowledgeable and competent teachers. Due to teachers' poor mathematical backgrounds, many abstract concepts and formulas are introduced without paying much attention to aspects such as logic,

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reasoning, and understanding (Karnasih & Soeparno, 1999:1). This causes many of the learners' to think that geometry is very difficult to learn (Kerans, 1994:1). In support of the latter statement, Thekwane (2001:1) also reports that it is well known that on average pupils' performance in matric (Grade 12) Geometry is far worse than in algebra. In my personal experience, this also applies to South Africa. For example, learners' in South Africa are often passive throughout the Mathematics lessons; 'chalk and talk' is the preferred teaching style; emphasis is always made on factual knowledge and questions which require only single word answers, and often answered in chorus. Consequently, learning for conceptual understanding is inhibited.

The Mathematics curriculum at secondary in South Africa is divided into General Education Training (GET) and Further Education Training (FET). Despite the education system advocating a learner-centred approach, the Mathematics curriculum, in my view, is still examination- driven. Therefore, teaching for conceptual understanding is difficult. Instead, teachers in general tends to give learners' mainly what they think is important for their examinations at the end of the year.

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2.3.1 Problems Encountered by Learners in Learning Geometry in a Second Language

Learners encounter many problems when using a second language to learn Mathematics in general, Geometry in particular. The use of English as a medium of instruction in the South African classroom in black schools has been found to be one of the reasons for poor performance in Geometry. The issue concerning second language problems has a bearing on learning Geometry by inductive approach, since it involves reading and understanding instructions.

The use of English in black schools as language of instruction from Grade 5 was a political decision influenced by the Soweto Uprising of 1976 (Setati, 2009:65). The decision was also based on the reasoning that learners' would be able to communicate in English if they learn it in the early grades. This approach has not

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been successful because learners still cannot handle Mathematics learning content in English (Setati, 2009:65).

Hunter (1990:34) is of the opinion that language-related obstacles that hinder maximum performance in Geometry might be divided as follows:

- Communicative difficulties; and
- Ordinary English and the language of Mathematics.

Nowadays, Mathematics teachers use the constructivist approach to teach Mathematics. This approach has implications for the use of the language of instruction in the learning of Geometry, since it involves learners communicating with one another. In order for them to be actively involved in the discussion, they should be able to communicate with one another.

2.3.2 Constant Change within the Curriculum

In the early 1980s, the USA concerned itself with curricula, which were not keeping up with the dynamic changes of the profession. In general, poor courses planning meant that learners had major gaps in their knowledge, understanding and skills (Grover, 2000:47). The challenges that were encountered in developed countries with regard to the teaching and learning of geometry led to changes of the curriculum as follows:

- Better planning of Geometry education, drawing on national guidance, to build on learners' prior learning;
- Increase pace of work and greater challenge in task set; and
- Improve approaches to assessing and recording pupil achievement, and an increase in direct teaching

According to Grover (2000:47), developed countries have introduced a curriculum that reflect the demand not only of the field of knowledge, but also the field of skills and capabilities, and the field of human qualities and dispositions. This in turn, emphasises the importance of teachers understanding the complexity of the task of teaching and the relationship between how they act in the classroom and the lessons

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of the young people really learn. It is no longer sufficient for teachers simply to be masters of their subjects and to be the source of insight and truth. In developing countries like Botswana, the Mathematics syllabus is built on the foundation laid by the junior secondary Mathematics. It is also caters for learners who are very motivated but have no previous encounter with Geometry.

The introduction of Outcomes-based Education (OBE) in 1998 may bring a new culture of teaching and learning Geometry. The new policy document shows that Mathematics should be learnt through investigations and discovery (DNE, 1997:20). It places emphasis on formulating, testing and justifying conjectures and solving problems. Geometry has been defined in terms of space shape and motion. The new curriculum places emphasis on teaching Geometry through integration of both Euclidean and Non-Euclidean Geometries (DNE, 1997:10). These aspects are learnt inductively. This shows that the new curriculum is in line with Geometry curricula in other countries.

The Minister of Education in South Africa appointed a panel of experts in July 2009 to investigate the nature of the challenges and problems experienced in the implementation of the National Curriculum Statement. This decision to review the curriculum was based on commitment to improving the quality of teaching and learning in South African schools in both the short and long-term period (DoE, 2009:55). DoE (2009:62) recommended that changes should occur within the framework of a five-year plan from 2010 to 2014. The National Curriculum Statement documents such as learning guidelines and assessment guidelines were to be resolved and made available to schools, district's offices and to parent via the media. Subject advisors in Mathematics were given the task of moderating the curriculum.

At the time of conducting this study, the policy document National Curriculum and Assessment Policy Statement (CAPS) for Further Education and Training (FET) was being implemented in Grade 12. It has been already been pointed out that Geometry problems (theorems) may be taught both inductively and deductively. In other words, the inductive approach should play a major role in discovering theorems while the deductive approach should test and justify them. A foundation will have

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been laid in senior phase classes for learners to cope with the deductive approach in the FET Phase. Teaching geometry in the junior secondary phase is an indication that Geometry curricula give learners the opportunity to express themselves. The question is whether teachers will implement what is in the curriculum.

The Geometry curriculum places emphasis on learning discovery. It gives learners an opportunity to experiment, conjecture and explain. This is an indication that the inductive approach has a role to play in learning Geometry. Geometry has also been used as a vehicle for the inductive approach.

2.3.3 Teachers Qualifications and Training

Developed countries like New Zealand encounter the problem of teacher qualification because the training system is split according to different categories of teachers and their related culture (Seng, 2003:4). According to Laderrier (2002:8), the major problem was on the educational background and the civil status of French teachers. There was a weak interest in the French academic world in educational science, especially in the teaching and learning process.

Secondary education was dominated by the mono-disciplinary education of future teachers. The training of teachers in developed countries was insufficient and not related to the real teaching and learning condition that existed in secondary schools. Teachers were not trained in aspects like designing the curriculum and assessment strategies. There was no professional development for teachers (Kelly, 1998:67). Countries like Hungary also experienced a problem of the demand and supply of teachers. They have a problem of a shortage of Mathematics teachers.

Teacher Training Colleges in Central and Eastern Europe have lower status than universities. Seng,(2003:4) shows that their institution are often described as failing to keep up with developments, and are extensively criticised as failing to prepare learners' for the appropriate modern teaching approaches. There would seem to be a strong case for reviewing the roles and functions of the former colleges.

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There is a similarity between developed and developing countries; both have many unqualified teachers in the teaching field. In most developing countries, for example, Zimbabwe, Mozambique and Zambia, teachers do not have formal training in Mathematics. Highly- qualified and experienced teachers seek other professions because the career prospects and remuneration in other sectors are attractive. The private sectors attract Mathematics teachers and hence create a shortage of qualified Mathematics teachers. The deterioration of teacher working conditions has also made it difficult for the Department of Education to attract Mathematics teachers (Ministry of Education in Zambia, 2008:6).

In Zimbabwe, teachers do not have adequate training related to the implementation of the curriculum. The teachers are unable to create their own materials, space of instruction and allocation of time (Ministry of Education Zimbabwe, 2008:5). In Namibia, for example, qualified teachers are unevenly distributed. The Ministry of Education of Basic Education and Culture wrote a report about the equitable distribution of qualified teachers across the country. It is still a problem that cannot be solved, especially in rural areas, where the services of teachers are needed the most.

The issue of quality of training is also crucial. Seng, (2003:4) contends that other problems facing many developing countries are lack of skilled and experienced teachers, those who can teach and develop a curriculum, which can stimulate and allow teachers to achieve good results. In terms of incentives for teachers, in some cases, the additional qualifications in themselves are sufficient rewards, especially when they form part of an accumulation scheme, which builds to nationally-recognised certificates, diplomas and even post-graduate qualifications. Laderriere (2002:6) shows that in some countries, the reward of salary increases based on their qualifications.

Some communities in South Africa are proud of teachers. However, there is criticism in relation to teachers' lack of qualifications, subject knowledge and even commitment. Most teachers are not well- qualified and they are a problem to learners who are willing to learn. According to the Gardiner (2008:25), most of teachers do not have a diploma and yet they are teaching learners who are in Grade

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12. In some provinces, such as Limpopo, Kwazulu Natal and Eastern Cape, teachers are teaching with less than a matric qualification. Some principals and heads of department of Mathematics do not allocate duties to teachers according to qualification. In addition, teachers who are unqualified teach Mathematics, and some of them specialised in Mathematics when they were trained in colleges and universities (Gardiner, 2008:25).

South Africa offers several routes to qualification. For example, one route is a full-time 3 or 4-year degree course, having education as the main focus with teacher training included. A second option might be a subject specific degree with teacher training added during a further year's study and practice. Learners' with subject specific degree are place in schools for their training year (Ngidi, 2005:10). This implies that teachers who furthered their studies are the ones who are recognised in South Africa.

2.3.4 Teacher Experience and Professional Development

According to Ball (1990:66), Mathematics education has not been exposing enough alternatives teaching methods for teaching Geometry, with an emphasis on meaning. They add that pre-service secondary Mathematics teachers often lack sufficient geometrical understanding to teach the subject effectively.

The lack of adequate professional development opportunities for some teachers is a barrier to learners' academic achievement in Geometry. In "Learning without Limits: An agenda for the Office of Post-secondary Education" (2000:30), it was reported that experienced teachers do not have adequate opportunities to improve their knowledge and skills. The report cites the following problems regarding the in-service training of teachers:

- In-service training remains largely short-term and on collaborative
- In-service training is often unrelated to the teacher 'need and challenges faced by the learners
- Teachers are offered in-service training opportunities that last for a few hours (less than eight).

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2.4 STRATEGIES THAT CAN BE USED TO IMPROVE THE QUALITY IN THE PERFORMANCE OF LEARNERS IN GEOMETRY

Robitaille and Garden (1989:1) point out that there are some factors that influence effectiveness of teachers, namely, their teaching strategies, beliefs about teaching, and the general classroom process that provide an immediate learning environment of Geometry. Teaching strategies can be classified in several ways; for example, teacher-centred or learner-centred. Teacher-centred strategies are those in which the teacher has direct control. Learner-centred strategies are those strategies that allow learners to play a more active role.

In this regard, Steen (1998:19) suggests some factors in providing effective instruction for secondary learners, namely;

- He/she argues that the most important factor is the teacher,
- He/she suggested that learners must be engaged in appropriate instruction for sufficient time to master the academic skills,
- A successful lesson includes appropriate expectations, frequent monitoring and helpful feedback.

Furthermore, he/she argues that the entire school experience of the learner should be designed to produce the maximum learning success for each individual. The negative effects of disorganized home environment can be overcome by providing a safe and consistent school environment. The learners' feelings of alienation can be overcome by showing genuine care for them and by involving them and making the school their own.

Ysseldyke, Spicuzza, Kosciolek & Boys (2003:163) identify some of the instructional features that are related to improved learners' achievement in Geometry. Some of these features include:

- Direct and frequent monitoring of progress.
- Corrective and motivational feedback.
- Learner academic involvement.
- Total length of time allocated for instruction.

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2.4.1 Geometry Best Practices

Sabean & Bavaria (2005:1) have synthesized a list of the most significant principles related to Geometry teaching and learning. This list includes the expectations that teachers know what learners need to learn based on what they know, teachers ask questions focused on developing conceptual understanding, experiences and prior knowledge provide the basis for learning Mathematics with understanding, learners provide written justification for problem solving strategies, problem-based activities focus on concepts and skills, and that the Mathematics geometrical curriculum emphasizes conceptual understanding.

The following Geometry best practices for implementing effective Geometry lessons in Mathematics classes should be followed:

- Learners' engagement is at a high level.
- Tasks are built on learners' prior knowledge.
- Scaffolding takes place, making connections to concepts, procedures, and understanding.
- High-level performance is modelled.
- Learners are expected to explain thinking and meaning.
- Learners self-monitor their progress.

The role of discovery and practice and the use of concrete materials are two additional topics that must be considered when developing a programme directed at improving Geometry achievement. Sabean & Bavaria (2005:1) examined research, which suggested that such a programme must be balanced between the practice of skills and methods previously learned and new concepts discovered. This discovery of new concepts, they suggest, facilitates a deeper understanding of geometrical connections.

Johnson (2000:1) reported findings that suggest that when applied appropriately, the long-term use of manipulative materials appears to increase geometric achievement and improve learner attitudes towards Geometry. The utilization of manipulative materials helps learners understand mathematical concepts and processes,

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increases thinking flexibility, provides tools for problem-solving, and can reduce geometric anxiety for some learners. Teachers using manipulative materials must intervene frequently to ensure a focus on the underlying geometrical ideas, must account for the "contextual distance" between the manipulative materials being used and the concept being taught, and take care not to overestimate the instructional impact of their use.

Sabean & Bavaria (2005:1) have summarized the research suggesting that the development of practical meaning for geometrical concepts is enhanced using manipulative materials. They have further suggested that the use of manipulative materials must be long-term and meaningfully-focused on geometrical concepts.

The National Council of Teachers of Mathematics has developed a position statement, which provides a framework for the use of technology in Mathematics teaching and learning. The NCTM statement endorses technology as an essential tool for effective Mathematics learning. Using technology appropriately can extend both the scope of content and range of problem situations available to learners'. NCTM recommends that learners and teachers have access to a variety of instructional technology tools, teachers be provided with appropriate professional development, the use of instructional technology be integrated across all curricula and courses, and that teachers make informed decisions about the use of technology in Mathematics instruction (Johnson, 2000:1). Acknowledging and responding to the varied learning styles of learners' is a critical component of effective inquiry oriented standards-based geometric instruction.

Effective strategies for differentiating geometry instructions include rotating strategies to appeal to learners'' dominant learning styles, flexible grouping, individualizing instruction for struggling learners, compacting (giving credit for prior knowledge), tiered assignments, independent projects, and adjusting question level (Jonhson, 2000:1).

The recent results from the Third International Mathematics and Science Study (TIMSS) have made many teachers in the United States and Canada take a closer look at strategies and techniques used by Japanese teachers in teaching Geometry.

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TIMSS results documented the advanced performance and more in depth mathematical thinking of Japanese learners'. A central strategy in the success of the Japanese Mathematics teachers has been the use of Lesson Study, an instructional approach that includes a group of teachers developing, observing, analysing and revising lesson plans that are focused on a common goal. This process is focused on improving learners thinking and includes selecting a research theme, focusing the research, creating the lesson, teaching and observing the lesson, discussing the lesson, revising the lesson and documenting the findings. A key element of the Lesson Study process is that it helps to facilitate teachers working together using interconnecting skills across grade levels and lessons (Johnson, 2000:1).

2.4.2 Learners' Desire to Explore Geometrical Figures be made Innovative and Practical

Geometry education can be traced previous years and was a response to the failure of traditional teaching methods, the impact of technology on curriculum and the emergence of new approaches to the scientific study of how Geometry is learned. Basic to the reform movement was a standards-based approach to the "what and how" of Geometric teaching (Battista, 1999:80).

In the new Mathematics approach, the focus is on problem-solving, geometrical reasoning, justifying ideas, making sense of complex situations and independently learning new ideas. Learners must be provided with opportunities to solve complex problems, formulate and test Geometrical ideas in Mathematics and draw conclusions. Learners must be able to read, write and discuss geometrical concepts in Mathematics, use demonstrations, drawings and real-world objects, and participate in formal geometrical and logical arguments (Battista, 1999:80).

The driving force behind the standards-based approach to Geometry of instruction has been the standards developed by the National Council of Teachers of Mathematics (NCTM). The Principles and Standards for School Mathematics, published by NCTM in 2000, outline the principles and standards for developing a comprehensive school Mathematics programme. The document delineates six guiding principles related to equity, curriculum, teaching, learning, assessment and

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technology, and identifies five content and process standards outlining what content and processes learners should know and be able to use. The content standards are organized around content strands related to numbers and operations, algebra, Geometry, measurement and data analysis and probability. The process standards are organized around the areas of problem-solving, reasoning and proof, communication, connections and representations (Johnson, 2000:1).

A set of basic assumptions about teaching and schooling practices is implicit. First, all learners' must have an opportunity to learn new Geometry. Second, all learners' have the capacity to learn more Geometry than we have traditionally assumed. Third, new applications and changes in technology have changed the instructional importance of some geometrical concepts. Fourth, new instructional environments can be created using technological tools. Fifth, meaningful geometrical Mathematics learning is a product of purposeful engagement and interaction which builds on prior experience (Romberg, 2000:54).

A recent concept paper published by the American Mathematical Society has been influential in identifying some common areas of agreement about Geometry. The identified areas of agreement are based on three fundamental premises; basic skills with numbers continue to be important and learners need proficiency with computational procedures, Geometry requires careful reasoning about precisely defined objects and concepts, and learners' must be able to formulate and solve problems.

The areas of agreement emerging from these premises include:

- Geometrical Mathematics fluency requires automatic recall of certain procedures and algorithms.
- Use of calculators in instruction can be useful but must not impede the development of fluency with computational procedures and basic facts.
- Teachers must ensure that the use of "real-world" contexts for teaching Geometry maintains a focus on mathematical ideas.

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- Geometrical concepts should be taught using multiple strategies; however, the teacher is responsible for selecting the strategies appropriate for a specific concept.
- Geometrical Mathematics teachers must understand the underlying meaning and justifications for ideas and be able to make connections among topics (Ball, Ferrini-Mundy, Kilpatrick, Milgram, Schmid & Scharr, 2005:12).

2.4.3 Standards-based Mathematics

Standards-based instruction in Geometry is designed to clearly identify what learners should learn at each level. Standards provide more than a curriculum framework as they delineate the skills, concepts and knowledge that are to be mastered. For successful standards-based implementation, teachers must understand the rationale for using standards, know applicable national and state standards and use them as a basis for planning instruction, and implement best practices instructional strategies. Essential characteristics of an effective standards-based Mathematics classroom include:

- Lessons designed to address specific standards-based concepts or skills.
- Student-centred learning activities.
- Inquiry and problem-solving focused lessons.
- Critical thinking and knowledge application skills.
- Adequate time, space, and materials to complete tasks.

Varied, continuous assessment, designed to evaluate both student progress and teacher effectiveness (Johnson, 2000:1).

The implementation of a standards-based Geometry curriculum brings with it some special challenges. In addition to ensuring learners are actively engaged, teachers should adhere to the following guidelines:

- Create a safe environment where learners' feel comfortable.
- Establish clear procedures and routines.
- Provide both challenge and support.
- Use carefully assigned and well-managed cooperative groups.

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- Make frequent real life connections.
- Use an integrated curriculum.
- Provide engaging educational experiences that is relevant to learners'.
- Present activities where learners' produce and share products (Johnson, 2000:3).

2.4.4 Mathematics Instruction and Assessment

Johnson (2000:1) reported research suggesting that the impact of standards in establishing external assessment expectations is profound. Understanding these standards and their related assessments allows teachers to plan and adjust instruction accordingly. Effective assessment of Geometric learning must be performance-based, use multiple strategies and employ more open-ended assessment tasks than have been used in the past. Effective assessment practices are essential to support Mathematics instruction that produces improved student performance. Teachers and learners have been placed under tremendous pressure to prepare learners for the accountability measures and standardized tests required. Despite these pressures, Mathematics teachers must resist the tendency to rely on the results of standardized tests only to measure learner performance in Geometry (Johnson, 2000:1).

Assessment in a standards-based environment requires that learners be judged in terms of mathematical literacy, understanding of concepts and procedures, and the application of mathematical knowledge in problem-solving situations. Since most traditional assessment strategies were not designed for these purposes, new assessment models must be developed. One such model, developed by the Organization for Economic Cooperation and Development, focuses on assessing large ideas such as change and growth, space and shape, and chance. The model also organizes the assessment of thinking skills into three categories focused on tasks requiring simple computations and definitions, tasks requiring that connections be made to solve problems and tasks requiring higher level mathematical thinking and analysis (Romberg, 2000:56).

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Assessment strategies can be classified as diagnostic, formative or summative. The manner in which teachers use assessment in their instruction is a major variable in determining learner achievement. Diagnostic assessment strategies are focused on assessing learner prior knowledge, strengths, weaknesses and skill levels. Formative assessments are directed at providing immediate feedback and evidence of student performance. Summative assessments are more comprehensive and are typically administered at the end of a specific unit or timeframe (Johnson, 2000:1).

Assessment strategies can also be characterized as traditional or alternative in nature. Multiple choices, true/false or matching tests represent traditional approaches to assessment, whereas, strategies such as portfolios, journal writing, student self-assessment, and performance tools may be considered alternative assessment strategies.

Traditional and alternative assessments may be used for diagnostic, formative or summative purposes (Johnson, 2000:1).

2.5 WAYS IN WHICH LEARNERS' CAN LEARN, UNDERSTAND, GRASP GEOMETRICAL CONCEPTS, GEOMETRICAL THEOREMS AND APPLICATION THEREOF

There are so many ways to get learners involved in learning geometrical concepts. There are many hand-on activities, such as geoboards, construction with compass and protractor, measuring angles and side that can be used. In addition, there are so many interactive website such as activities with Geometry's sketchpad that can be used. This activity allows learners to experiment and do hands-on on activities, which can lead to them to discover geometric principles. Even young children (Van de Walle, 2001:12) could easily grasp the basic concepts of parallel lines, shapes, etc. Hands-on activities will provide learners' with the opportunity to investigate, to build and take part, to create and make drawings, and to observe about shapes in the world around them (Van de Walle, 2001:12). This provides the basis for more formal activities at higher levels later on.

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Understanding Geometrical Concepts or Van Hiele Levels

During the primary school years, most learners are making the transition from inductive methods of reasoning (conclusions based on several past observations) to a more formal method of deductive reasoning (proving statements from accepted postulates, definitions, theorems and given information (Mateya, 2008:14). However, learners at this age may be functioning at many different levels of reasoning ability. Therefore, before beginning instruction, it is important to assess learners' reasoning level. This allows teachers to differentiate instruction based on student readiness. There are five developmental levels of geometric reasoning based on a study by Dina van Hiele-Geldof and her husband (Mateya, 2008:14) .They are:

- **Level 0 (Basic Level): Visualization**

At this level learners' view objects as entire entities, not noticing individual components or properties. The focus is on the whole object, not its parts. Learners reason about basic Geometry concepts, primarily by means of visually consideration of the concept as whole. In Geometry, learners recognize Geometry by changes in the figure and motion "visual approach" without explicit regard to their properties.

- **Level 1: Analysis**

Learners' begin to recognize that geometric shapes have parts and special properties. However, they are not able to describe how these properties are related, nor are they able to understand definitions. Learners also see each property in isolation from other properties

- **Level 2: Abstraction**

At this level, learners' comprehend the connection between properties within geometric figures and from one set of figures to another. Learners are able to follow proofs, but are not able to construct one themselves. Learners perceive the implication and class inclusion of the properties.

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- **Level 3: Deduction**

At this level, learners can construct a geometric proof and understand the connection between postulates, theorems, and undefined terms.

- **Level 4: Rigor**

At this level, learners see Geometry in the abstract. Learners can move between different geometric systems and can compare and contrast them (Mateya, 2008:25).

A number of assumptions are basic to the Van Hiele model.

- Learners'' levels are not affected by their age;
- Learners' must master each developmental level to progress in their geometric understanding; and
- Level is determined by concepts that have been taught to the learners'.

At primary school level, it is of utmost importance that teachers begin to prepare learners for the more formal study of Geometry to follow in high school.

2.6 COMPUTER AND INTERACTIVE GEOMETRY

A computer can really help in geometrical teaching, since it allows a dynamic, interactive manipulation of a figure. A learner can move, rotate or stretch figure and observe what properties stay the same. There are also exist dynamic Geometry software that is specifically designed to teach Geometry in an interactive investigation way.

Developed countries make use of commercial software as it prepares learners for lifelong learning, as well as technological environments in the teaching and learning of Geometry. According to Jayaprakash (2005:1), the use of computers in the learning of geometry equips learners with critical thinking skills to solve problems. Learners have to derive their own skills while the teacher just gives guidance. Developed countries have been teaching Geometry through the internet for a while. The teachers communicate with learners through computers. When learners are

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ready for a test; they do that on the internet and get results immediately. Learners find it interesting, as teachers teach them on- line.

2.7 USING EDUCATIONAL TECHNOLOGY

Technology is very important in the teaching and learning of Geometry and they improve the performance of learners if properly used. Let us imagine a Mathematics class full of Geometry learners' with iPads. The teacher asks a question to find the best geometric form of a deep-sea submarine. What can the learners do? The learners can find out the necessary information about how deep the ocean is, about what kind of pressures exist there, and the maths necessary to determine the strongest geometric form. They can also collaborate with their peers by walking across the room and showing them their results on the iPad. In addition, they can ask the teacher questions through the network, and the learners can find, or better yet, create pressure simulations to predict the results. They can check out lectures from experts and professors at iTunes U, and they can share and save what they have learned with other learners' on the network. They can graph their results, sketch a possible example of what a submarine of this form might look like, and then do a presentation on what they learned (John, 2012:1).

The teacher might be tempted to direct the learners to use a Geometry sketch program, a Geometry vocabulary program, a self-paced Geometry lesson, or an online lecture. While these are good application of computers, these restrict and funnel learner thinking, rather than expand it. The teacher could have 30 learners, not all doing the same thing at the same time on their iPads, but this makes sense. The learners have a powerful information tool in their hands, and as The Common Core State Standards for Mathematics require learners to think critically and solve problem solve, there is no way that a teacher can get learners to become independent learners in sync. While there may be some useful apps that help the learner gain the skills, knowledge or insight into the subject, and a teacher might want the class to do it together, focusing solely on the apps, or student control, limits the true potential of the iPad - "a tool to think with" (John, 2012:1).

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2.8 TEXTBOOKS

Developed countries are able distribute textbooks to their schools timeously and ensure that those textbooks cover the same outcomes to be achieved by learners who are studying Mathematics. Teachers in these countries are involved in making decisions on the textbooks they will use in teaching and learning (NCTM, 2000:10).

Teachers are also trained on how textbooks are selected. In South Africa, the DoE (2009:54) recommended that each learner must be provided his or her own textbook in relation to the availability and use of textbooks in the teaching and learning of Geometry. The DoE had promised to issue guidelines of formal procedure for textbook retrieval, which strengthen best practices in the schools. The teachers will be provided with better and more teaching materials, which would facilitate their task. In relation to this, better maintenance of the school buildings is called for.

2.9 INFLUENCE OF PARENTS ON STUDYING GEOMETRY

Tan and Laswad (2006:23) have found that the international learners', in particular, regard the views of parents and career counsellors as important in the selection of the intended area of specialization. These findings are consistent with the findings of the World Bank Organisation, which found that Asian learners' tend to place more value on the opinion of important references, particularly their parents in their major intentions.

Shafika (2007:12) points out that it is not only student's own perception that affect their career decisions, but also the perception of those around them. Therefore, their Mathematics teachers from high schools or university, parents, relatives or friends influence learners in developing countries. Some studies show that teachers do not play a significant role in student choice of majors. In contrast, Shafika (2007:13) shows that referents have an influence on student's choice of major. The evidence regarding the influence of others, for example, parents and friends is also inconclusive. Studies such as Tan and Laswad's (2006:24) indicate that parents, followed by instructors, had a strong influence on learners'' choice of major.

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In South Africa, parental role is also encouraged. Teachers in secondary schools seek greater parental participation in the education of their children. Their parents with homework do not assist most of the learners in rural areas. It was also noted that there was a notable improvement amongst learners who are assisted by parents. The DoE (2009:32) introduced School Governing Bodies (SGBs), in order to involved parents in the education of their children.

2.10 COOPERATIVE LEARNING IN MATHEMATICS CLASSES

Working within a group at school helps learners develop efficient team skills. It improves their communication abilities needed in cooperative learning settings. Forsyth, Lolliffe & Stevensens (1999:1) underlined some of the objectives of cooperative learning method, such as actively involving learners in the learning process, increasing their motivation, encouraging learners to learn from each other, giving learners the opportunities to express their opinions and ideas, improving oral communication among the learners, allowing learners to work independently of the larger group, and encouraging learners to take responsibility for their own learning.

Cooperative learning method has recently attracted more scholarly attention than other teaching methods because of its sociological, psychological, educational, and pedagogical benefits. Many research findings underlined the positive cognitive and affective results of cooperative group instruction. It was noted that cooperative group instruction could enhance learners' geometrical performance, develop friendships between learners', and enhance self-esteem (Guyton, 1991:315).

Cooperative learning method improves thinking abilities. The researchers stated that cooperative learning improves performance in many subject areas and at all age levels, especially for those activities that require concept attainment. Forsyth, Jolliffe & Stevens (1999:1) concluded that group instruction allows learners to achieve cognitive skills of higher order such as synthesis and analysis and to develop attitudinal skills. Likewise, Stewards & McCormack (1997:167) emphasized that in a positive motivational environment that involves interaction with the others, learners learn better. According to Kutnick & Rogers (1994:1), effective small-group work provides a good climate for the learner. Slavin (1990:29) reviewed 46 studies on

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cooperative learning in different areas and reported that cooperative learning increased learners' performance.

Turkish scholar came to similar results. Erdem (1993:1) stated that cooperative learning method increased achievement scores of university learners'. Similarly, Bulut (2002:126) found that learners taught through cooperative learning methods have higher test scores in probability than learners taught by traditional learning method.

Cooperative learning also increases learners'' motivation to learn. Good et al., (1989-90:56) reported that learners who worked in cooperative learning settings were more active, motivated and enthusiastic about Geometry. Good's study showed that learners respond to work in cooperative groups in different ways. Some learners become active, while others prefer to be passive and show minimal involvement in the group activities. While most low achievers manifested a passive behaviour, some high achievers tended to work alone.

The educator is also responsible for orchestrating cooperation among learners. For example, Slavin & Karweit (1994:29) notes that mere telling learners to cooperate are not enough.

A programme based on cooperation among children must be engineered to overcome the problems that emerge during group work and adapt cooperative activities to the need of learners and the limitations of the classroom. Teachers should be aware of the individual differences between the learners in order to promote active involvement of all learners into the classroom activities. At the same time, the teacher must ensure that the group has the resources, such as intellectual skills, relevant information and properly prepared task instructions, necessary to complete the assignment successfully. Learners' prerequisite skills are important factors influencing the success of both individual learner and a group. The task of instructions should also be clear to avoid misunderstanding.

Finally, groups should be provided with corrective feedback that helps avoid misunderstandings and misconceptions. Providing feedback-correctives would

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encourage all group members to help each other achieve the common goal (Mevarech, 1991:225).

Cooperative learning method is one of the most effective learning methods. Current scholarship holds that this method is very effective in increasing learners'' achievement in Geometry. In addition, cooperative learning method gives learners an opportunity to develop their personal, social and psychological skills. However, one should remember that benefits of cooperative learning could be properly achieved only in a long-term application. The short-term treatment only may bring about an improper outcome.

2.11 STATUS OF GEOMETRY TEACHERS

Out-dated teaching practices and lack of basic content knowledge have resulted in poor teaching standards. A large number of under-qualified or unqualified teachers who teach in overcrowded and non-equipped classrooms have also exacerbated the poor standards. The combination of all these factors has in turn produced a new generation of teachers who are further perpetuating the cycle of mediocrity (DoE, 2001:6). The National Teacher Education Audit of 1996 followed by the Mathematics and Science Audit of 1997 produced factual and statistical revelations about teachers and teaching in these areas. Whilst policies and programmes were produced on a general scale, very little has happened at a systemic level to address the challenges of providing quality of Geometry teachers.

The Mathematics Audit revealed that more than 50% Geometry teachers have had no formal subject training. The problem of inadequate training was particularly identified in the GET phase (DoE, 2001:12). An estimated 8 000 – Geometry teachers therefore needed influential development to address their shortcomings in these subjects (DoE, 2001:12). Another problem is that very few learners' graduating with Mathematics choose teaching as a career. A consequence of this is a vicious cycle of not many learners' taking Mathematics related subjects at universities, resulting in an under-supply of teachers. In some instances, this has resulted in schools not offering Mathematics. Even those that offer this subject do not have facilities and equipment to promote effective teaching and learning. This

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situation has resulted in the teaching of Geometry, for example, remaining at a theoretical level without proving any theorem to enhance understanding and application of knowledge.

To overcome problems, such as under-qualified teachers and too few learners' taking Mathematics related subjects, a number of initiatives and programmes have been developed at national and provincial levels as well as by higher education institutions. From the government side, a typical example is the setting up of Dinaledi schools, which are to be increased to about 400. The Dinaledi focus schools project is described as: The Dinaledi Focus Schools Project is part of the National Strategy for Science, Mathematics and Technology, to increase the number of learners studying Mathematics in Grades 10–12; to increase the number of higher grade learners in these subject, especially girls and formerly disadvantaged learners; to increase the pass rate and achievement in Geometry in these grades; to develop the capacity of the Mathematics teachers (DoE, 2005:1).

Universities have also introduced bridging courses aimed at improving the content knowledge of Mathematics learners' entering university. What has been shown is the fact that a number of issues affect the teaching and learning of Geometry throughout the school system in South Africa.

2.12 CONCLUSION

Major findings from the literature review indicate that the main factors contributing to the performance of learners in geometry in secondary schools incudes the way newly-appointed teachers have been trained, also the fact that there are some teachers who still possess an M+3 which is regarded as the lowest qualification in South Africa. Inadequate roles of subject advisors, compounded by the fact that they also received inadequate training, constant changes within the curriculum, which confuses the teachers, especially when it comes to teaching strategies or methodology that, may use to teach Geometry, and the effectiveness of the educator in the classroom. The performance of learners in Geometry is also affected by the physical structures, which are not in good condition; some of educational media are not available at school. The attitude of teachers and learners towards Geometry is

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also influenced by some factors. The ultimate result is a shortage of Mathematics teachers as they leave the teaching profession for other private sectors. There are learners who lack parental help when studying Mathematics as most of them are not qualified to teach Mathematics. The size of the classroom and condition of the classroom also contribute to the academic performance of learner. Knowledge of the subject content and English as medium of instruction also contributes to learners' performance. Several strategies for teaching and learning Geometry were discussed in Chapter 2. Chapter Three presents the research design and methodology of the study.

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CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter presents research design and methodology, qualitative and quantitative methods, population and sample, data collection procedures, research instruments, trustworthiness, research ethics, data analysis and summary. This section provides an exposition of the research design and subsequent methods of data collection.

3.2 RESEARCH DESIGN

Creswell (2009:107) defines the research design as a set of guidelines and instruments to be followed in addressing the research problem. The research design summaries the model, which was used in the study. This study adopted the mixed methods design. A mixed methods design is the type of research in which the researcher combines elements of qualitative and quantitative research approaches for the purposes of breadth and depth of understanding and corroboration (Creswell, 2010:123).

3.3 RESEARCH METHODOLOGY

Research methodology refers to the different techniques, methods and procedures that were used in the process of implementing research design or research methods (Creswell, 2009:18).

The following was an outline of the methods that were used to collect data:

3.3.1 Qualitative Research Methods

Qualitative data was collected through interviews. An interview is a method of data collection, information or opinion gathering that specifically involves asking a series of questions. Most commonly, interviews are conducted on a face-to-face basis and

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they can take a variety of forms. They can range from informal, unstructured, naturalistic, in-depth discussions through to very structured formats with answers offered from a prescribed list in a questionnaire or standardized interview schedule (Jupp, 2006:157 and Creswell, 2009:181). According to Creswell (2009:16), the purpose of qualitative research is to try to gather full information in a real setting, in order to develop understanding of everything being answered by participants and observation by the researcher. Teachers, heads of departments, school principals and subject advisors were interviewed.

3.3.2 Quantitative Research Methodology

Quantitative data was accessed through questionnaires to establish the views of learners on their performance in the Euclidian Geometry. A questionnaire is a set of carefully designed questions given in exactly the same form to a group of people in order to collect data about some topic in which the researcher is interested (Jupp, 2006:252). The researcher administered questionnaires to selected learners' who participated in the study.

3.3.3 Population

The population was comprised of all the FET band learners who chose Mathematics as a field of study at secondary schools in Nzhelele East Circuit.

3.3.4 Sampling Procedures

Two sampling procedures were used to determine the sample. Purposive sampling was used to select participants who contributed to the qualitative data because they had the relevant knowledge. Cluster and random sampling methods were used to select learners who participated in the study. Cluster sampling was used to classify schools into three categories of low, average and high performing. Each cluster had three schools. This means that nine schools were selected for this study. From each cluster, the learners who participated were in grade 10, 11 and 12.

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3.3.5 Sample

A sample is the number of participants who are selected from the population and from whom data are collected (Tavakoli, 2012:561). The sample consisted of 6 school principals, 6 heads of departments and 6 teachers who participated in the interviews. Nine schools were selected and questionnaires were administered to 405 learners of which 45 were randomly selected from each school. In addition, 15 learners were randomly selected from each grade level.

3.3.6 Data Collection Procedures

Permission to conduct the study was sought from the Vhembe District office. After that, the purpose of the study was exposed to the participants. An interview with principals, heads of departments and teachers was scheduled separately. Questionnaires with learners were administered within a period of one hour in the classrooms.

3.4 RESEARCH INSTRUMENTS

This section describes the instruments that were used to collect data. The interview schedule and questionnaires were designed according to the objectives of the study.

3.4.1 Interview

According to Van den Aardweg & Van den Aardweg (1998:120), an interview is a goal-directed attempt by an interviewer to obtain reliable valid measures in the form of verbal responses from one or more interviewees. In this study, 6 school principals, 6 heads of departments and 6 teachers were interviewed.

3.4.2 Questionnaires

A questionnaire is a set of structured questions that enables the participants to answer them according to their experiences and opinions. It is a data-collecting instrument where participants directly supply their own answers to a set of questions

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(Van den Aardweg & Van den Aardweg, 1998:190). In this case, the researcher designed a structured questionnaire that was administered to randomly selected learners who chose Mathematics as the field of study. In this study, 405 learners were answered questionnaires.

3.5 TRIANGULATION DATA

Triangulation is an approach to inquiry that combines both qualitative and quantitative forms. It involves the use of qualitative and quantitative approaches and the mixing of both approaches in a study so that the overall strength of a study is greater than either qualitative or quantitative research (Creswell, 2009:4). The researcher based the inquiry on the assumption that collecting diverse of data best provides an understanding of a research problem. This approach is useful when either the qualitative and quantitative approach by itself is adequate to the best understanding of a research problem or strength of both quantitative and qualitative research can provide the best understanding (Creswell, 2009:16). In this study, triangulation was achieved by conducting interviews, administering questionnaires and analyzing performance of learners in Geometry at secondary schools. Principals, heads of department and educators were interviewed, learners were answering questionnaires to ensure that the data collected from interviewed and questionnaires were valid and reliable.

3.6 PILOT STUDY

A pilot study is often described as a smaller version of the proposed study and is conducted to refine the methodology (Hallway & Jefferson, 2007:94). A pilot study helps to identify possible problems in the proposed study and allows the researcher to revise the method and instrument before the actual study is conducted (De Vos, Strydom, Fouche & Deport, 2005: 54).

In order to increase the validity of this study, questionnaires and interview questions were first piloted to determine whether they elicited the intended responses (Hallway & Jefferson, 2007:94). The aim of the pilot study was to give the researcher an insight on whether the intended questions to be given to learners' would yield the

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desired data required to answer the research questions. The class and age group of learners' in the pilot study and that of the final group study were the same. In order to determine to what extent they understood the question and to decide whether some of the contents of the questions should be reconstructed or not, I decided to assess the time they took to complete the task and other difficulties such as language, meaning, and choice they make (Thomas, 2003:59). After the pilot study of questionnaires, I administered an interview. Responses from the questionnaires and interview went through the same analysis to determine learners'' difficulties. The process of the interview had to be improved upon. This was because I initially planned that the interview will be conducted for three days. However, I realised after the pilot study that respondents were not willing to stay behind for too long after school. Hence, the interview was restructured to accommodate three respondents per day. This then made the interview to last for six days, and three respondents were interviewed per day. During the interview, and questionnaires, I reiterated that the information would be kept confidential and used for research purposes only.

3.7 TRUSTWORTHINESS

Trustworthiness seeks to establish the credibility of the research. This study used multi-methods of both qualitative (interviews) and quantitative (questionnaires) approaches. In this case data drawn from different participants (principals, heads of departments, teachers and learners) and at different times and in different schools was triangulated (Jupp, 2006:305). According to Shenton (2004:63) trustworthiness involves establishing credibility, transferability, dependability and conformability.

3.7.1 Credibility

Credibility in qualitative research is defined as, the extent to which the data and data analysis are believable and trusted. Credibility is analogous to internal validity; that is, how research findings match reality. However, according to the philosophy underlying qualitative research, reality is relative to meaning that people construct within social contexts (Shenton, 2004:71). In this study, the researcher piloted the interview schedule. During the analysis of the piloted data, the researcher always checked participants' responses against the research questions and objectives.

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Participants' responses spoke to the research questions. To ensure honesty in participants, prior to conducting the interviews, the researcher explained to participants that their participation must be voluntary and they are free to quit at any stage during the interview and no reason of quiting will be demanded from them. The researcher pledged to respect confidentiality and anonimity and ensured participants that there are no wrong or right responses to questions.

3.7.2 Transferability

Research findings are transferable or generalizable only if they fit into new contexts outside the actual study context. Transferability is analogous to external validity, that is, the extent to which findings can be generalized (Shenton, 2004:69). The researcher ensured transferability as an aspect of trustworthiness by providing information such as nine secondary schools being purposefully selected from Nzhelele east circuit in the Vhembe District. The researcher was the only fieldworker and conducted a total of 18 interview sessions and 405 questionnaires. The conception of involving more than one school from circuit was a transferability measure as the researcher constantly compared the responses with policy stipulations and literature results.

3.7.3 Conformability

Shenton (2004:72) avers that conformability is the qualitative investigator's comparable concern to objectivity. Shenton cautions that steps must be taken to help ensure as far as possible, study that the findings are the result of the experiences and ideas of the research participants, rather than the characteristics and preferences of the researcher. Thus, researcher ensured that the sample size, respondents and similar research instruments were used. This researcher adhered to this as evident in Chapter Four where the analysis of each question was backed up by a quotation of the response of a participant. In all instances, such a quotation is one of many representing the view of the majority.

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3.7.4 Dependability

Dependability is analogous to reliability; that is, the consistency of observing the same finding under similar circumstances. According to Merriam (1998:205), dependability refers to the extent to which research findings can be replicated with similar subjects in a similar context. It emphasises the importance of the researcher accounting for or describing the changing contexts and circumstances that are fundamental to consistency of the research outcome. In this study, this may be achieved through the use of overlapping methods such as focus group and individual interview which is the case in the present study as the data were collected using learners' and individual interviews.

3.8 VALIDITY AND RELIABILITY OF THE STUDY

This section describe the validity and reliability of the study

3.8.1 Validity of the Study

Validity refers to the extent to which inferences made based on numerical scores are appropriate, meaningful and useful to the sample (McMillan & Schumacher, 2001:90). Validity also checks whether the instruments provides an adequate sample of items that represent that concept (De Vos et al., 2005:160).

In this study, both construct and content validity were used to check if the questionnaires and interview questions really measured the concepts that I assumed it measured.

3.8.2 Reliability of the study

The reliability of a measurement procedure is the stability or consistency of the measurement. This means that if the same variable is measured under the same conditions, a reliable measurement procedure will produce identical measurements. In other words, it refers to a measuring instrument's ability to yield consistent

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numerical results each time it is applied; it does not fluctuate unless there are variations in the variable being measured (De Vos, 2005:160).

The reliability of a test or instrument refers to the extent to which it consistently measures what it is supposed to measure (Creswell, 2010:91). A test is reliable to the degree that it measures accurately and consistently, yielding comparable results when administered a number of times (Creswell, 2010:91). To ensure reliability of the data collected in this study, the contents of the questionnaires and interviews went through verification from an independent body (colleague) that is knowledgeable in the line of Mathematics education to ascertain the degree to which the contents of the test items and interview were in harmony with the intended purpose. The initial suggestions and input from the verification exercise from my professional colleagues, led me to reframe, add and delete some existing questions.

3.9 RESEARCH ETHICS

Participants of the study remained anonymous. All the participants were treated with respect. Each one signed a consent form, which explained the purpose of the study and their rights such as withdrawal from participation should they wish to do so without being compelled to give an explanation.

3.10 DATA ANALYSIS

Data analysis is the process of reducing accumulated data to a manageable science developing summaries looking patterns and performing statistical analyses (Tavakoli, 2012:144). Two types of data were analyzed that is qualitative and quantitative data. Qualitative data was analysed by the thematic analysis and quantitative data was analysed by the statistical package for social sciences (SPSS) Version 22.

3.11 CONCLUSION

This chapter addresses the research design and methodology of the investigation that was conducted in secondary school in Nzhelele East Circuit. A detailed description of the study samples, instruments used was discussed. The chapter

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further described the sampling, data collection methods, trustworthiness and analysis. The next chapter presents the analysis of data collected from the questionnaires and interview.

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CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

This chapter presents the findings on FET band learners, school principals', head of departments and teachers. The purpose of this study was to investigate how learners perform in Euclidian Geometry as a branch of Mathematics at the FET band of secondary schools. The methods used in this study were qualitative and quantitative. Qualitative data was analysed through thematic analysis and quantitative data was analysed through the Statistical Package for Social Sciences (SPSS) Version 22.

The two research questions that guided the study were:

- What are the factors that contribute to learners' performance in Euclidian Geometry as a branch of Mathematics?
- How can Geometry be taught to learners in terms that are easy to understand?

The findings were presented and discussed according to the two research questions stated above.

The questionnaires for learners comprised of the following salient headings:

- Biographical information;
- Factors that contribute to learners performance in Geometry; and
- Strategies that can be used to teach Geometry in terms that is easy for learners to understand.

Data is organized in terms of the following headings:

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SECTION A: BIOGRAPHICAL INFORMATION

4.2 DATA PRESENTATION PERTAINING TO LEARNERS

The following are the data presentation pertaining to learners.

4.2.1 Gender of the Respondents

Table 4.1 shows that 52% (218) of the learners were males, while 46.2%(187) were females. The data also indicates that there were more females than males completing the questionnaire. This means that this category seems to have more females than males doing Mathematics.

Table 4.1: Gender

Gender	Frequency	Percentage
Male	187	46.2
Female	218	53.8
Total	**405**	**100**

4.2.2 Age Group

From Table 4.2 it can be noted that 57.7% (233) of the learners were aged between 15 and 17 years. 35.1% (142) of the learners were between 18 and 20 years of age, while 6.4% (26) were between 21 and 23 years. Only 1% of the learners were between 24 and 26 years. The age distribution, as reflected in Table 4.2 reveals that most of the learners started primary school at the appropriate age. This implies that this is the accepted age of learners in secondary schools.

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Table 4.2: Age

Age group	Frequency	Percentage
15-17	233	57.5
18-20	142	35.1
21-23	26	6.4
24-26	4	1.0
Total	**405**	**100**

4.2.3 Number of Dependents

Table 4.3 shows that learners with no dependents were about 33.6% (136) of the respondents, while 22.0% (89) of the learners had a dependent. 25.7% (104) learners had two dependents, while 18.5% (75) had three dependents. The remaining 2% (1) did not respond. The data revealed that most of the learners live alone, without parents, while others live with them. This could influence the performance of learners in a subject such as Mathematics, which needs constant support by teachers and parents.

Table 4.3: Number of Dependents

Dependent	Frequency	Percentage
No dependant	136	33.6
1 dependant	89	22.0
2 dependent	104	25.7
3 dependant and above	75	18.5
No response	1	2
Total	**405**	**100**

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4.2.4 Level of Education

Table 4.4 shows that 34% (141) of the learners were in Grade 10 while 35% (143) were in Grade 11 and 29% were in Grade 12. The data reveals that the percentages in grades were more or less the same.

Table 4.4: Level of Education

Grade	Frequency	Percentage
Grade 10	141	34
Grade11	143	35
Grade12	119	29
No respond	2	5
Total	**405**	**100**

4.2.5 Home Language

The majority of the learners were Venda- speaking who constituted 92.6% (375) of total the respondents. Another 3.2% (13) respondents had Sepedi as their home language, while 1.7% (07) were Tsonga-speaking and 1.5% (06) were Sotho-speaking. Other languages constituted 1% (4). The majority of learners were Venda- speaking because the schools are situated in a Venda- speaking area.

Table 4.5: Home Language

Language	Frequency	Percentage
Venda	375	92.6
Sepedi	13	3.2
Tsonga	07	1.7
Sotho	06	1.5
Others	4	1.0
Total	**405**	**100**

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SECTION B: FACTORS THAT CONTRIBUTE TO LEARNERS' PERFORMANCE IN GEOMETRY (See Appendix A)

The following are the data presentation pertaining to factors that contribute to learners' performance in geometry.

4.2.6 The Learning Environment is Conducive for Learning

Table 4.6 shows that 28.4% (115) of the learners strongly agreed that the learning environment is conducive for learning Mathematics; 43.0% (174) agreed with this statement; 15.6% (63) disagreed and 12.8% (52) strongly disagreed that learning environment is conducive to learning. The responses imply that the infrastructure and facilities were conducive for learning, while other schools need to be developed. The school environment can determine teacher effectiveness in the classroom (see paragraph 2.1.2, p.19).

Table 4.6: Conducive Learning Environment

	Frequency	Percentage
Strongly agree	115	28.4
Agree	174	43.0
Disagree	63	15.6
Strongly Disagree	52	12.8
Total	404	99.8
Missing system	1	2
Total	**405**	**100**

4.2.7 Schools in Rural Area Perform better in Mathematics than Schools in the City

Table 4.7 shows that 14.1% (57) of the learners strongly agreed that school in rural areas perform better in Mathematics than those in the city; 26.7% (108) agreed;

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33.6% (136) disagreed; 25.7% (104) strongly disagreed. This means that the classrooms in rural areas are in a poor state to enable effective learning and teaching of Geometry to take place. The rural learners tend to perform worse than other learners do (see paragraph 2.2.1, p.21).

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Table 4.7: Level of Performance of Schools in the City and Schools in Rural Area

	Frequency	Percentage
Strongly Agree	57	14.1
Agree	108	26.7
Disagree	136	33.6
Strongly Disagree	104	25.7
Total	**405**	**100**

4.2.8 Class Size Contributes to the Performance of Learners in Mathematics

Table 4.8 shows that 21.7% (88) strongly agreed that class size contributes to the performance of learners in Mathematics; 38.8% (157) of the learners agreed; 26.2% (106) disagreed with this, while 13.3% (54) strongly disagreed. The implication is that class size contributes to learner performance in Mathematics. The larger classes have a negative influence on academic achievement of learners in Geometry at secondary schools (see paragraph 2.2.1, p.21)

Table 4.8: Class Size Contributes to the Performance of Learners in Mathematics

	Frequency	Percentage
Strongly Agree	88	21.7
Agree	157	38.8
Disagree	106	26.2
Strongly Disagree	54	13.3
Total	**405**	**100**

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4.2.9 Your School is well-resourced in the Teaching and Learning of Geometry

Table 4.9 indicates that 20.0% (81) of the learners strongly agreed that their schools are well-resourced in the teaching and learning of Geometry; 32.1% (130) agreed; 30.6% (124) disagreed, while 17.3% (70) strongly disagreed. This response implies that resources in most of the schools are adequate whereas in other schools are inadequate for effective teaching and learning of Geometry. The most significant contribution to improvement in Geometry teaching can be made by the development of good resources, supported by carefully designed activities (see paragraph 2.1.1, p.15).

Table 4.9: Availability of Resources

	Frequency	Percentage
Strongly Agree	81	20.0
Agree	130	32.1
Disagree	124	30.6
Strongly Disagree	70	17.3
Total	**405**	**100**

4.2.10 Curriculum Changes Affect the Learners' Performance in Geometry

Table 4.10 shows that 25.5% (102) of the learners strongly agreed that curriculum changes affect the learners' performance, while 39.5% (160) agreed to the statement. The table further shows that 23.2% (94) disagreed, while 12.1% (49) strongly disagreed. The responses imply that constant changes within the curriculum affect learners' performance in Geometry. Because the teachers resist to changes and still use the old methods of teaching. Therefore, learners lack the knowledge, understanding and skills that affect their performance in Geometry (see paragraph 2.3.2, p.29).

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Table 4.10: The Impact of Changes in the Curriculum

	Frequency	Percentage
Strongly Agree	102	25.2
Agree	160	39.5
Disagree	94	23.2
Strongly Disagree	49	12.1
Total	**405**	**100**

4.2.11 Culture Contributes to Learners' Performance in Geometry

Table 4.11 shows that 11.1% (45) were strongly agreed that culture contribute to learners' performance in Geometry; 20.7% (84) of the learners agreed; while 34.1% (138) of the learners disagreed and 33.8% (137) of the learners strongly disagreed to the statement. Culture background influences aspect of Geometry that different culture may stress. Learners perform poorly in Geometry and blame cultural-related factors such as inability to realise the usefulness of Geometry in their lives, both present and future; lack of success in previous Geometry courses; failure to receive positive career counselling; absence of role models; parental attitudes, values and beliefs (see paragraph 2.1, p.22).

Table 4.11: Culture Contributes to Learner Performance in Geometry

	Frequency	Percentage
Strong Agreed	45	11.1
Agreed	84	20.7
Disagree	138	34.1
Strongly Disagree	137	33.8
Total	404	99.8
System	1	2
Total	**405**	**100**

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4.2.12 The Foundation of Learners is in Mathematics in Primary Schools Affects Learner Performance

Table 4.12 indicates that 32.6% (132) of the learners strongly agreed that the foundation of learners in Mathematics in primary schools affects learner performance; 29.1% (118) agreed, while 23.5% (95) disagreed and 14.8% (60) strongly disagreed. The responses imply that the learners' had a poor foundation in Mathematics in primary schools, as such cannot solve problems even when similar Geometry examples were given. Lack of foundation in lower classes makes learners fail to cope with the deductive approach in FET phase (see paragraph 2.3.2, p.30).

Table 4.12: The Maths Foundation in Primary Schools Affects Learners' Performance

	Frequency	Percentage
Strongly Agree	132	32.6
Agree	118	29.1
Disagree	95	23.5
Strongly Disagree	60	14.8
Total	**405**	**100.0**

4.2.13 Learning and Teaching Media Makes Teaching and Learning of Geometry more effective

Table 4.13 indicates that 33.3% (135) of the learners strongly agreed that learning and teaching media makes teaching and learning of Geometry easy; 44.4% (180) agreed, while 13.3% (54) disagreed and 8.9% (36) strongly disagreed. This response implies that if learning and teaching is done through media, the learners' performance in Geometry will improve. If there is poor infrastructure in schools to the extent that some of the classrooms do not have electricity, teaching and learning cannot take place through learning channels or the computer (see paragraph 2.2.1, p.23).

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Table 4.13: Educational Media Make Teaching and Learning of Geometry More Effective

	Frequency	Percentage
Strongly Agree	135	33.3
Agree	180	44.4
Disagree	54	13.3
Strongly Disagree	36	8.9
Total	**405**	**100**

4.2.14 Attitude Contributes to Learners' Performance in Geometry

Table 4.14 shows that 36.6% (136) strongly agreed that attitude contribute to learners' performance in Geometry; 38.8% (157) agreed with this, 17.5% (71) disagreed and 10.1% (41) strongly disagreed. The responses imply that the attitude of learners' towards learning Geometry is very poor**.** Learners' attitudes towards Geometry either may positively or negatively influence learners' confidence in Geometry (see paragraph 2.2., p.23).

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Table 4.14: Attitude of Learners

	Frequency	Percentage
Strongly Agree	136	33.6
Agree	157	38.8
Disagree	71	17.5
Strongly Disagree	41	10.1
Total	**405**	**100**

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4.2.15 Boys Perform Better than Girls in Geometry

Table 4.15 shows that 24.9% (101) strongly agreed that boys perform better in Geometry than girls; 18.3% (74); 24.4% (99) disagreed and 32.3% (131) strongly disagreed. The responses imply that there are more girls than boys because there is a higher percentage of strongly disagree. It appears as if no girls agree with the statement. More boys than girls have positive attitudes towards Mathematics at the schools (see paragraph 2.2.2, p.23).

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Table 4.15: Boys Perform Better than Girls in Geometry

	Frequency	Percentage
Strongly Agree	101	24.9
Agree	74	18.3
Disagree	99	24.4
Strongly Disagree	131	32.3
Total	**405**	**100**

4.2.16 Peer Pressure Affects Learners' Performance in Geometry

Table 4.16 indicates that 40.0% (162) of the learners strongly agreed that peer pressure affects learners' performance in Geometry; 33.3% (135) agreed with the statement, while 17.0% (69) disagreed and 9.6% (39) strongly disagreed. This response implies that peer attitude is one of the most influential factors in learners' geometrical achievements. Peer pressure in Geometry affects all learners, successful ones as well as those who are less successful**.** Their peers from taking challenging geometry discourage learners, while others are encouraged by their peers to pursue academic excellence in Geometry (see paragraph 2.2.2, p.25).

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Table 4.16: Peer Pressure Affects Learners' Performance in Geometry

	Frequency	Percentage
Strongly Agree	162	40.0
Agree	135	33.3
Disagree	69	17.0
Strongly Disagree	39	9.6
Total	**405**	**100**

4.2.17 Interest in Geometry Improves Learners' Performance

Table 4.17 shows that 45.5% (186) of the learners strongly agreed that interest in Geometry improve learners' performance; 36.3% (147) agreed; 10.4% (42) disagreed and 7.4% (30) strongly disagreed. The responses imply that interest of Geometry in learners improves performance. The implication here is that the interest of learners in Geometry contributes to their achievement in the subject area. In general, learners show interest in Geometry as a useful and important topic to learn, which provides them with certain skills and background, which are directly related to their future careers (see paragraph 2.2.2, p.25).

Table 4.17: Interest in Geometry

	Frequency	Percentage
Strongly Agree	186	45.5
Agree	147	36.3
Disagree	42	10.4
Strongly Disagree	30	7.4
Total	**405**	**100**

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4.2.18 You Enjoy Teaching and Learning of Geometry

Table 4.18 shows that 37.8% (153) of the learners strongly agreed that they enjoy teaching and learning of Geometry; 38.0% (154) agreed with this, while 14.3% (58) disagreed and 9.9% (40) strongly disagreed. The data reflects that most of the responses agreed that they enjoy teaching and learning of Geometry. Learners who enjoyed and have ability in Geometry perform better than those who hate it. Learners who have, more enjoyable experiences while learning Geometry achieves higher scores (see paragraph 2.2.2, p.25).

Table 4.18: Enjoyment of Teaching and Learning of Geometry

	Frequency	Percentage
Strongly Agree	153	37.8
Agree	154	38.0
Disagree	58	14.3
Strongly Disagree	40	9.9
Total	**405**	**100**

4.2.19 Ability in the Teaching of Geometry Contribute to Learners' Performance

Table 4.19 shows that 30.1% (122) strongly agreed that ability in the teaching of Geometry attribute to learners' performance; 50.6% (205) agreed with this, while 12.1% (49) disagreed and 7.2% (29) strongly disagreed. The data reflects that most of the responses agreed that ability in the teaching of Geometry contributes to learner performance. Learners that have more ability while learning geometry achieves higher scores (see paragraph 2.2.2, p.25).

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Table 4.19: Ability of Teaching Geometry

	Frequency	Percentage
Strongly Agree	122	30.1
Agree	205	50.6
Disagree	49	12.1
Strongly Disagree	29	7.2
Total	**405**	**100**

4.2.20 Memorization Helps in the Teaching and Learning of Geometry

Table 4.20 shows that 33.8% (137) of the learners strongly agreed that memorisation helps in the teaching and learning Geometry; 42.7% (173) agreed with this statement; 16.3% (66) disagreed and 7.2% (29) of the learners strongly disagreed. The implication is that learning by memorisation is important for learners. Learners tend to think of classroom Mathematics as requiring memorization of equations and formulas and knowing the rules (see paragraph 2.2.2, p.25). The fact that learners tend to memorize formulas and theorems makes them perform poorly because they forget whatever they were taught.

Table 4.20: Memorization of Geometry

	Frequency	Percentage
Strongly Agree	137	33.8
Agree	173	42.7
Disagree	66	16.3
Strongly Disagree	29	7.2
Total	**405**	**100**

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4.2.21 Psychological Impact of the Topic Geometry Contributes to Learners' Performance

Table 4.21 shows that 18.0% (73) strongly agreed that Psychological impact of the topic Geometry contributes to learners' performance; 42.2% (171) agreed; 28.6% (116) disagreed; and 11.1% (45) of the learners strongly agreed. The responses imply that impact in psychology contributes to learner performance in Geometry. If the psychological impact of the learner towards the topic of Geometry were positive, the learner would perform better (see paragraph 2.2.2, p.23).

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Table 4.21: Psychological Impact

	Frequency	Percentage
Strongly Agree	73	18.0
Agree	171	42.2
Disagree	116	28.6
Strongly Disagree	45	11.1
Total	**405**	**100**

4.2.22 Learners do Solve Geometry Problems at Home, because there is Somebody to Guide them

Table 4.22 shows that 23.3% (95) of the responses strongly agreed that learners do solve Geometry problems at home, because there is somebody to guide them; 34.8% (141) agreed, while 21.7% (88) disagreed and 19.9% (80) strongly disagreed. This means that the assistance that learners' get from parents in solving homework problems enhances their performance. Subjects like Mathematics need constant support from parents. Parents and teachers play an important role in shaping the academic performance of learners (see paragraph 2.9, p.45).

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Table 4.22: Parental Support in Solving Geometry Problems

	Frequency	Percentage
Strongly Agree	95	23.3
Agree	141	34.8
Disagree	88	21.7
Strongly Disagree	80	19.8
Missing	1	2
Total	**405**	**100**

4.2.23 Learners have Mathematical Instruments for Drawing Geometric Shapes

Table 4.23 shows that 32.7% (132) of the learners strongly agreed with this statement, that learners have mathematical instrument for drawings in Geometry; 33.8% (137) agreed; 13.3% (54) disagreed and 20.2% (82) strongly disagreed. The responses imply that most learners have mathematical instruments, which improve their performance in Geometry. The utilization of mathematical instrument helps learners understanding of mathematical concepts and increases thinking and flexibility, and can reduce geometric anxiety for some learners (see paragraph 2.4.1, p.35).

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Table 4.23: The use of mathematical Instruments in Geometry

	Frequency	Percentage
Strongly Agree	132	32.6
Agree	137	33.8
Disagree	54	13.3
Strongly Disagree	82	20.2
Total	**405**	**100**

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4.2.24 The use of Television in the Teaching of Mathematics Affects Learners' Performance

Table 4.24 shows that 19.1% (77) of the learners strongly agreed that the use of television in the teaching of Mathematics affects learners' performance, 33.7% (136) agreed. The table further shows that 27.7% (112) disagreed and 19.5% (79) strongly disagreed. The responses imply that television is necessary to assist learners to understand Geometry. The use of television as an essential tool for effective Mathematics learning and can extend both the scope of content and range of problem situations available to learners' (see paragraph 2.4.2, p.37).

Table 4.24: Educational Media Assist in Learners' Performance

	Frequency	Percentage
Strongly Agree	77	19.1
Agree	136	33.7
Disagree	112	27.7
Strongly Disagree	79	19.5
Missing	1	2
Total	**405**	**100**

4.2.25 Saturdays or/and Winter School Affect Learners' Performance in Geometry

Table 4.25 indicates that 27.7% (112) of the learners strongly agreed that Saturdays or/and winter school affect learners' performance in Geometry; 29.6% (120) agreed, while 20.2% (82) disagreed and 22.5% (91) strongly disagreed. This means that some of learners do not attend extra classes, which makes them perform poorly in Geometry; while the majority of the learners attend extra class. Extra lesson make learners actively involved in the learning process, increase motivation and encourage learners to take responsibility for their own work (see paragraph 2.10, p.46).

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Table 4.25: Extra Lessons in Geometry

	Frequency	Percentage
Strongly Agree	112	27.7
Agree	120	29.6
Disagree	82	20.2
Strongly Disagree	91	22.5
Total	**405**	**100**

4.2.26 Teacher Attitude towards Geometry Contributes to Learners' Performance

Table 4.26 shows that 40.5% (164) of the learners strongly agreed that teacher attitude towards Geometry contribute to learners' performance; 38.0% (154) agreed; 12.8% (52) disagreed and 8.6% (35) strongly disagreed. This indicates that the attitude of teacher towards Geometry is very good. The attitude of teaching Geometry depends on a number of key elements, such as the teachers' mental content and schemes, particularly the system of beliefs concerning Geometry and its teaching and learning; the social context of the teaching situation, particularly the constraints and opportunities it provides and teachers' level of thought process of reflection(see paragraph 2.2.3, p.25).

Table 4.26: Attitude of Teachers in Geometry

	Frequency	Percentage
Strongly Agree	164	40.5
Agree	154	38.0
Disagree	52	12.8
Strongly Disagree	35	8.6
Total	**405**	**100**

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4.2.27 Your Teacher is Competent to Teach Geometry

Table 4.27 shows that 31.9% (129) strongly agreed that their teachers are competent to teach Geometry; 44.0% (178) agreed with this, while 15.8% (64) disagreed and 8.4% (40) strongly disagreed. The data shows that most of the responses supported the statement that their teacher is competent to teach Geometry. The responses imply that the knowledge, skills and competences of teachers directly shape the understanding of learners. The role of the teacher is not clearly spelt out and this result in professional development courses for teachers not being learned properly, as the teachers were not properly trained to support, learners (see paragraph 2.11, p.48).

Table 4.27: Competence of Teachers in Geometry

	Frequency	Percentage
Strongly Agree	129	31.9
Agree	178	44.0
Disagree	64	15.8
Strongly Disagree	34	8.4
Total	**405**	**100**

4.2.28 Your Teacher is Knowledgeable about Geometry

Table 4.28 indicates that 38.5% (156) of the learners strongly agreed that their teachers are knowledgeable in Geometry; 36.8% (149) agreed with, while 13.3% (54) disagreed and 11.5% (46) strongly disagreed. This response implies that the teachers' knowledge is very important because most of the student agree with the statement. Most of the teachers are not well qualified and there is a problem for learners who are willing to learn (see paragraph 2.3.3, p.32).

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Table 4.28: Knowledge of the Teacher in Geometry

	Frequency	Percentage
Strongly Agree	156	38.5
Agree	149	36.8
Disagree	54	13.3
Strongly Disagree	46	11.4
Total	**405**	**100**

4.2.29 Extra Support from Teacher Affects Learners' Performance

Table 4.29 shows that 36.3% (147) of the learners strongly agreed that extra support from the teacher affect learners' performance in Geometry; 30.4%(123) agreed, while 18.0% (88) strongly disagreed and 15.3% (62) disagreed. The data reflects that most of the learners agreed that extra support from the teacher improves the performance of the learners. Extra support preserves and provides learners with the opportunity to examine and revise their assumptions about how Geometry should be taught, and how learners learn geometry
(see paragraph 2.2.3, p.26).

Table 4.29: Extra Support from the Teacher

	Frequency	Percentage
Strongly Agree	147	36.3
Agree	123	30.4
Disagree	62	15.3
Strongly Disagree	73	18.0
Total	**405**	**100**

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SECTION C: STRATEGIES TO ENHANCE TEACHING AND LEARNING GEOMETRY (see Appendix A)

The following are the data presentation pertaining strategies to enhance teaching and learning geometry.

4.2.30 Instructional Materials are Adequate to Teach Geometry

Table 4.30 shows that 23.7% (96) of the learners strongly agreed that instructional materials are adequate to teach Geometry; 47.9% (194) agreed with this statement; 19.0% (77) disagreed and 9.4% (38) strongly disagreed. The responses imply that the availability of instructional materials such as textbooks, workbooks and slides to meet the pedagogical demands of the curriculum imposed on teachers, improve the performance in Geometry. The DoE has promised to issue guidelines of formal procedures for textbook retrieval, which will strengthen best practices in the schools. It will provide teaches with better and more teaching materials, which would facilitate their task (see paragraph 2.8, p.45).

Table 4.30: Instructional Materials

	Frequency	Percentage
Strongly Agree	96	23.7
Agree	194	47.9
Disagree	77	19.0
Strongly Disagree	38	9.4
Total	**405**	**100**

4.2.31 Geometrical Topics in Schools Related to Real Life Situation

Table 4.31 shows that 13.6% (49) strongly agreed that Geometrical topics in schools are related to real life situation, while 36.3% (147) agreed; 28.4% (115) disagreed. The table furthermore shows that 21.7% (88) of the learners strongly disagreed. The

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responses are neutral means that some related geometrical topics are related to real life, while some are not. Teachers must ensure that the use real- life world context for teaching Geometry (see paragraph 2.4.2, p.37). This means that using real-life situation should create a safe environment where learners' feel comfortable.

Table 4.31: Geometrical Topics Related to Real Life

	Frequency	Percentage
Strongly Agree	55	13.6
Agree	147	36.3
Disagree	115	28.4
Strongly Disagree	88	21.7
Total	**405**	**100**

4.2.32 Frequent Monitoring should Improve Learners' Performance

Table 4.32 indicates that 26.7% (108) of the learners strongly agreed that frequent monitoring should improve learners' performance; 48.6% (197) agreed, while 19.0% (77) disagreed and 5.7% (23) strongly disagreed. Learners' argues that if the necessary provisions and monitoring are made, the problem of poor learner performance will be out dated because student performance in Geometry will improve (see paragraph 1.1, p.1). This means that teachers should give support to learners to assist them in solving the problems of Geometry

Table 4.32: Frequent Monitoring

	Frequency	Percentage
Strongly Agree	108	26.7
Agree	197	48.6
Disagree	77	19.0
Strongly Disagree	23	5.7
Total	**405**	**100**

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4.2.33 Frequent Helpful Feedback can Improve Learners' Performance

Table 4.33 shows that 36.3% (147) of the learners strongly agreed with this statement that frequently feedback can improve learners' performance; 46.7% (189) agreed; 9.6% (39) disagreed and 7.4% (30) of the learners strongly disagreed. The responses imply that feedback given by the teacher after assessing their work improves performance in Geometry. Effective assessment practices are essential for supporting Mathematics instruction that produces improved student performance (see paragraph 2.4.4, p.40).

Table 4.33: Helpful Feedback Provided

	Frequency	Percentage
Strongly Agree	147	36.3
Agree	189	46.7
Disagree	39	9.6
Strongly Disagree	30	7.4
Total	**405**	**100**

4.2.34 Spending more Time on the Tasks should Make the Learner Master Geometrical Skills

Table 4.34 shows that 49.9% (202) of the learners strongly agreed that spending more time on the task should makes the learner master Geometrical skills, while 31.4% (127) agreed with the statement. The table further shows that 9.9% (40) disagreed; and 8.9% (36) strongly disagreed. The data reflects that most of the learners supported the value of spending more time on tasks improves the performance of the learners. Learners suggested that spending more time on tasks and being engage in appropriate instruction for sufficient time can help them master the academic skills. Teachers should get enough time to teach Geometry at early time of the year for the learners to understand Geometry content and develop their problem solving skills (see paragraph 2.4, p.34). This means that when learners use

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to practice geometrical skills always it will be easy to them grasp Geometry with easy.

Table 4.34: Spending more Time to Master Geometrical Skills

	Frequency	Percentage
Strongly Agree	202	49.9
Agree	127	31.4
Disagree	40	9.9
Strongly Disagree	36	8.9
Total	**405**	**100**

4.2.35 The Learning Environment should be Made Conducive for Effective Teaching/learning to Take Place

Table 4.35 shows that 31.4% (127) of the learners strongly agreed that the learning environment should be made conducive for effective teaching/ learning takes place; 44.7% (181) agreed with this, 16.85% (68) disagreed and 7.7% (29) strongly disagreed. The data imply that a conducive learning environment encourages learners to achieve excellence in the Geometry. The negative effects of disorganised school environment can be overcome by providing a safe and consistent school environment. The learners' feelings of alienation can be overcome by showing genuine care for them and by involving them and making the school their own (see paragraph 2.4, p.34).

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Table 4.35: Effective Teaching and Learning Environment

	Frequency	Percentage
Strongly Agree	127	31.4
Agree	181	44.7
Disagree	68	16.8
Strongly Disagree	29	7.7
Total	**405**	**100.0**

4.2.36 Learners should be Made to Work Extra–hard to Improve on their Foundation

Table 4.36 shows that 52.8% (214) of the learners strongly agreed that learners should be made to work extra – hard to improve on their foundation; 30.4% (123) agreed, 9.4% (38) disagreed and 7.4% (30) strongly disagreed. The responses imply that extra hard- work of learners help them to identify their strength, which helps them to improve their confidence in learning and increase student motivation to learn. In addition, it encourages learners to learn from each other, allowing learners to work independently of the larger group and encouraging learners to take responsibility for their own learning (see paragraph 2.10, p.46).

Table 4.36: Extra Hard-work Improves the Foundation of Learners

	Frequency	Percentage
Strongly Agree	214	52.8
Agree	123	30.4
Disagree	38	9.4
Strongly Disagree	30	7.4
Total	**405**	**100.0**

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4.2.37 Learners should be More Involved in Practical Work than Theoretical Work

From Table 4.37 it is noted that 37.5% (152) of the learners strongly agreed that learners should be more involved in practical work than theoretical work, while 35.6% (144) agreed. The table further shows that 20.5 % (83) disagreed; while 6.4% (26) strongly disagreed. The data reflects that most of the learners supported the value of involvement in practical work more than theoretical work. This means that practical work makes learners better able to solve problems in Geometry. This comes from the experience of solving problems and using them in daily situations. This can build the confidence of the learners in learning and using Geometry widely (see paragraph 2.4.1, p.35).

Table 4.37: Learners' Involvement in Practical Work

	Frequency	Percentage
Strongly Agree	152	37.5
Agree	144	35.6
Disagree	83	20.5
Strongly Disagree	26	6.4
Total	**405**	**100.0**

4.2.38 Parents should Buy the Necessary Learning Instructional Materials for their Learners/children in School

Table 4.38 shows that 50.6% (205) of the learners strongly agreed that parents should buy the necessary learning instructional materials for their learners/children in school; 31.6% (128) agreed; 10.1% (41) disagreed while 7.7% (31) strongly disagreed. The responses imply that parents have the responsibility of buying the necessary materials to improve the performance of learners in Geometry. Parents should be actively involved in the education of their learners and monitor their

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performance. They should give full support to their children by buying them the necessary materials in order for them to perform well (see paragraph 2.9, p.45).

Table 4.38: Necessary Learning Instructional Materials

	Frequency	Percentage
Strongly Agree	205	50.6
Agree	128	31.6
Disagree	41	10.1
Strongly Disagree	31	7.7
Total	**405**	**100.0**

4.2.39 Learners should be Willing to Learn on their Own

Table 4.39 indicates that 43.2% (175) of the learners strongly agreed that learners should be willing to learn on their own; 33.8% (137) agreed, 13.8% (56) disagreed while 9.1% (37) strongly disagreed. This response implies that most of the learners agreed that learners' willingness to learn on their own improve their performance in Geometry. They should be motivated by the school to learn on their own because it improves their thinking ability and provides a good climate for the learners to learn (see paragraph 2.10, p.46).

Table 4.39: Learners' Willingness to Learn on their Own

	Frequency	Percentage
Strongly Agree	175	43.2
Agree	137	33.8
Disagree	56	13.8
Strongly Disagree	37	9.1
Total	**405**	**100.0**

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4.2.40 Working in Groups can Improve Learners' Performance in Geometry

Table 4.40 shows that 59.9% (242) of the learners strongly agreed that working in groups could improve learners' performance in Geometry; 29.4% (119) agreed, 6.4% (26) learners disagreed while 4.4% (18) strongly disagreed. The data imply that learners understand more when they work in groups and it improves their performance. Working within a group at school helps learners to develop efficient team skills, it also improves their communication abilities, needed in cooperative learning settings. Group method is one of the most important effective learning methods and is very effective in increasing student' achievement in Geometry, it also gives learners an opportunity to develop their personal, social and psychological skills (see paragraph 2.10, p.46).

Table 4.40: Working in Groups

	Frequency	Percentage
Strongly Agree	242	59.9
Agree	119	29.4
Disagree	26	6.4
Strongly Disagree	18	4.4
Total	**405**	**100**

4.2.41 Hands-on Activities in Geometry Help Learners to Grasp Geometrical Concepts effectively

Table 4.41 shows that 28.9% (117) of the learners strongly agreed that hands on activities in Geometry help learners to grasp geometrical concepts effectively; 47.9% (194) agreed; 18% (73) disagreed and 5.2% (21) disagreed. The responses imply that hands-on activities assist learners to grasp the basic Geometry concepts. Hands-on activities provide learners' with the opportunity to investigate, build and take part, create and make drawings, and observe about shapes in the world around

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(see paragraph 2.5, p.41). This means that when learners involved themselves hands-on they will grasp and understand geometrical concepts easier.

Table 4.41: Hands-on Activities Help Learners to Grasp Geometrical Concepts

	Frequency	Percentage
Strongly Agree	117	28.9
Agree	194	47.9
Disagree	73	18
Strongly Disagree	21	5.2
Total	**405**	**100.0**

4.2.42 Interactive Websites should Make Learners Perform Better in Geometry

Table 4.42 shows that 27.2% (110) of the learners strongly agreed that interactive websites should make learners perform better in Geometry, 47.7% (193) agreed while. The table further shows that 18.5% (75) disagreed; while 6.7% (27) strongly disagreed. The data reflect that most of the learners supported the value of interactive websites. Limited access to computers by learners' compromises their learning potential in Euclidian Geometry. There are many interactive website such as activities with a Geometry sketchpad that can be used. This activity allows learners to experiment and do hands-on activities, which can lead them to master discover geometric principles. Even young children could easily grasp the basic concepts of parallel lines, shapes, and so on (see paragraph 2.5, p.41).

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Table 4.42: Availability of Interactive Websites

	Frequency	Percentage
Strongly Agree	110	27.2
Agree	193	47.7
Disagree	75	18.5
Strongly Disagree	27	6.7
Total	**405**	**100.0**

4.2.43 Identification of Properties of Geometrical Figures Improve Learners' Performance

Table 4.43 shows that 34.3% (139) of the learners strongly agreed that identification of properties of geometrical figures improve learners' performance; 47.9% (139) agreed, 12.1% (49) disagreed, while 5.7% (23) strongly disagreed. The data implies that more need to be done in the identification of properties of geometrical figures to improve the learners' performance. There are five developmental levels of geometrical properties, which learners should know to improve their geometric reasoning; namely, visualization, analysis, abstraction, deduction, and rigour (see paragraph 2.5.1, p.42).

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Table 4.43: Identification of Geometrical Figures

	Frequency	Percentage
Strongly Agree	139	34.3
Agree	194	47.9
Disagree	49	12.1
Strongly Disagree	23	5.7
Total	**405**	**100.0**

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4.2.44 Understanding Geometrical Concepts Improves Learners' Performance

Table 4.44 indicates that 49.9% (202) of the learners strongly agreed that understanding geometrical concepts improves learners' performance; 36.8% (149) agreed 8.4% (34) disagreed, while 4.9% (20) strongly disagreed. This response implies that teachers need to put more effort on making learners understand geometrical concepts in order for their teaching to improve performance. Learners' reasoning about basic Geometric concepts is primarily through of visually consideration of the concept as whole . They learners recognize Geometry through changes in the figure and motion "visual approach" without explicit regard to their properties (see paragraph 2.5.1, p.42).

Table 4.44: Understanding Geometrical Concepts

	Frequency	Percentage
Strongly Agree	202	49.9
Agree	149	36.8
Disagree	34	8.4
Strongly Disagree	20	4.9
Total	**405**	**100.0**

4.2.45 Computers and Interactive White-Boards can Make Learners to Grasp Geometrical Concept

Table 4.45 shows that 27.4% (111) of the learners strongly agreed that computers and interactive white-boards could make learners to grasp geometrical concepts easier; 38.8% (157) agreed; 23.5% (95) disagreed, while 10.4% (42) strongly disagreed. The responses imply that most learners' find computer and interactive white boards as the teaching aid that helps them grasp geometrical concepts easier (see paragraph 2.6, p.43). The use of computers in the learning of geometry equips learners with critical thinking skills to solve problems. Learners have to derive their

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own skills, while the teacher just provides guidance. This means that limited access to computer by learners' compromises their learning potential in Geometry.

Table 4.45: Availability of Interactive White Board and Computers

	Frequency	Percentage
Strongly Agree	111	27.4
Agree	157	38.8
Disagree	95	23.5
Strongly Disagree	42	10.4
Total	**405**	**100**

4.2.46 Construction of Simple Geometrical Figures using Straight Edge, Compasses, Protractor and Setsquare Makes Learners to Learn and Grasp Geometrical Concepts

Table 4.46 indicates that 33.8% (137) of the learners strongly agreed that constructional of simple geometrical figures using straight edge, compasses, protractor and setsquare makes learners learn and grasp geometrical concepts easier; 42.2% (171) of the learners agreed with the statement, 15.3% (62) disagreed and 8.6% (35) strongly disagreed. This response implies that the performance of learners would be affected negatively if the necessary teaching aids were not available at their schools, because all geometric figures are drawn using those teaching aids. This ultimately affects the performance of learners in their examination. Learners must be able to read, write and discuss geometrical concepts in Mathematics, use demonstrations, drawings and real-world objects, and participate in formal geometrical and logical arguments (see paragraph 2.4.2, p.37).

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Table 4.46: Construction of Simple Geometrical Figures

	Frequency	Percentage
Strongly Agree	137	33.8
Agree	171	42.2
Disagree	62	15.3
Strongly Disagree	35	8.6
Total	**405**	**100.0**

4.2.47 Calculation of Unknown Angles using Geometrical Properties of Intersecting and Parallel Lines Makes Grasp Learn Geometrical Concepts Easier

Table 4.47 indicates that 37.0% (150) of the learners strongly agreed that calculations of unknown angles using geometrical properties of intersecting and parallel lines makes learners grasp geometrical concepts with easier; 42.0% (170) agreed, 11.9% (48) disagreed, while 8.9% (36) strongly disagreed. This response implies that teachers, which are important for learners to learn Geometry, mostly use geometrical properties. Teachers should realise that what learners need to learn is based on what they know. They ask questions focused on developing conceptual understanding, experiences and prior knowledge to provide the basis for learning Mathematics with understanding. Therefore, learners should provide written justification for problem solving strategies, problem- based activities focus on concepts and skills, and that the Mathematics geometrical curriculum emphasizes conceptual understanding (see paragraph 2.4.1, p.35). This means that learners learn geometrical concepts easier by understanding the concepts.

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Table 4.47: Calculations Makes Learners Grasp Geometry with Ease

	Frequency	Percentage
Strongly Agree	150	37.0
Agree	170	42.0
Disagree	48	11.9
Strongly Disagree	36	8.9
System	1	.2
Total	**405**	**100.0**

4.3 DATA PRESENTATION PERTAINING TO INTERVIEWS (APPENDIX E, F AND G)

The following are the data presentation pertaining to interviews.

4.3.1 Interview Schedule for Mathematics Teachers

The following are the views expressed by the Mathematics teachers concerning the learners' performance of Geometry in secondary schools in Nzhelele Circuit.

Question 1: Learners tend to experience problems in understanding geometrical concepts, such as angles and quadrilaterals, theorems. How can we turn the situation around*? (See Appendix E*)

Some of the Mathematics teachers indicated that Geometry should be learnt practically where each learner should be able to measure angles, draw sketches and interpret. Others teachers also indicated that the situation will be turning by introducing, defining, understanding the terminology used in Euclidean Geometry and teaching the concepts with method and examples easily understood by learners and teachers should start showing geometrical concept at early stages i.e. squares, parallelogram, circles etc. This is what some of them had to say:

> *"We should start by showing geometrical concepts at early stages i.e. squares; parallelogram, circles etc. (see Appendix E line 7). Learners*

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must be encourage to do practical work as far as Mathematics is concerned e.g. learners have to measure the length and the angles of the building and know the symbols of the road signs, thus are good examples of triangles, circle and quadrilaterals (see Appendix E, line 9). Learners able to define and understand the terminology used in Euclidean Geometry like angles, quadrilaterals and theorems" (see Appendix E, line 12).

The teacher by stating that hands –on activities provide student with the opportunities to investigate, build, create, and make drawings and to make observations about the shapes in the world. (see paragraph 2.5, p.41).
This means that practical work improves learners' performance.

Question 2: One of the problems with many geometry learners' is their weakness in the language of Geometry. What can we do to improve this situation? *(See Appendix E*)

Two teachers indicated that we should use simple terms at first before introducing the technical terms. Other teachers believe that learners should learn all the basics concept of Geometry from the lower grade in order to master all geometrical concepts. One of the teachers also indicated that in order to improve the situation, they should teach and link Geometry with real- life situations. This is what some of them had to say:

"The teachers should first allow learners to use simple language for their better understanding of mathematical figures and concepts e.g. similarities where in learners have to compare. They have to learn mathematical slow by slow so that they should be used to it (see Appendix E, line 16). Teach and link Geometry with real life situation. One must appreciate, and understand and interpret Geometry behind. Learners should be compete in mathematically language and mathematically symbols i.e. diagrams and geometrical figures". (see Appendix E, line 19).

Geometry language, especially in the comprehension of Geometry terms, plays a very important role in learning and understanding of geometric terms (see paragraph 1.1.1, 2). Using both first language and English may help learner to have better understand Geometry because learners encounter many problems when dealing with the second language when they learn Mathematics, Geometry in particular. To

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support the above findings the teacher should use simple mathematically language which learners will be able to understand.

Question 3: Geometry riders tend to combine several figures like triangles, circles, rectangle etc. What methods can a teacher use to assist learners to see relationships of these figures? *(See Appendix E*)

The teachers indicated that learners should do many of practical's, interpret all the Geometrical concepts, draw diagrams, practice small portions of riders, giving properties of the shapes and identified their relationships. One of teachers believes that co-operative learning, learners' involvement and problem solving method can be used to assist learners. One of them said the following:

> *"Learners should be encouraged to consider small portion of a rider e.g. a circle or a triangle one after another to analysed to avoid confusion to learners" (see Appendix E, line 25).*

Teaching methods need to encompass the encouragement of the development and the use of conjecturing, deductive reasoning and proof, as well as developing skills of applying Geometry through modeling and problem solving in a range context (see paragraph 1.1.3, p.3).This implies that good methods should encourage learners and makes learners to solve problems of the real world.

Question 4: What strategies would you use to develop a clear understanding of the application of a theorem? *(See Appendix E*)

Teachers indicated that analyses the RTP (in terms of the angles), know different types of angles, state the theorems from the observed result and memorized all properties, link them with the previous one and give them more practical work to do. The excerpt is an example of what they said:

> *"I think stating the theorem from observed results i.e. derive the theorem and not just cram it. Derived theorems are easier remember and easily proved and applied (see Appendix E, line 29). All learners should be able to learn one aspect or diagram at a time. All properties*

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should be mention and linked with the previous one". (see Appendix E 31).

The teachers by showing that it would be helpful for learners' if Geometry lessons could be taught using with hands –on activities; through "touch-see-and-do" and interacting with the objects of their learning, learners' can learn geometry in a more imaginative and successful way(see paragraph 1.1.2, p.2). This implies that one strategy for learning Geometry is through practical work

Question 5: What opportunities would lead learners to discover and conceptualize geometrical concepts on their own? *(See Appendix E*)

Some of the teachers indicated that by giving them exercises related on properties would encourage them to do more activities and practical's. Others teachers also indicated that they should observing, recalling, and comparing geometrical concepts on their own and also indicated that after studying, learners have opportunities of getting themselves working as plumber, builder, electricians etc. Some of them indicated the following:

"Give them exercises on related properties for which they can generalize the concepts, i.e. Use discovery method when introducing concepts (see Appendix E, line 36). After studying, learners has an opportunities of getting themselves working as a plumber, builder, electrician etc." (see Appendix E, line 36).

Opportunities which lead learners to discover and conceptualize geometrical concepts in Mathematics includes focus on problem- solving, geometrical reasoning, justifying ideas, making sense of complex situations independently learning new ideas(see paragraph 2.4.2, p.37).These opportunities help learners to read, write discuss geometrical concepts, use demonstrations, drawing and real world objects, participate in formal geometrical, and make logical arguments.

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Question 6: What learner support materials should teachers use to simplify mastery of geometrical concepts? *(See Appendix E*)

Most teachers believe that mathematical instruments, calculators, textbooks, computer modeling and rubber are relevant materials used to simplify geometrical concepts. The learners support materials mentioned were as follows:

> *"Calculators, mathematical sets, textbooks exercises and computer modeling." (see Appendix E, line 42).*

Some of the materials uses to master geometrical concepts are geoboards, construction with compass, protractors and models of angles (see paragraph 2.5, p.41).

This implies that support materials make learners to master geometrical concepts to improve performance.

Question 7: How do you motivate learners to learn Geometry with ease and in an understandable way? *(See Appendix E*)

Teachers indicated that by giving them more practical work to do so; so that they become well- equipped in Mathematics and solve real- life situation. Others said that teachers must help learners to first discover the concepts and provide easier the easy ways to find the relationships among the concepts. One of them said:

> *"Firstly, I will make use of all the statement that is given regarding the theorems (rider problems). Try to connect what learners know to prove the conclusion deducted from what is given. Also by making learners to know the patterns of each theorems and practically using riders of many various type". (See Appendix E, line 54).*

Teachers must ensure that the use real world context for teaching Geometry maintains a focus on mathematical ideas and it will motivate learners to learn Geometry in an understandable way.

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4.3.2 Interview Schedule for Mathematics Departmental Heads *(See Appendix F)*

The following are the views expressed by the departmental heads concerning the performance in Geometry at secondary school in Nzhelele East.

Question 1: How do you encourage learners to perform optimally in Geometry? *(See Appendix F)*

Heads of department of different schools indicated this can be done that by using practical examples where Geometry has been applied. They said this will encourage this learners to perform better. Others indicated that making learners understand the basic theorems and how to apply them in geometric riders would help and encouraging learners to revise the basic knowledge in Geometry, such as parallel lines, triangle and quadrilaterals. The following are examples of what they said:

> *"First, I will use to let learners to know practical example where Geometry is applicable like roofing where angles are supposed to be measured and to get the examples of real life situation (see Appendix F, lines 61). By showing them the importance of mastering the section of prior grade before attempting the current year content." (see Appendix F, lines 65).*

Practical examples provide learners' with the opportunities to investigate, build, create, make drawings and observe about the shapes in the world (see paragraph 2.5, p.41).This implies that practicing daily geometrical content will improve the results

Question 2: In what ways do you influence Mathematics teachers to improve learner performance? *(See Appendix F)*

Mathematics departmental heads indicated that they inform teachers that they should start with concrete things where learners used to link Geometry with practical examples and influence them to do many exercises with learners. Some indicated that by giving them incentives after performing better and by developing themselves through attending workshops and short courses and encouraging them to love

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Mathematics, will influence the teacher to improve the performance of learners. Some indicated the following:

> *"I know Mathematics is not a difficult subject; I use to inform teachers that they should start with in concrete things where learners use to link Geometry with real things everywhere and to try to find problems areas in order to know where to start (see Appendix F, lines 68). We provided them with certificate of good performance; cash and praise them among other teachers." (see Appendix F, lines 69).*

The practice of teaching Geometry is the key elements, such as the teachers' mental contents and schemes, particularly the system of belief concerning Geometry and its teaching and learning (see paragraph 2.2.3, p.25).

Question 3: What are the challenges you experience in managing teachers who teach Mathematics? *(See Appendix F*)

The heads of department indicated that teachers do not want to teach Geometry in Mathematics paper 2 and said that they always complain that learners are too lazy and do not have any interest in Mathematics. Others indicated that most Mathematics teachers have problems themselves because they are teachers not trained in Mathematics, which makes them skip some topics, like Geometry. This makes learners to perform poorly. One the teachers said:

> *"Teachers experience problems with learners who lack confidence in their Mathematics skills. Teachers also give exercise less that those stipulated in the policy." (see Appendix F, lines 78).*

It is not only teacher belief about Geometry and its usefulness that are important, but also that the teachers' attitude about learners' ability to do Geometry has an influence on how to manage and subsequently on how learners learn (see paragraph 2.2.3, p.26).

This implies that negative attitude towards Geometry is a major challenge among teachers and heads of department.

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Question 4: What kinds of teaching and learning support materials are made available to teachers of Mathematics? *(See Appendix F*)

All heads of department indicated that Mathematics textbooks, study guides, learning channels, and so on, should available to teachers, so that they can improve the results. One of them said:

> *"Textbooks, videos; that is, learning channels; study guides and so on." (see Appendix F, lines 84).*

Question 5: How would you rate the performance of learners in Geometry as compared to other areas like Algebra/ Trigonometry? *(See Appendix F*)

Most of the departmental heads indicated that performance in Geometry is lower than in other areas. Another departmental head indicated that the performance is improving because they were increasing the interest in the subject and explaining everything to make it simpler. Some of heads of department said:

> *"Thanks, in my class this topic of Geometry, learners perform better than other topics. I explain everything to make it simpler. I always do revision and learners end up understanding (see Appendix F, lines 92). Very bad for now, because more learners and educators say it is difficult, since there is no proper foundation for it."(see Appendix F, lines 94).*

Worse performance of learners in Geometry than algebra has been a concern to Mathematics teachers, parents and government. He identified Geometry as core difficult area where learners'' performance has always been low (see paragraph 1.2, p.4).

Question 6: What are the challenges that affect learner performance in geometry? *(See Appendix F*)

Heads of department indicated that lack of prior knowledge; foundation and application of the theorems are the most important challenge in Geometry. They

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further indicated that understanding the axioms and corollaries of theorems is a very serious challenge. The following the examples of what they said:

> *"The main important challenge in Geometry is lack of pre-knowledge. This is compounded by the fact that its emphasis is in lower grade (see Appendix F, lines 98). Learners experience challenges as they lack the foundation knowledge and application of the theorems. Other learners' performance is affected by lack of practice." (see Appendix F, lines 102).*

Lack of a solid foundation in the lower classes makes learners fail to cope with the deductive approach in FET phase (see paragraph 2.3.2, p.29). This implies that if learners did not master the foundation, it will be difficult for them to perform optimally.

Question 7: What are the strategies that you use to enhance learner performance in geometry? *(See Appendix F*)

Mathematics departmental heads indicated that by encouraging learners to master the basics concepts terminology in Geometry and understand the theorems will make learners better able to apply them and recognize figures from complex systems of figures and to analyse the figures. They added that,

> *"Learners have to understand the basic concepts of Geometry. They must be able to recognize the figures from a complex system of figures and able to analyse these figures (see Appendix F, lines 105). Starting teaching them using the Grade 8 and 9 knowledge. Taught them as if they have not been taught." (see Appendix F, lines 107).*

It would be helpful for learners' if Geometry lessons could be interactive with the objects of their learning, learners' would learn geometry it in more imaginative and successful ways (see paragraph 1.1.2, p.2).

Question 8: Are there any ways in which learners can learn and grasp geometrical concepts easier? *(See Appendix F*)

Almost all the heads of departments indicated that there are ways in which learners can learn and grasp geometrical concept easier, for example, by giving them

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practice on solving geometric riders frequently and learning their theorems thoroughly, as well as giving give them basic knowledge in grade 8 and 9.This is what one of them said:

> *"Yes, being familiar with geometrical patterns and their properties. Knowing theorems of prior grades." (see Appendix F, lines 116).*

Most learners are making use of a transition from inductive methods of reasoning (conclusions based on several past observations) to a more formal method of deductive reasoning (providing statements from accepted postulate, definitions, theorems and given information) (see paragraph 2.4.2, p.37).

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Question 9: Is there anything else you would like to tell me about learner performance in Geometry? *(See Appendix F*)

Heads of departments indicated that frequent written work and assessment in control test in Geometry would improve learner performance. One of the departmental heads indicated that the commercial group used to ignore some of the topics that made the performance poor. This is what one of them said:

> *"Yes, learners should write short test frequently in Geometry and should be assed in controlled tests so that they will have to practice it frequently." (see Appendix F, lines 122).*

Effective assessment practices are essential to support Mathematics instruction that produces improved student performance. If the necessary provisions and monitoring are made to learners' and teachers, this problem will be thing of the past because the results of Geometry will be improved (see paragraph 2.4.4, p.40). This means that heads of departments should give support to teachers to assist them in solving Geometry problems.

4.3.3 Interview Schedule for Principals *(See Appendix G*)

These are the views that were expressed by the school principal of Nzhelele East Circuit.

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Question 1: How do you insure that teaching and learning improves learner performance in Mathematics? *(See Appendix G*)

Some of the principals indicated that written work, giving learners feedback in all written tasks, encouraging HOD's and teachers to learn recent techniques in their teaching and contact sessions fortnightly with expert teachers will improve learner performance. Others also indicated that purchasing extra LTSM such as study guide, mathematical instruments' and group teaching will improve learner. This is what some of them said:

> *"Encouraging HOD and teachers to learn recent technics in their teaching. Encourage contact session fortnightly with expect teachers (see Appendix G, lines 134). By giving learners more written work such as classwork and homework, weekly and monthly test. By giving learners feedback in the entire written task." (see Appendix G, lines 136).*

Effective monitoring and managing should be done to support Mathematics heads of departments produce better performance (see paragraph 2.4.4, p.40).

Question 2: How do you encourage HODs to motivate Mathematics teachers? *(See Appendix G*)

Most of the principals believe that having meetings regularly, discussing the methods of teaching; following the subject policy and profiling learners will motivate Mathematics teachers. Most of them said:

> *"To call them to meetings. Discuss methods of teaching, encourage use of tools and techniques. To strive to teach Mathematics in a practically way using our natural surroundings (see Appendix G, lines 141). By giving praise and rewards for good performance like trophies and certificates, demonstrating the importance of Mathematics in the modern world (see Appendix G, lines 142).*

Better planning of Geometry education, drawing on national guidance, to build learner prior learning, increase pace of work and greater challenges in the tasks , improving approaches to assessing and recording learners achievement, should makes them to manage well (see paragraph 2.5.2, p.29).

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Question 3: How do you manage curricular issues to improve student results? *(See Appendix G*)

Principals stressed that Mathematics teachers should adhere to the work schedule and pace setters. Others indicated that by encouraging HOD to assist teachers where they encounter difficulties and intervening when teachers encounter challenges, results could improve. One of the principals indicated that**:**

> *"Applying teaching and learning policy detailing matters such as subject policies, number of written works, LTSM, control of curricular issues, roles of HOD's and subject educators etc." (see Appendix G, lines 149).*

Question 4: What strategies do you use to insure that every HOD performs maximally? *(See Appendix G*)

Principals indicated that monitoring HOD's weekly on how they are performing in their control of teachers works. Others indicated that the principals should show appreciation of the work done by HODs by offering dinner, breakfast, and so on, and controlling their work and giving feedback, as well as motivating them, ensuring that they attend in-service training and workshop could help. One of the principal said:

> *"Monitoring HOD's weekly on how they are performing in their control of educators work. Weekly monitoring that indicates whether performance is going up or down." (See Appendix G, lines 155).*

If the necessary provisions and monitoring are made to educators and HOD, this problem of learner performance in Geometry will be improved (see paragraph 1.2, p.5). This implies that meaning full feedback and monitoring should be done to learners.

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Question 5: How is the performance of Grade 10-12 learners in Mathematics? *(See Appendix G*)

All the principals indicated that the performance is not satisfactory in Mathematics from grade 10-12. Some of the principals said:

> *"Performance of Mathematics is below average in Grade 10-12 (see Appendix G, lines 163). It is not satisfactory because the foundation (Grade 8-9) is not taught thoroughly and teachers do not finish the syllabus." (see Appendix G, lines 164).*

The mass failure in Mathematics examination is real and the trend of learners'' performance has been on the decline (see paragraph 1.1, p.1). This implies that the performance of Mathematics in Grade 10-12 is very poor.

Question 6: What are the strategies that you use to improve curricular? *(See Appendix G*)

Principals indicated that extra lessons, outsourcing, attending workshop and availability of LTSM improve the curricular. This is one of them said:

> *"Ensure that LTSM are available, educators attend their periods and teach, learners attend school and also do their work, the parent and the department support both learners and educators and the SMT's do their work." (see Appendix G, lines 169).*

Extra hard work of learners in the learning process, increasing motivation, encourages learners to learn from each other, allowing learners to work independently of the larger group and encouraging learners to take responsibility for their own learning (see paragraph 2.10, p.46). This means that LTSM support from parents and attendant of period by teachers improve learner performance.

4.4 SUMMARY AND GENERAL IMPRESSION

In this study male and female percentage were more or less the same. Majority of learners in the questionnaire were age between 15-17 years and 18-20 years. The

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respondents were learners who are doing Mathematics from Grade 10 to 12. Most of them speak Tshivenda.

The learning environment in most of the school was conducive to learn. Class size in some of the schools contributes to the performance learners because some of the classes were overcrowded. The learning and teaching media could be also being a contributory factor to the performance in Geometry. Teachers were being competent to teach Geometry. Knowledge of the subject content is a contributing factor in the performance of Geometry learners. Practical work and instructional material in teaching and learning of Geometry influence academic performance. Computer and interactive websites contribute in the learners' performance.

The responses from the learners are presented and anaysed. The respondents were the learners, teachers, and heads of departments and the principals of Nzhelele East. Findings for this investigation are also provided. Chapter 5 presents the major findings and recommendations stemming from the study.

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CHAPTER 5

OVERVIEW, MAJOR FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 OVERVIEW OF THE STUDY

In this chapter, a brief summary of the study is provided in order to present a global overview of entire study. It further presents the major findings in the light of the literature review, provide the responses of learners to the questionnaires, teachers, heads of departments and principals to the interviews on enhancement of learners performance in Geometry at secondary schools as well as recommendations on how learners, teachers, heads of departments and principals believe performance can be improved.

In Chapter One the background of the study, the problem statement, aim of the study, research questions, research design and methodology, assumption, definition of concepts were briefly discussed.

Chapter Two provided an overview of literature related to the topic of the study on the factors that contribute to the learners' performance in Geometry as a branch of Mathematics. The literature study was undertaken to determine what other authors had found on learners' performance in Geometry. The research instruments were drawn with the basis of the literature study in mind.

Chapter Three presented the research design and methodology. The study employed the qualitative and quantitative approaches to collect data. Questionnaires and interviews served as research tools. The research learners were identified and instruments were compiled based on the research questions designed in Chapter One. Participants were chosen based on their involvement in the teaching of Geometry at secondary school.

Chapter Four contains a presentation of the research findings pertaining to the learners, teachers, heads of the departments and principals.

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Chapter Five presents the major findings, conclusions and recommendations of the study.

5.2 MAJOR FINDINGS

The major findings were categorized according to the subsidiary research questions in Chapter One (see paragraph 1.4). The two subsidiary research questions are:

- What are the factors that contribute to learners performance in Euclidian Geometry as a branch of Mathematics? (see paragraph 1.4)
- How can Geometry be taught to learners in terms that are easy to understand (see paragraph 1.4)

5.2.1 Major Findings from Research Question No.1 (What are the Factors that Contribute to Learners' Performance in Euclidian Geometry as a Branch of Mathematics

The following are some of the findings pertaining to this research question:

- **Learning environment and class size**

The learning environment, such as infrastructure and facilities were not conducive to learning and teaching Geometry. Some classrooms are in a poor state, which makes it difficult for teaching and learning to take place in such conditions. Poor learning environment may also make learners uninterested in Geometry (see paragraph 4.2.6)

Class size contributes to learner performance in Geometry. Class sizes have been shown to have an impact on learners' success. Some grades are congested, such as Grade 10 and Grade 11, while Grade 12 has less than 30 learners. Larger classes have a negative influence on performance of learners in Geometry. In some schools, there are many learners in a classroom, whereas in some schools are few. Some of the classrooms are not conducive for learning (see paragraph 4.2.8).

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- **Resources for Geometry (educational media)**

Resources in most of the schools are adequate, whereas in a few school they are inadequate. In some schools, learners struggle to learn on their own because of the lack resources (see paragraph 4.2.10). If learning and teaching are done through the media, the learners'' performance in Geometry improves. There is also poor infrastructure in some schools, to the extent that some of the classrooms do not have electricity. As a result, teaching and learning cannot take place through learning channels or computer (see paragraph 4.2.13).

- **Attitude and interest of learners**

Attitude of learners towards learning Geometry is very poor. There is also lack of willingness and readiness to learn. Learners have a negative attitude towards Geometry. Learners' attitudes towards Geometry either positively or negatively influence learners' confidence in Geometry (see paragraph 4.2.14). Learners' interest in Geometry is a useful aspect, especially if directly related to their future careers (see paragraph 4.2.17). Learners' who have the interest and ability in Geometry perform better than those who have no interest.

- **Knowledge of the teacher**

The knowledge of the teacher is very important to the learners. The finding shows that teachers are knowledgeable in Geometry. Some communities in South Africa are proud of teachers; however, there is a criticism in relation to teachers' lack of qualifications', subject knowledge and even commitment. Most teachers are not well qualified and this is a problem for learners who are willing to learn (see paragraph 4.28). Extra support from the teacher contributes to the improvement of the performance of learners. Lack of commitment due to lack of motivation affects learners' performance (see paragraph 4.29).

It has been-stated that learners have a poor foundation in Mathematics primary schools. Lack of a solid foundation in the lower classes makes learners fail to cope with the deductive approach in the FET phase (see paragraph 4.2.12).

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- **Curriculum changes**

The study has also showed that changes within the curriculum affect learners' performance in Geometry. Dynamic curriculum changes causes poor planning, meaning that learners have major gaps in their knowledge, understanding and skills. The changes in the curriculum have contributed to the resistance of teachers in the implementation of new curriculum, as result the performance of learners has gone down (see paragraph 4.2.10).

5.2.2 Major Findings from Research Question No. 2 (How can Geometry be Taught to Learners in Terms that are Easy to Understand?)

- **Instructional materials**

Availability of instructional materials such as textbooks, workbooks and slides to meet the pedagogical demands of the curriculum imposed on teachers improve the performance in Geometry. The DoE has promised to issue guidelines of formal procedures for textbook retrieval, which strengthen best practices in schools. The teachers will be provided with better and more teaching materials, which would facilitate their task (see paragraph 4.2.30).

Necessary materials improve performance of learners in Geometry. Learners should get full support from their parents by buying them necessary materials in order for them to perform well. Parents should be actively involved in the education of their learners and know their performance (see paragraph 4.2.38).

- **Frequent monitoring**

Learners' show that if the necessary provisions and monitoring are made to learners', this problem will be the thing of the past because the result of Geometry will be improved. This means that teachers should give support to learners to assist them in solving the Geometry problems (see paragraph 4.2.32).

Feedback given by the teacher after assessing their work has been shown to improve performance in Geometry. An effective assessment practice is essential for

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supporting Mathematics instruction that produces improved student performance (see paragraph 4.2.33).

- **Extra-hard work**

Extra-hard work of learners identifies learners'' strength, which helps them to improve their confidence in learning and motivation to learn. Extra-hard work also, increases motivation, encourages learners to learn from each other, allows learners to work independently of the larger group and encourages learners to take responsibility for their own learning (see paragraph 4.2.36).

Learners supported the value of involvement in practical work than theoretical work. This means that practical work encourages learners to solve Geometry problems. This mainly comes from the experience of solving problems and using them in daily situations, which can build the learners confidence in learning and using Geometry widely (see paragraph 4.2.37).

- **Working in Groups**

Learners understand more when they work in groups. Group work therefore improves their performance. Working within a group at school helps learners to develop efficient team skills and improves their communication abilities needed in cooperative learning settings. Group method is one of the most effective learning methods and is very effective in increasing learners'' achievement in Geometry. It also it gives learners an opportunity to develop their personal, social and psychological skills (see paragraph 4.2.40).

- **Hands-on activities in Geometry**

Hands-on activities assist learners to grasp the basic Geometry concepts. Hands-on activities will provide learners' with the opportunity to investigate, build and take apart, create and make drawings, and observe about shapes in the world around them .This means that when learners themselves are involved themselves, they grasp and understand geometrical concepts easily (see paragraph 4.2.41).

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- **Computer and interactive white-boards**

Most learners' find computers and interactive white-boards as teaching media that help them grasp geometrical concepts easier. The use of computers in the learning of geometry equips learners with critical thinking skills required to solve problems. Learners have to derive their own skills while the teacher just gives guidance. This means that limited access to computer by learners' compromises their learning potential in Geometry (see paragraph 4.2.45).

5.3 CONCLUSIONS

Based on the major findings presented above the following conclusions were drawn:

5.3.1 Major Findings from Research Question No.1 (What are the Factors that Contribute to Learners' Performance in Euclidian Geometry as a Branch of Mathematics

- Teaching and learning environment in Geometry not conducive to learning. Class size and the condition of classrooms contribute to the performance of learners because Mathematics learners, share classrooms with others studying other subjects'. This leads to overcrowding, which has a negative impact on the learners, as they spend most of their time without learning. Class size and condition of the classrooms for teaching and learning is a contributory factor for performance in Geometry. Class overcrowding prevents teachers from attaining their teaching goals optimally.
- Educational media can be a contributing factor in the performance of learners in Geometry if the teacher lacks of skills because learners can also perform well even though the resources are not adequate. It depends on the teacher's initiative.
- Attitude of learners' towards learning Geometry is very poor. There is also a lack of willingness and readiness.
- Changes in the curriculum contribute a lot to the performance of learners in Geometry because of the confusion it brings to teachers and learners.

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5.3.2 Major Findings from Research Question No. 2 (How can Geometry be Taught to Learners in Terms that are Easy to Understand?)

The following are some of the findings pertaining to this research question:

- Lack of teaching media in the schools contributes to learners' performance. This is because all geometric figures are drawn using teaching media and this ultimately affects the performance of learners in their examination.
- It was found that if the necessary provisions are made and proper monitoring are made on the learners' and teachers, these problems of poor performance will be eradicated.
- If there is frequent feedback and proper monitoring by teachers are made, this problem will be solved.
- Hands-on activities allow learners to experiment and discover geometrical concepts.
- The use of ICT can make learners to grasp geometrical concepts easier and has positive effects on learners in Geometry.

5.4 RECOMMENDATIONS PERTAINING TO THE STUDY

The following is a discussion of recommendation pertaining to the study.

5.4.1 Recommendations on Research Question No. 1 ((What are the Factors that Contribute to Learners' Performance in Euclidian Geometry as a Branch of Mathematics?)

The following are some of the recommendation pertaining to this research question:

- **Learning environment and class size**

The government should provide necessary infrastructure and facilities that will motivate teaching and learning Mathematics in schools. Learning environment should be conducive to learning. Some of the schools do not have enough classes, and facilities such as desks and chairs are not enough for learners. This makes it

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hard for the teacher to give each learner individual attention and it would be easy for the teacher to identify the learners if classes are not too large.

- **Well-resourced schools**

The shortage of teaching and learning materials in schools influences learners to resist changes; therefore' the Department of Education should provide schools with the relevant learning and teaching resources in order to promote the implementation of change in performance of Geometry in schools. The circuit manager should encourage the sharing of available resources among the various schools to ensure their efficient use.

Learning and teaching media should improve the performance of learners. The Department should improve school infrastructure by electrifying the classrooms so that teachers can adopt some of the new methods of teaching and learning.

- **Attitude of learners**

From this study, it was clear that learners have negative attitude towards Mathematics. In this regard, district managers, circuit managers and principals should coordinate efforts to increase interest in educational achievement in Geometry and encourage learners to engage in Geometry activities. Parents, peers, teachers and guidance teachers need to provide more convincing evidence that there is an economic payoff, when one follows Mathematics-related careers at tertiary institutions. Schools should come up with packages and reward the hardworking learners to motivate them. Special programmes should be devised for learners to support after normal class lessons as early as grades 10 and 11.

- **Knowledge of the teacher**

Teachers should be encouraged to work as a team, share ideas with their colleagues in order to share knowledge. Department of Education should establish professional development workshops to develop educators. It is very important for teachers to be sent for developmental programmes in order to be developed for every change that is made to the Geometry. Training of teachers and work-shopping them to deal with problems concerning Geometry considered important, as well as the facilitation of parental guidance programmes that may enable parent to help learners at home.

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Outsourcing experts or specialist from other sectors responsible for guiding learners towards Geometry in lower grades should be initiated or enhanced.

- **Curriculum changes**

Changes in curriculum should be clearly addressed to teachers by subject advisors, as they are the ones who carry out the responsibility of informing teachers about the changes in the curriculum. Teachers should also be encouraged to use policy documents from the Department in order to teach the relevant curriculum, changes in terminology and using different methodologies. If the teachers should be aware of this changes of curriculum it will helps them to be more effective in the teaching of Geometry. The study showed resistance to change among educators and learners (see paragraph 4.2.10).

5.4.2 Recommendations of Research Question No. 2 (How can Geometry be Taught to Learners in Terms that are Easy to Understand?)

The following are some of the recommendations pertaining to this research question:

- **Instructional materials**

Principals cannot escape their roles as resource providers because teachers need to be well-equipped with instructional resources and materials. Despite financial and authority in secondary schools, principals should assume their roles as resource providers by devising a school financial committee to manage a limited school budget and designing sustainable fund raising activities, to ensure that important resources and materials are available for teachers and learners.

- **Frequent helpful feedback and monitoring**

Feedback should be given all the time. The Department of Education should intensify follow-up workshops on performance of learners in Geometry in order to avoid a collapse at the end of the year. Workshops should be established to allow a climate that is conducive to feedback. Teachers should give learners feedback and try as much as possible to relate their lessons to real life situation in order to reduce abstract nature of Geometry concepts.

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- **Hands-on activities**

Teaching and learning of geometry should involve more hands–on activities that will actively engage the learners', involve them in geometrical concepts and allow them to experiment.

- **Computer and interactive website**

The use of effective training models of ICT tools in teaching and learning should help learners to grasp geometrical concepts easier. Technology is very important in the teaching and learning of Geometry and it improves the performance of learners, if properly used.

5.5 RECOMMENDATIONS FOR FURTHER STUDY

The study achieved its aim; namely, *to investigate how learners performance in Geometry at secondary schools.* However, it has therefore opened up the following avenues for further research:

- The study was confined to secondary schools in the Nzhelele East Circuit Vhembe District. Not all circuits were covered in the Vhembe District, therefore a further suggestion would be that a similar study be conducted in the other circuits in order to assess whether the study would yield similar findings regarding the learner performance in Geometry in secondary schools.

- This study focused on the learners' performance in Geometry in secondary schools; therefore, future studies should, which would investigate learner performance in Mathematics in grade 12. Such study would make a significant contribution the improvement of Mathematics performance in secondary school because it will involve grade 12 learners who are about to exit the school system

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5.6 LIMITATIONS OF THE STUDY

This study has the following limitations:

- Due to financial constraints, the research was restricted to nine secondary schools in the Nzhelele East Circuit. If more schools had been involved in the research, different findings might have emerged in the same circuit.
- The study was only conducted at Nzhelele East Circuit in the Vhembe District of Limpopo Province. Possibly different findings would have been made at provincial level if the study was extended to other districts of Limpopo province. The results of the study can therefore not be generalised to a lager, provincially- based population.
- Nzhelele East Circuit represents a rural area and findings therefore are limited to rural area perceptions.

5.7 CONCLUDING REMARKS

The improvement of learner performance depends on the Department of Education, district managers, circuit managers, school managers and all educators, as all have to work together towards the implementation of successful learner performance in Geometry. The outcome of such commitment from everyone will significantly enhance learner performance in Geometry, thereby ensuring the promotion of quality education in South Africa. Improvement in the learner performance will play a major role in boosting learners' self–esteem. The performance of learners who are studying Geometry can be improved if teachers teach in an effective way. However, it is not only effective teaching that determines the performance of learners in Geometry in Grade 10-12. There are also various factors, such as changes in the curriculum. This contributes much to the performance of learners in Geometry because of the confusion it brings to teachers and learners', Class size and the condition of classrooms contribute to the performance of learners because Mathematics shares classroom with learners of other subjects. This leads to overcrowding which has a negative impact on the learners, as they spend most of their time without learning, and the learners have a poor foundation in Mathematics. Such student cannot solve maths, problems even when similar examples are given.

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Educational media is also a contributing factor in the performance of learners in Geometry because learners can also perform well even if resources are not adequate. This is because performance also depends on the teacher's initiative, attitude of student towards learning Geometry, as well as of willingness and readiness to learn. However, some factors are more influential in some schools than others. Therefore, the cause of poor performance could be different from one school to another, depending on the situation in a particular school. It is hoped that the findings and recommendations in this study will enhance the teaching and learning of Geometry and Mathematics in general.

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APPENDICES

APPENDIX A

QUESTIONNAIRE SCHEDULE FOR LEARNERS (10-12)

ENHANCEMENT OF LEARNERS' PERFORMANCE IN GEOMETRY AT SECONDARY SCHOOLS IN THE VHEMBE DISTRICT

Aim: The aim of this questionnaire is to gather information about enhancement of learners' performance in geometry as a branch of Mathematics in secondary schools.

Instructions:

1. Please answer all questions.
2. Your name is not required.
3. Please give your true response to all questions.

Strong Agree	:	SA
Agree	:	A
Disagree	:	DA
Strongly	:	SD

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SECTION A: GENERAL INFORMATION

A. Biographical Data

1.1 Gender

M	F

1.2 Age group

15-17	18-20	21-23	24-26

1.3 Number of dependents

No dependent	1 dependent	2 dependent	3 dependent and above

1.4 Level of Education

Grade10	Grade11	Grade12

1.5 Home language

Venda	Sepedi	Tsonga	Sotho	Others

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SECTION B: FACTORS THAT FACILITATE LEARNER PERFORMANCE

2.1	SCHOOL RELATED VARIABLES	Strong Agree	Agree	Disagree	Strong Disagree
2.1.1	The learning environment is conducive to learning Mathematics				
2.1.2	Schools in rural areas perform better in Mathematics than those in the city				
2.1.3	Class sizes contributes to the performance of the learner in Mathematics				
2.1.4	Your school is well resourced in the teaching and learning of Geometry				
2.1.5	Curriculum changes affect the learners' performance in Geometry				
2.1.6	Culture contributes to learner performance in Geometry				
2.1.7	The foundation of learners in Mathematics in primary school affects learners' performance				
2.1.8	Learning and teaching media makes teaching and learning of geometry easier.				
2.2	**LEARNER RELATED VARIABLES**				
2.2.1	Attitude contributes to learner performance in Geometry				
2.2.2	Boys perform better than girls in Geometry				
2.2.3	Peer pressure affects learner performance in Geometry				
2.2.4	Interest in Geometry improves learners' performance in Geometry				
2.2.5	You enjoy teaching and learning of				

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	Geometry				
2.2.6	Teaching of Geometry contributes to learners' performance				
2.2.7	Memorization helps in the learning and teaching of Geometry				
2.2.8	Psychological impact of the topic Geometry contributes to learner performance				
2.2.9	Learners do solve Geometry problems at home because there is somebody to guide them				
2.2.9	Learners have mathematical instruments for drawings in Geometry				
2.2.10	The use of television in the teaching of Mathematics affects learners' performance				
2.2.11	Saturday's or/and Winter school affect learner performance in Geometry				
2.3	**TEACHER RELATED VARIABLES**				
2.3.1	Teacher attitude towards Geometry contributes to learners' performance				
2.3.2	Your teacher is competent to teach Geometry				
2.3.3	Your teacher is knowledgeable in Geometry				
2.3.4	Extra support from the teacher affects learners' performance in Geometry				

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SECTION C: STRATEGIES TO ENHANCE TEACHING AND LEARNING GEOMETRY

		Strong Agree	Agree	Disagree	Strong Disagree
3.1	Instructional materials are adequate to teach Geometry				
3.2	Geometrical topics in schools are related to real life situations				
3.3	Frequent monitoring should improve learner performance				
3.4	Frequent helpful feedback can improve learners' performance				
3.5	Spending more time on the task should help the learner master geometrical skills				
3.6	The learning environment should be made conducive for effective teaching/learning to take place				
3.7	Learners should be given extra-hard work to improve on their foundation				
3.8	Learners should be more involved in practical work than theoretical work				
3.9	Parents should buy the necessary learning instructional materials for their learners/children in school				
3.10	Learners should be willing to learn on their own				
3.11	Working in groups can improve learners' performance in Geometry				

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SECTION D: WAYS IN WHICH LEARNERS CAN LEARN AND GRASP GEOMETRICAL CONCEPTS EASIER

		Strong Agree	Agree	Disagree	Strong Disagree
4.1	Hands-on activities in Geometry can help learners grasp geometrical concepts easier				
4.2	Interactive websites should make learners perform better in Geometry				
4.3	Identification of properties of geometrical figures improves learners' performance				
4.4	Understanding geometrical concepts improves learner performance				
4.5	Computers and interactive whiteboards can make learners to grasp geometrical concepts				
4.6	Construction of simple geometrical figures using straight edge, compasses, protractors and setsquares help learners to grasp geometrical concepts easier				
4.7	Calculations of unknown angles using the geometrical properties of intersecting and parallel lines help a learner to grasp geometrical concepts with ease				

THANK YOU FOR RESPONDING TO THIS QUESTIONNAIRE!!!

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APPENDIX B

INTERVIEW SCHEDULE FOR HEADS OF DEPARTMENTS OF MATHEMATICS

Hello

My name is Reaneth Mamali and I am conducting a study on the performance of learners in Geometry.

I am pleased to meet you. I would like to ask you a few questions on the performance of learners in Geometry.

1. How do you encourage learners to perform better in Geometry?

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……
……

2. In what ways do you influence Mathematics educators to improve learners' performance?

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……
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3. What are the challenges you experience in managing educators who teach Mathematics?

……
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……

4. What kinds of teaching and learning support materials are made available to teachers of Mathematics?

……
……
……

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5. How would you rate the performance of learners in Geometry as compared to other areas like algebra/ trigonometry?

……

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6. What are the challenges that affect learners' performance in Geometry?

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7. What are the strategies that you use for enhancing learners' performance in Geometry?

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8. Are there any ways in which learners can learn and grasp geometrical concepts with ease?

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9. Is there anything else you would like to tell me about learners' performance in Geometry?

……

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……

THANK YOU FOR YOUR TIME!!!

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APPENDIX C

INTERVIEW QUESTIONS POSED TO MATHEMATICS TEACHERS

Hello

My name is Reaneth Mamali and I am conducting research on the performance of learners in Geometry.

I am pleased to meet you. I would like to ask you a few questions on the performance of learners in Geometry.

1. Learners tend to experience problems in understanding geometrical concepts such as angles, quadrilaterals, theorems etc. How can we turn the situations around?

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……

2. One of the problems with many geometry learners' is their weakness in the language of Geometry. What can we do to improve this situation?

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3. Geometry riders tend to combine several figures like triangles, circles, rectangle etc. What methods can a teacher use to assist learners to see relationships of these figures?

……
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4. What strategies would you use to develop a clear understanding of the application of a theorem?

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5. What opportunities would help learners discover and conceptualize geometrical concepts on their own?

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6. What learners support materials would teachers use to simplify mastery of geometrical concepts?

……

……

……

7. How do you motivate learners to learn Geometry with ease and in an understandable way?

……

……

……

THANK YOU FOR YOUR TIME!!!

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APPENDIX D

INTERVIEW SCHEDULE FOR PRINCIPALS

Hello

My name is Reaneth Mamali and I am conducting a study on the performance of learners in Geometry.

I am pleased to meet you. I would like to ask you a few questions on the performance of learners in Geometry.

1. How do you insure that teaching and learning improves learners' performance in Mathematics?

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……
……

2. How do you encourage HOD to motivate Mathematics educators?

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……
……

3. How do you manage curricular issues to improve student results?

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……

4. What strategies do you use to insure that every HOD performs maximally?

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5. How is the performance of grade 10-12 learners in Mathematics?

……

……

……

6. What are the strategies that you use to improve curricula?

……

……

……

THANK YOU FOR YOUR TIME!!!

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APPENDIX E

VERBATIM INFORMATION ON INTERVIEWS

INTERVIEWS WITH MATHEMATICS TEACHERS

The interview was conducted with 6 teachers from different schools in the Nzhelele East.

Researcher: Good morning? 1

Respondent: Good morning 2

Researcher: How are you? 3

Respondent: Very fine and how are you? 4

Researcher: Fine too. 5

Question 1

Researcher: **Learners tend to experience problems in understanding geometrical concepts such angles, quadrilaterals and theorems. How can we turn the situations around? 6**

Respondent 1: We should start by showing geometrical concepts at early stages i.e. squares, parallelogram, circles, etc. 7

Respondent 2: By introducing and teaching the concepts with methods and examples easily understood by learners. 8

Respondent 3: Learners must be encouraged to do practical work in as far as Mathematics is concern for example learners have to measure the length and the angle of a building, also know that symbol of a road signs are good examples of triangles, circle and quadrilaterals.

9

Respondent 4: Geometry should be learnt practically where each learner should be able to measure angles, draw sketches and interpret. 10

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Respondent 5: Let learners be taught geometrical concepts in lower grades 11

Respondent 6: Learners able to define and understand the terminology used in Euclidean Geometry like angles, quadrilaterals and theorems. 12

Question 2

Researcher: **One of the problems with many Geometry learners' is their weakness in the language of Geometry. What can we do to improve this situation? 13**

Respondent 1: We should show them the given statement and what is to be proved. 14

Respondent 2: Use simply terms at first before introducing the technical terms. Find ways of grouping theorems to enhance remembering them. 15

Respondent 3: The educator should first allow learners to use simple language for their better understanding of mathematical figures and concepts e.g. similarities where in learners have to compare. They have to learn mathematical slow by slow so that they should be used to it. 16

Respondent 4: Learners should learn all the basic concepts of Geometry from grade 8 onwards to master all geometrical concepts. 17

Respondent 5: The only way to improve this can be by introducing the concepts in lower grade. 18

Respondent 6: Teach and link Geometry with real life situation. One must appreciate,
and understand and interpret Geometry behind. Learners should be competent in mathematically language and mathematically symbols such as diagrams and geometrical figures.

19

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Question 3

Researcher: **Geometry riders tend to combine several figures like triangles, circles, rectangle etc. What methods can a teacher use to assist learners to see relationships of these figures?** **20**

Respondent 1: Different types of methods, like textbook method and problem solving methods 21

Respondent 2: Cooperative learning, learner involvement, problem solving 22

Respondent 3: Experimental, practical and textbook methods 23

Respondent 4: Interpretation method (when interpret all geometrical concepts and diagrams). 24

Respondent 5: Learners should be encouraged to consider small portion of a rider; for example a circle or a triangle one after another to analyzed to avoid confusion to learners. 25

Respondent 6: Start by giving them properties of this shapes and identify their relationships. 26

Question 4

Researcher: **What strategies would you use to develop a clear understanding of the application of a theorem?** **27**

Respondent 1: Teach them simple English. Let them know different types of angle e.g. acute, obtuse, reflex, complementary, supplementary etc. 28

Respondent 2: I think stating the theorem from observed results; for example, deriving the derive the

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theorem and not just cramming it. Derived theorems are easier to remember and easier for proved and apply. 29

Respondent 3: Learners should be given more practical work to do. For example, Learners could draw their own house plan etc. On the other hand, learners should use group work. 30

Respondent 4: All learners should be able to learn one aspect or diagram at a time. All properties should be mentioned and linked with the previous one. 31

Respondent 5: To put more emphasis on the previous grade's work 32

Respondent 6: Analyze the required to prove (in terms of angle). Pay attention to the key words given. Rewrite a formal proof. 33

Question 5

Researcher: **What opportunities would lead learners to discover and conceptualize geometrical concepts on their own? 34**

Respondent 1: By giving them simple exercise to do will encourage them to do more activities. 35

Respondent 2: Give them exercise on related properties for which they can generalize the concepts for example, use the discovery method when introducing concepts. 36

Respondent 3: After studying, learners has an opportunities of getting themselves working as a plumber, builder, electrician and so on 37

Respondent 4: Knowing different figures such as triangles and quadrilaterals, with all their different properties. 38

Respondent 5: Doing more exercise on their own. 39

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Respondent 6: Observing, recalling, comparing and construction 40

Question 6

Researcher: **What learners support materials would teachers use to help mastery of geometrical concepts?**

Respondent 1: Compass, protractors, rulers and calculators. 41

Respondent 2: Calculators, mathematical sets, textbooks exercises and computer modelling. 42

Respondent 3: Learners should have their own textbooks, rulers, pencils and all relevant materials for drawing. 45

Respondent 4: Textbooks, mathematical instruments, rulers and calculators. 46

Respondent 5: Since Geometry is too practical, let the learners use objects available in the class. 47

Respondent 6: Instruments, calculators computers, textbooks, geoboards. 48

Question 7

Researcher: **How do you motivate learners to learn Geometry with ease and In an understandable way?**

Respondent 1: By showing them opportunities in real life (careers) 49

Respondent 2: I will help them first discover the concepts and give them easy way to relationships among the concepts. Let them understand key principles in proofs and application. 50

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Respondent 3: By giving them more practical work to do so that they must be well-equipped in Mathematics and to solve real life situation problems. 51

Respondent 4: Teach them all the concepts learnt from grades 8-9 as a basic. It will be easier to learn Geometry. 52

Respondent 5: By telling them that the subject is too practical and needed for life and without it no buildings can be erected. 53

Respondent 6: Firstly I will make use of all the statement that is given regarding the theorems (rider problems). Try to connect what learners know to prove the conclusion deducted from what is given. Also by making learners understand the patterns of each theorem and practically using various riders. 54

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APPENDIX F

VERBATIM INFORMATION FROM INTERVIEWS

INTERVIEW WITH THE MATHEMATICS DERPARTMENTAL HEADS

Interview was conducted with 6 Mathematics heads of departments from different schools in the Nzhelele East Circuit.

Researcher: Good afternoon? 55

Respondent: Good afternoon 56

Researcher: How was your day? 57

Respondent: Fine and good, what about you? 58

Researcher: I am fine.

Question 1

Researcher: How do you encourage learners to perform better in Geometry? 59

Respondent 1: I encourage learners to revise the basic knowledge in Geometry like parallel lines, triangles, quadrilaterals, and so on. 60

Respondent 2: First, I use to get some practical example where Geometry is applicable like roofing where angles are supposed to be measured. Get examples of real life situation. 61

Respondent 3: I show them that it is easy when I give them practical examples; for example roof, models of BMW and so on. 62

Respondent 4: To practice as many examples as they can. To use study guides and previous papers. 63

Respondent 5: Learners have to know the basic theorems and be able to apply them in Geometric riders and also the terminology in Geometry. 64

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Respondent 6: By showing the learners the importance of mastering the section of prior grade before attempting the current year's content. 65

Question 2

Researcher: In what ways do you motivate Mathematics educators to improve learner performance? 66

Respondent 1: I motivate Mathematics teachers by requesting them to do a lot of exercises with learners. Practice makes perfect. 67

Respondent 2: I know Mathematics is not a difficult subject and I use to inform teachers that they should start with concrete things where learners use to link with real life things everywhere and try to find problems areas in order to know where to start. 68

Respondent 3: Provide them with certificate of good performance and also cash and praises them among the others. 69

Respondent 4: By developing themselves first i.e. attending short courses, workshops, lastly they must love Mathematics. 70

Respondent 5: Learners should gain an interest in Mathematics so that they would have to practice and acquire the basics rapidly and study it with ease. 71

Respondent 6: Involving learners during lessons, by giving them activities to to work on. 72

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Question 3

Researcher: What are the challenges you experience in managing educators who teach Mathematics? 73

Respondent 1: Ee...most of Mathematics teachers have problems. They are not good in terms of knowledge and skip the topic which is difficult to them, it causes learners to perform poor. 74

Respondent 2: There are few challenges experienced in managing educators. The challenges mostly lie with learners. 75

Respondent 3: No signatures on learners exercise books 76

Respondent 4: Teachers do not want to teach trigonometry and Geometry. 77

Respondent 5: Teachers experience problems with learners who lack confidence in their Mathematics skills. Teachers also give exercise less than those stipulated in the policy . 78

Respondent 6: They always complain that learners are lazy, and do not have an interest in Mathematics as a result, their performance is poor. 79

Question 4

Researcher: What kinds of teaching and learning support materials are made available to teachers of Mathematics? 80

Respondent 1: Protractors, rulers, compass, graph papers, and so on 81
Respondent 2: Calculators, guides, protractors and textbook. 82
Respondent 3: Study guides, video tapes based on Mathematics 83

Respondent 4: Textbooks, videos i.e. learning channels, study guides etc. 84

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Respondent 5: Workbooks, textbooks, study guides, and so on 85

Respondent 6: Textbooks, CD and DVDs for Mathematics lessons. 86

Question 5

Researcher: How would you rate the performance of learners in Geometry as compared to other areas like Algebra/Trigonometry? 90

Respondent 1: The performance of learners in Geometry is the poorest. Learners are not motivated when dealing with Geometry 91

Respondent 2: Thanks, in my class this topic of Geometry, learners perform better than other topics. I explain everything to make it simpler. I used to do revision and learners end up understanding. 92

Respondent 3: The performance is not good because learners have negative attitudes. 93

Respondent 4: Very bad for now, because more learners and educators say is difficult, since there is no proper foundation for it. 94

Respondent 5: Performance in Geometry is still lower in others areas. 95

Respondent 6: Geometry is far much lower than other areas of Mathematics 96

Question 6

Researcher: What are the challenges that affect learner performance in Geometry? 97

Respondent 1: The main important challenge in Geometry is lack of pre-knowledge. This is compounded by the fact that its emphasis is in lower grade. 98

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Respondent 2: I realize that challenges is to understand the axioms, corollaries and theorems. 99

Respondent 3: Grades 8 and 9 knowledge is the problem. Teachers pay little attention to the lower the topic in lower grades. 100

Respondent 4: Not teaching learners Geometry in lower grades. Teaching Geometry towards the end of the year and giving it limited time. 101

Respondent 5: Learners experience challenges as they lack of foundation knowledge and application of the theorems. Other learners' performance is affected by lack of practice. 102

Respondent 6: Lack of prior knowledge. 103

Question 7

Researcher: What are the strategies that you use in enhancing learners' performance in Geometry? 104

Respondent 1: Learners have to understand the basic concepts of Geometry. They must be able to recognize the figures from a complex system of figures and able to analyse these figures. 105

Respondent 2: When I give diagnostic test, I use to categorize and group them together to get special remedy. Everybody should be given a special remedy. 106

Respondent 3: Starting teaching them using the Grades 8 and 9 content. teach them as if they have not been taught. 107

Respondent 4: There should be more workshops for teachers to understand the use Policy documents, outsourcing of teachers and teachers must use the work schedule when they teach. 108

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Respondent 5: I encourage learners to master the basic and terminology in Geometry and understand the theorems so that they could be able to apply them. 109

Respondent 6: Encouraging educators to do extra classes with slow learning learners. 110

Question 8

Researcher: Are there any ways in which learners can learn and grasp geometrical concepts with ease? 111

Respondent 1: Ja,….ja there are program where learner have to do on their own. It makes learners easy to understand Geometry simpler. 112

Respondent 2: Yes. Give the basic knowledge of Grade 8, show them the careers that they can follow. 113

Respondent 3: Yes, there are many ways like studying Grades 8 and 9 work. 114

Respondent 4: Learners have practice solving Geometry riders frequently and also know their theorems thoroughly. 115

Respondent 5: Yes, being familiar with geometrical patterns and their properties. Knowing theorems of prior grades. 116

Respondent 6: Yes, but with the time and educator experience they can learn and grasp geometrical concept with easy. 117

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Question 9

Researcher: Is there anything else you would like to tell me about learner performance in Geometry? **119**

Respondent 1: Yes, when we talk about learners performance, they are learners whoperform well and we give them extra work to do and also encourage them. Additional extra work can help learners understand better. 120

Respondent 2: Yes, the commerce group ignores the topic, but those who Have career goals in commerce seek more knowledge of it. 121

Respondent 3: Yes, learners should write short tests frequently in Geometry and should be assed so that they will have to practice it frequently 122

Respondent 4: Yes, revising previous years' question paper and do lot of practice. 123

Respondent 5: Yes, learners should be given extra work to do every day. 124

Respondent 6: I think learners should be drilled by giving them more tasks all the time. Parents should be encouraged to buy study guides for their learners. 125

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APPENDIX G

VERBATIM INFORMATION FROM INTERVIEWS

INTERVIEW WITH THE PRINCIPALS

The interview was conducted with 6 principals from the Nzhelele East Circuit. Principals are responsible for monitoring the work done by teachers and heads of department.

Researcher: Good afternoon Sir? 126

Respondent: Good afternoon. 127

Researcher: How are you? 128

Respondent: Very fine and how are you? 129

Researcher: I am very much fine. 130

Researcher: I just want to ask you a few questions, are you ready? 131

Respondent: Yes, I am ready. 132

Question1

Researcher: How do you insure that teaching and learning improves learner performance in Mathematics? 133

Respondent 1: Encouraging HOD and teachers to learn recent techniques in their teaching. Encourage contact session fortnightly with expect teachers. 134

Respondent 2: By creating learning space to encourage individual group teaching and ensures discipline in class also that involves more participation. 135

Respondent 3: By giving learners more written work such as classwork and homework, weekly and monthly test. By giving learners feedback in all the written task. 136

Respondent 4: Written work feedback, profiling learners. 137

Respondent 5: By purchasing extra LTSM such as study guides, mathematical

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instruments and other apparatus. We can also do this by enrolling learners in Mathematics programs
and competition, subscribing to Mathematics magazines, outsourcing and involving curriculum advisors. 138

Respondent 6: By purchasing subject related materials for the teachers 139

Question 2

Researcher: How do you encourage HOD to motivate Mathematics teachers? 140

Respondent 1: To call them to meetings. Discuss methods of teaching, encourage use of tools and techniques. To strive to teach Mathematics in a practical way using our natural surroundings. 141

Respondent 2: By giving praise and rewards for good performance like trophies and certificates, demonstrating the importance of Mathematics in the modern world. 142

Respondent 3: Departmental meetings, encourage teachers to profile learners, group work and competition within the school. 143

Respondent 4: By having meeting fortnightly, subject policy must be followed most improved teachers and learners are rewarded. 144

Respondent 5: HOD show respect by providing relevant support materials like LTSM, schedule, assessment policy and have faith in his or her colleagues. 145

Respondent 6: Regular meeting focusing on performance. Teamwork, HODs should encourage teachers to work as a team 146

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Question3

Researcher: How do you manage curricular issues to improve student performance? 147

Respondent 1: By encouraging HOD to assist educators where they encounter Difficulties and intervening when teachers encounter challenges. 148

Respondent 2: Applying teaching and learning policy detailing matters such as subject policies, number of written works, LTSM, control of curricular issues, roles of HOD's and subject educators etc. 149

Respondent 3: Mathematics teachers should adhere to the pace setter and work schedules. 150

Respondent 4: Work schedules must adhere to; feedback to learners must be given the syllabus to be finished on time and awards given to learners. 151

Respondent 5: By providing sufficient information to teachers of all curriculum relating to teaching and learning and also guide (supervise). 152

Respondent 6: By encouraging educators to follow the work schedule and pace setter when teaching. 153

Question 4

Researcher: What strategies do you use to insure that every HOD performs maximally? 154

Respondent 1: Monitor HOD's weekly on how they are performing in their control of educators' work. Usage of a monitoring weekly that indicates whether performance is going up or down. 55

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Respondent 2: By showing appreciation for the work done by HODs by offering dinner, breakfast and so on.
introduce HOD's to parents and show them how hardworking they are. 156

Respondent 3: Regular monitoring, control written work and develop content monitoring tool. 157

Respondent 4: Motivation, incentives, appraisal for work well done and support where they are challenges. 158

Respondent 5: Controlling their work, giving feedback, motivating them, ensuring that they are attending in-service training and workshops. 159

Respondent 6: Hold meeting every quarterly, set up policy in the department and do more extra work in teaching and learning. 160

Question 5

Researcher: How is the performance of Grade 10-12 learners in Mathematics? 161

Respondent 1: The performance is very poor. Learners seem to lack basic pre-knowledge of Mathematics. 162

Respondent 2: Performance of Mathematics is below average in Grade 10-12. 163

Respondent 3: It is not satisfactory because the foundation (Grade 8-9) is not not taught thoroughly and teachers do not finish the syllabus. 164

Respondent 4: It is below 40% and not acceptable. 165

Respondent 5: Performance is not good at all, learners perform is below average. 166

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Respondent 6: The performance of Mathematics learners in grades 10-12 is very poor, It seems as if most of learners have a negative attitude towards Mathematics 167

Question 6

Researcher: What are the strategies that you use to improve curricular? 168

Respondent 1: Ensure that LTSM are available, educators attend their periods and teach, learners attend school and also do their work, the parent and the department support both learners and educators and the SMT's do their work. 169

Respondent 2: Outsourcing, teaching during weekends, enrichment classes and studies. Expect teachers must teach different topics in different grade. 170

Respondent 3: Extra lessons, encouraging learners to practice on their own to encourage them to form small working groups. 171

Respondent 4: Always interact with colleagues, show commitment, and build up confidence on both learners and colleagues. 172

Respondent 5: Encourage educators to attend workshops. 173

Respondent 6: The Department must avoid re-deployment of teachers during the year, and more Mathematics teachers should be employed and trained. 174

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APPENDIX H

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

ENQUIRIES: N.R MAMALI
TEL: 0712417084/0845045609

P.O, BOX 3012
DZANANI
0955

20 August 2015

The district Senior Manager
ATTENTION: Dr Rambiyana
P/BAG X2250
SIBASA
0970

DEPARTMENT OF EDUCATION
VHEMBE DISTRICT
26 -08- 2015
PRIVATE BAG X 2250 SIBASA 0970
TEL : 015 962 1313/4 FAX 015 962 6035
LIMPOPO PROVINCE

Dear Sir

REQEST FOR PERMISSION TO CONDUCT RESEARCH

I hereby request permission to conduct a research in Nzhelele East circuit in the Vhembe District. I am currently studying for a Master's Degree in Curriculum Studies at the University of Venda. The topic of my study is Learners enhancement in Geometry at secondary schools.

I also would like to inform you that all the information gathered from learners and the educators will be used solely for research purposes, and that the anonymity of all is guaranteed.

I trust that you will kindly grant me the consent in conducting my research.
Thanking you in anticipation.

Yours faithfully

.....

NR Mamali

55

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APPENDIX I

PERMISSION TO CONDUCT RESEARCH: YOURSELF

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION
VHEMBE DISTRICT

REF : 14/7/R
ENG : Manenzhe T.A
TEL : 082 868 3499

DEPARTMENT OF EDUCATION
VHEMBE DISTRICT
2015 -09- 09
PRIVATE BAG X2250 SIBASA 0970
LIMPOPO PROVINCE

N.R Mamali
P. O. Box 3012
Dzanani
0955

PERMISSION TO CONDUCT RESEARCH: YOUR SELF

1. The above matter refers.
2. Permission is here by granted to you to conduct research in Nzhelele East circuit as requested.
3. Your research process should however not disrupt the normal teaching and learning time.
4. You are further advised to conduct your research with the consent of both the Circuit manager and principals of the schools you will identify.
5. Wishing you all the best in your studies

DISTRICT SENIOR MANAGER

09/09/2015
DATE

Thohoyandou government Building, Old Parliament, Block D, Private Bag X 2250, Sibasa, 0970
Tel: (015) 962 1313or015 962 1331, Fax: 015 962 6039 or 015 962 2288

The heartland of southern Africa - development is about people!

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APPENDIX J

RECOMMEND APPLICATION TO CONDUCT RESEARCH AT NZHELELE EAST CIRCUIT

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NZHELELE EAST CIRCUIT

REF: 54/1/1/1
ENQ: RAMUTSHELI M.D
TEL: 015 9730517/9
DATE: 10 SEPTEMBER 2015

TO: MRS MAMALI N.R

RECOMMEND APPLICANTION TO CONDUCT RESEARCH AT NZHELELE EAST CIRCUIT.

The above matter refers.
I would like to recommend the application to conduct research at Nzhelele East Circuit in Secondary schools.
The permission is given on the bases that your research will not disturb teaching and learning.

Hoping that you will find this in order

.....
THE CIRCUIT MANAGER NZHELELE EAST CIRCUIT

NZHELELE EAST CIRCUIT
DEPARTMENT OF EDUCATION
2015 -09- 10

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