EXPLORING THE FACTORS INFLUENCING GRADE 11 LEARNER PERFORMANCE IN GEOMETRY IN TWO HIGH SCHOOLS IN THE UMLAZI DISTRICT.

By

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DEDICATION

This study is dedicated to my wife Thembelihle Zamisa for her prayers, encouragement and moral support, without her my dissertation would have been difficult. I also dedicate it to my children Nomfundo, Noluthando and Thabiso.

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Firstly, I would like to sincerely thank God, the Almighty for giving me the mental and physical capacities to carry out this study.

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Special thanks go to my children, Nomfundo, Noluthando and Thabiso. I love you, my children. Your existence inspires me. I hope you will do better than I have done.

DECLARATION

I, Paulos Musawenkosi Zamisa, declare that the work presented in this thesis entitled Exploring the factors influencing grade 11 learner performance in geometry in two high schools in the Umlazi District, is a representation of my own efforts and is original. Where work from another source has been used, proper referencing has been given.

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Acronyms

DBE	Department of Basic Education
DoE	Department of Education
FET	Further Education and Training
GET	General Education and Training
HOD	Head of department
HOTS	High – order thinking skills.
IQMS	Integrated quality management system
KZN	KwaZulu-Natal
MAN	Mathematical Association of Nigeria
NCS	National Curriculum Statement
NDP	National Development Plan
OECD	Organisation for economic co-operation and development
PISA	Programme for International Learner for Assessment
PPN	Post provisioning norm
RNCS	Revised National Curriculum Statement
SA	South Africa
SES	Socio-economic
SMT	School Management Team
TIMSS	Trends in Mathematics and Science Study

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Abstract

Performance of learners in geometry has persistently been poor compared to other sections of mathematics. 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 demonstrate good reasoning and problem-solving skills. This has a negative impact on the overall mathematics results of learners. My study was aimed at exploring factors that influence learner performance in geometry and establish the strategies that can be adopted to improve performance in geometry by learners in public secondary schools of Umlazi District. The study explored (school-based, home-based, Department of Education based and learner-based) contributory factors that influence learners' performance in geometry in secondary schools.

The theory guiding the study, was social constructivism which was derived from the work of Vygotsky. Vygotsky's social constructivism was used as a theoretical framework to understand the ways that learners acquire knowledge about groups. His theoretical framework states that social constructivist teaching, knowledge construction is achieved through learners' collective social interaction.

The study used a qualitative methodology to provide rich data and compare and incorporate findings and get a holistic view of the phenomenon. The sample size constituted of 16 participants. The study used focus group discussions with grade 11 learners and face-to-face semi-structured interviews with educators, Heads of Department and Principals of the two secondary schools under the Umlazi District. The qualitative data were collected by means of interviews with the participants. Thematic analysis was used to analyse qualitative data. The findings of the study led to the conclusion that the significant factors contributing to poor performance included lack of prior knowledge by learners, negative attitude toward geometry, lack of motivation, anxiety and fear of geometry, parental educational background, parental involvement, poor teaching strategies, geometry educators' knowledge, lack of professional development of educators, class size, lack of resources and facilities.

Keywords: Factors, Geometry, poor performance

CHAPTER I

INTRODUCTION AND BACKGROUND

1.1 Introduction

This chapter consists of the background of the study, statement of the problem, the location, research objectives, followed by the research questions, the significance of the study, motivation to conduct this study, definition of concepts, limitations and chapters outline.

1.2 Background of the study

According to Ngussa and Mbuti (2017, p. 170), the mathematics curriculum is intended to provide learners with knowledge and skills that are essential in the changing technological world. Geometry is a part of mathematics that is related to learners' lives, because almost all the objects around them are geometric in nature (Safrina, Ikhsan & Ahmad, 2014, p. 120).

Being part of mathematics, geometry comprises approximately 30% of the final CAPS grade 12 paper in South Africa (Govender, 2017, p. 44). Corroborating the view that learners performed poorly in geometry, the study by Van der Walt, Maree and Ellis in Siyepu (2013, p. 1) for example argued that various environmental factors influence learner performance in geometry.

These factors are diverse and intertwined. For example, some factors originate from home, school, the Department of Education and some from the learners themselves. It is necessary to identify these environmental factors so that we can adapt them to the improvement of learner performance in geometry. Mafukata (2016, p. 68) argued that, among others, poor socio-economic background of learners, lack of appropriate learner support materials, general poverty of school environment, generally poor quality of educators and teaching, language instruction and an inadequate study orientation in geometry are all contributing factors.

1.3 Problem statement

Ngussa and Mbuti (2017, p. 170) point out that, high failure rates in geometry are due to several reasons which eventually disorient learners' learning. For example, the report by Malati (2014, p. 126) who observed primary school educators, mentioned that many primary school educators teach little or no geometry to their classes. The report also showed that regardless of all the educators' efforts in abstractly conveying Euclidean geometry content, learners continue to encounter difficulties with formal deduction and proof which are more abstract. Considering this, it appeared that learners at grade 11 lack knowledge and understanding of lower levels in Euclidean Geometry.

The transformation of the South African school curriculum from the National Curriculum Statement (NCS) of 2002, revised in 2009, to the Curriculum and Assessment Policy Statement (CAPS) of 2012 brought many instructional challenges to educators, in particular, secondary school mathematics educators. For example, in the NCS some topics, including circle geometry, were optional meaning that the topics were only offered by schools and candidates that wished to do so. These candidates were therefore required to write a separate examination paper (Paper 3) on the topics in addition to the compulsory Papers 1 and 2. In the NCS, most of the learners who opted for Paper 3 between 2009 and 2013 did not do well in the examination (Department of Basic Education, 2013). As a result, most schools discouraged their learners from opting for Paper 3 as the performance of learners in mathematics across the country has been generally poor (Campbell & Prew, 2017, p. 15)

In 2014, Geometry was brought back into the curriculum through the Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education (DBE), 2011d). It was once again examined in Paper 2 as it was in the old curriculum, and again it became compulsory. Due to this change in the curriculum, as a country, we are in the scenario where there are some educators who are capable of teaching geometry, some educators who struggle with it since they did not get a solid understanding of geometry themselves and some educators who were never taught geometry in school (Dr. J. Basson, personal communication, 2 May 2015). Bowie (2013) argued that geometry is not taught at some schools at all, which impacts negatively on the performance of the learners.

When geometry had been reinstated in 2014 as a compulsory section, the mathematics pass percentage of NSC nationally dropped by 5.6% (Department of Basic Education, 2015) and in 2015, it fell below 50% for the first time in four years (Department of Basic Education, 2016). In 2016, the number of learners writing mathematics was the highest compared to the previous years with 265 810 candidates (Department of Basic Education, 2012; Department of Basic Education, 2013, Department of Basic Education, 2017). With the number of learners writing mathematics increasing and the percentage of learners passing mathematics not following this trend, there was a need for an efficient and large-scale solution to the geometry problem.

1.4 Location of the study

The study was conducted in two secondary schools which are in the Umlazi District. These schools are in the disadvantaged areas where most learners come from informal settlements and squatter camps surrounding the schools. Kyei and Nemaorani (2014, p. 83) argued that school location affects secondary learners' mathematics performance in South Africa, where schools closer to town perform worse, because learners are distracted by entertainment, the home environment was not conducive to effective learning and, the low-level of parents' education, high unemployment rate, child-headed families and issues relating to gender role.

1.5 Research objectives

The study will be guided by the following specific objectives:

1. To explore factors influencing the teaching and learning of geometry in secondary schools and the reasons that are contributing to this effect.
2. To establish the effects of environmental factors (home, school, and DBE) which contribute to the learners' performance in geometry in secondary schools in the Umlazi District.
3. To adapt the environmental factors that can improve learner performance.

1.6 Research questions

The main research question of the study sought to explore the underlying factors that influence learner success in geometry in the two high schools of Umlazi district. To answer this question, the following subsidiary questions were developed:

1. What are the factors that influence learners' performance in geometry?
2. How do environmental factors (home, school, DBE) contribute to learner understanding in geometry?
3. How can environmental factors be adapted to improve learner performance?

1.7 Significance of the study

The findings of the study will assist policymakers in designing meaningful corrective instruments to address this challenge. The findings of this study may also assist in providing school authorities with significant factors that impact negatively on the performance of geometry learners. Additionally it may provide solutions that might help inform specific actions to be taken to efficiently and effectively address those factors within their schools to deter future hindrances and improve the performance of learners to a level that would allow them entrance to the university.

1.8 Motivation to conduct this study

The researcher's interest in this study was motivated by personal observations on learner performance in geometry during the period as an educator, and later as the Principal at one of the Secondary Schools in the province of KwaZulu-Natal. I had been teaching mathematics for over 15 years and was concerned about a constant decline in learners' performance in geometry, particularly in this province of KZN. This underperformance has motivated me to conduct a study to look closely at contributing factors to this phenomenon.

The diagnostic report on the 2014 national examinations carried out a diagnostic analysis of a sample of grade 12 mathematics scripts and found that the lowest average in that sample for the second mathematics paper was in the question on Euclidean geometry (DBE, 2015). The report recommended that learners need to spend much more time in solving geometry problems so that their skills in this area can be improved. However, in my own teaching experience, I have noted that learners are afraid of geometry and prefer to spend most of their time going over the algebra and trigonometry sections of mathematics. When I probed the reasons for the learners' fear of geometry, some learners reported that their mathematics educators often skipped the sections of geometry and tried to cover the topics by themselves with little success.

1.9 Definition of concepts

Geometry: Geometry is the branch of mathematics that deals with solids, surfaces, lines, points, angles, properties, measurements and relationships appropriate to them and their positions in space.

Factor: A factor is one of the elements contributing to a particular result or situation. By factor, the researcher refers to the family educational background, parents' involvement, instructional strategies, educators' knowledge, professional development of educators, school resources, class size, learners' prior knowledge and learners' attitude.

Learner: Tsanwani (2009:13) defined the word "learners" as follows: persons who learn, persons preparing for a particular subject, persons who through lengthy and systematic study attain a high degree of expertise, skill and efficiency, and persons who have the following attitudes or characteristics: curiosity, perseverance, initiative, originality, creativity and integrity. These characteristics are precisely those that are regarded as essential for achievement in geometry.

1.10 Limitations of the study

This study was confined to two secondary schools in the Umlazi District. The study focused on the Principals, Departments Heads, mathematics educators who teach grade 11 learners and grade 11 mathematics learners. Methodological limitations were also identified. For example, since the sample size was too small for a quantitative opinion, the choice fell on a qualitative research approach.

1.11 Chapters outline

This study consists of six chapters, the references, and the appendices. The contents of these chapters are briefly highlighted in this section.

Chapter 1: Introduction

This chapter presents the introduction and background of the study. Furthermore, the chapter also presents the statement of the problem, motivation to conduct this study, objectives of the study, research questions, and definitions of concepts and the limitations of the study.

Chapter 2: Literature Review

This chapter presents the literature review focusing on current and seminal research in mathematics, home-based environmental factors, school-based environmental factors, Department of Education based factors and learner related factors.

Chapter 3: Theoretical framework

This chapter outlines the theoretical framework of the study focusing on Social Constructivism and the view of Shulman's and Ball's theory of knowledge.

Chapter 4: Research Methodology

This chapter presents the research paradigm, research design, methodology, sampling procedures, data collection procedures, data analysis approach, data quality issues (reliability and generalizability) as well as ethical considerations.

Chapter 5: Data Analysis and Interpretation

This chapter presents data analysis, findings, interpretation, and discussions. The chapter also links the findings to the literature.

Chapter 6: Conclusion and Recommendations

This chapter presents the summary of findings, limitations, recommendations, and conclusion.

1.12 Conclusion

This study explored the factors influencing grade 11 learner performance in geometry. It was undertaken at two secondary schools in the Umlazi District of KwaZulu-Natal Province. Reviewed literature and the results of this study proved that indeed there were some serious complexities and constraints influencing grade 11 learners' performance in geometry which needed urgent attention at policy and school levels in South African schools. Recommendations were made at the end of this report.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

As explained, in Chapter 1, there is no particular single factor which is solely responsible for affecting learners' performance in geometry (Reddy in Siyepu 2013p.1) and this chapter outlined the literature review underpinning the factors influencing learner performance in geometry in the secondary schools. Its focus was based on home-based variables, school-based variables, the Department of Education based factors and learner related variables.

2.2 Learner performance in geometry

Research studies have shown that learners have difficulty with Euclidean geometry of which various sources have been identified. According to Harris and Bourne (2017, p. 11), geometry is one of the most challenging in mathematics for learners. Similarly, Adulyasa & Rahman (2014, p. 252) argued that geometry is one of the problematic topics in mathematics. It is the branch of human enquiry involving the study of shape and space and their relationships, especially their generalization and abstractions and their application to situations in the real world (Nicholson, 2014, p. 123). Notwithstanding its importance and the significance of geometry, many learners still obtain poor results in geometry (Govender, 2017, p. 46).

The Programme for International Learner for Assessment (PISA) study for 2015 has consistently found that Thailand faced alarming rates of underperformance in geometry among learners of all ages (Armstrong & Laksana, 2016, p. 15). Thai learners were underperforming compared to the other Asian countries as their scores were below the international average in mathematics subjects (Mala, 2016, p. 102). Thailand was ranked 54th out of a total of 70 countries according to the PISA study for 2016 (Pholphirul, 2016, p. 22).

Thien, Darmawan and Ong (2015, p. 3) stated that Thailand had many factors influencing learner performance in geometry. In their findings, they argued that these factors were learner related, home-related and others were school-related. The Thai school education system is centred on memorising textbook materials rather than developing self-learning abilities (Chowa, Massa, Ramos & Ansong, 2015, p. 121). However, a study conducted by Das, Das and Kashyap (2016, p. 14) outlined the lack of learners' motivation by educators and parents that could develop self-confidence within learners towards geometry. For example, there was no healthy communication between educators and learners in geometry classes (Nenthien & Loima, 2016, p. 18) hence there was low learner performance in geometry. Whereas, parents were shifting the responsibility to schools to motivate learners (p. 19).

Although other countries are also not performing well in geometry, South Africa achieves very low results in comparison (Mutodi & Ngirande, 2014, p.116). Mathematics was amongst the subjects with the lowest achievement since 2012, with a percentage achievement of 49.1% in the 2015 Matric examination (Department of Basic Education, 2015, p. 4). The South African 2015 and 2016 national senior certificate examinations diagnostic reports indicated poor results in geometry (DBE, 2016, 2017). According to the DBE Technical Report (2018, p. 22) for the 2017 National Senior Certificate examinations results, KwaZulu-Natal had the lowest achievement (41.6%) in mathematics in 2017. The Department of Basic Education's report (DBE, 2016, p. 32) indicated a 17% decline in the number of candidates who wrote geometry between 2013 and 2016 from about 290 400 to 241 400 (Campbell & Prew, 2017, p. 14) reported in the Mail & Guardian for the 7th of January 2017).

In an effort to identify the causes for low performance of learners in geometry, some researchers (Tshabalala & Ncube, 2013, p. 6; Akinloye, Adu & Adu 2015, p. 12; Karue & Amukowa, 2013, p. 34) had suggested that performance of learners in geometry in secondary schools is influenced by a number of variables. According to the Centre for Development and Enterprise (2014), the factors influencing learner performance in geometry were complex, intertwined and often structural. Many studies and authorities for example (Makeleni & Sethusha, 2014, p. 104; Sa'ad, Adamu & Sadiq, 2014, p. 32) presented many factors influencing learner performance in geometry in secondary schools. These variables include lack of meaningful school environmental factors, the quality of educators, shortage of well-trained educators, incessant transfers of educators, home environmental factors and family backgrounds, staff ratio, learner related factors and automatic promotions of learners.

Conversely, (Mega, Ronconi & De Beni, 2014, p. 32) stated that there is a common perception by learners that geometry is a very difficult section in mathematics, as a result, most of them tend to avoid taking mathematics courses because of the geometry sections embedded in them.

2.3 Home environmental factors

According to Banergee (2016, p. 117) main factors linking the disadvantages of learners to underachievement in geometry were classified into a deficiency of positive home environment and support. For instance, Mahanta (2014, p. 36) argued that the home environment particularly the socio-economic status had significant effects on learners' educational achievement. He stated that the home is the first environment in which every child comes into contact within the learning process (p. 37). The purpose of this study is to contribute to this area of research by exploring the home environmental factors that influence learners' performance in geometry in the Umlazi District.

2.3.1 Socioeconomic factors

Khaliq, Baig, Ameen and Mirza (2016, p. 7) indicated that there is a significant relationship between parental income/status/occupation and the learner's academic performance most particularly in geometry. Similarly, Sonali (2017, p. 44) stated that learners from low socio-economic status have greater academic stress and therefore have low performance in geometry than those with high socio-economic (SES) status. Scholars tended to agree that parental education is an index of socioeconomic status which potentially leads to better learners' performance (Mullis *et al.*, 2016, p.188). Contrary to that, a literature review by Devenish and colleagues revealed that neighbourhood level has a significant effect on youth outcomes independent of family socioeconomic status (Devenish, Hooley, & Mellor, 2017, p. 219).

The increasing disparity in household income and wealth within the United States over the past half-century Autor (2014, p. 843); Saez and Zucman (2016, p. 519); Alvaredo et al. (2017, p. 56) has amplified concerns about the dependency of achievement on a learner's socio-economic status (SES). Sean (2013, p. 7) presented in his comprehensive study how learners from families with high income showed a better performance than those from low-income families. His study took place in the United States of America. He posited that the impact of the parents' income can be shown in the early timing of the students' learning and maintained that parents of higher-income take their children to school earlier than their lower-income counterparts.

Similarly, Brito, Piccolo and Noble (2017, p. 54) found that learners from higher socioeconomic backgrounds perform better than learners from disadvantaged backgrounds in terms of cognitive performance. This is similar to the findings by Pearce et al. (2016, p. 108) that learners from the more disadvantaged group were twice more likely to get the lowest mark in geometry. A study conducted by Ndebele (2015, p. 72) reported similar findings. He discovered that the higher the income and socioeconomic status of the family, the more likely parents are to be involved in helping their learners with homework. Whereas, learners who come from families with lower socioeconomic status are less likely to have parents who are involved in helping with their homework.

In a Kenyan study, Mucee et al. (2014, p. 491) examined the socioeconomic factors that influenced learners' academic achievement in geometry in the secondary schools in Tharaka. They found that due to low socio-economic status, many school learners in Kenya were forced to get jobs and work after their school hours every day (Minister of National Education, 2015, p. 10). As a result of that, learners' performance at school was poor because they were unable to get enough time to do homework.

Another study conducted by Letsoalo et al. (2017, p. 177) on factors influencing learners' performances in geometry was associated with different socio-economic, psychological and environmental factors. Furthermore, he said that a wealthier family can create a better background for the child by hiring private tutors to assist the child with geometry. For example, wealthy families can pay for extra tuition organized by private organizations to enrich their children with geometry. Coupled with that, (Soni & Kumari, 2017, p. 331) argued that parents' education level is an indicator of SES, since it is known to be related to learners' school achievements.

As mentioned in Chapter 1 this study was based at schools in the Umlazi District where several learners came from poor families with little or no educational learning materials at homes as the level of poverty is very high in that area. Sikhwari (2016, p. 44) attributed the determinant owing to learner performance in geometry in South Africa to socioeconomic factors in the manner that approximately 75% of learners came from two-room houses. For this reason, all members of the family shared rooms and learners did not have enough space to concentrate on their geometry homework. Parents from poverty-stricken families feel inferior and distance themselves from school activities. A study by (Hair et al., 2015, p. 822; Silvernail et al., 2014, p. 261) found that educators also often exhibit different behaviour toward learners and parents according to their socioeconomic status. Therefore, the socio-economic status of the family may influence the self-esteem of the learners.

Whereas, learners who have access to educational resources at home, tend to perform better in geometry than those who do not (Visser et al., 2015, p. 48). South Africa's future socio-economic prospects for learners and the development of the country as a whole need enormous improvements in the teaching of geometry in the public schooling system (McCarthy & Oliphant, 2013p.`3).

2.3.2 Parental educational background

Previous research has shown that learners' performance in geometry is associated with the parental educational background (Kikas & Mägi, 2014, p. 148) and the quality of parental involvement in their children's learning is likely to be influenced by parents' education level (Kiadarbandsari et al., 2016, p. 1465). For example, a study conducted in the United Arab Emirates suggested that learners who perceived their parents' attitudes being positive towards geometry tended to have significantly high-performance rates (Areepattamannil, Khine, Melkonian, Welch, Nuaimi & Rashad, 2015, p. 17). In fact, parental education has been shown to be one of the strongest determinants of learners' educational performance consequently family educational level and attitudes toward geometry may either influence learners' performance in geometry positively or negatively (p. 18).

The study that was conducted by Skolverket (2012) in Sweden, reported an increase of learner achievement between 2007 and 2011 with a more differentiated measure of family educational level. The level of education and occupation of parents are associated with the academic attainment of learners. Leung, Chung and Kim (2016, p. 141) asserted that parental occupational class, parental income and participation of parents determine learners' goals and serve as an indirect indicator of the material resources that can be found to assist the child in his education. Subsequently, parental background with learners' academic attainment involves various aspects like parent income, ethnicity, profession and home atmosphere. Recent findings highlighted that parental background such as family size, parents' qualification and parents' level of income are linked with, and significant to children's academic performance in any educational environment (Ogbugo-Ololube 2016, p. 115).

As has been noted in the study conducted by Visser, Juan and Feza (2015, p. 49) learners whose parents were educated scored higher on standardized tests than those whose parents were not educated. Firstly, this is because educated parents can better communicate with their learners regarding the activities and the information being taught at school. In the Trends in International Mathematics and Science Study (2007) study, Visser, Juan and Feza (p. 50) found that learners whose parents had completed at least grade 12 (matric) in geometry, are much better in geometry. Therefore, the academic performance of learners depends heavily upon parental involvement in their academic activities to attain a higher level of quality in academic success. Secondly, parents can better assist their learners in their work and participate in school. The parental educational background plays an influential role in the educational development of the child in terms of assisting their learners with geometry homework as it should be given on a regular basis.

Lastly, parents with higher levels of education can generate higher incomes which can, in turn, be used to invest in their learners. Kainuwa and Yusuf (2013, p. 180) examined the influence of parental socio-economic status and educational background on their learners' education. It was observed that parents' level of education often determines the support and the ambitions they have on the education of their children. This was also supported by Chevalier et al. (2013, p. 18) who stated that more educated and richer parents can provide a better environment for their learners' educational performance in geometry and science subjects. Özcan & Erktin, (2015, p. 68) noted that some of the investments that better-educated parents make, include channelling their learners to geometry classes. Better educated parents are also knowledgeable about the returns of education and therefore might be willing to invest more money in providing quality education for their offspring (Erola, Jalonen & Lehti, 2016, p. 33). By so doing, they guide their children towards better job opportunities in the workplace.

The consensus amongst South African studies was that the availability or scarcity of key resources at home influence the performance of learners in geometry, with higher levels of resources being linked to better geometrical achievements. Research has shown that there is a positive connection between parental background and learners' academic attainment. Mutodi and Ngirande (2014, p. 435) established a positive correlation between parental education levels and the performance of learners in geometry in South African schools. Similarly, Aliyu and Mohammed Isa (2016, p. 450) point out that parents are expected to encourage and guide their children to become well-accomplished people in society. Similarly, the studies of (Pangeni, 2014, p. 30; Goforth, Noltemeyer, Patton, Bush, & Bergen, 2014, p. 196) emphasized the significance of parental education factor as a predictor of geometry achievement.

Moreover, parents transmit different beliefs and values to their children, including the ability to delay gratification and exert self-control, which have been shown to differ across cultures and explain school outcomes (Figlio et al., 2016, p. 225). Pangeni (2014, p. 31) suggested that parents who are educated to a higher level have greater access to a combination of economic and social resources that can be used to help their learners succeed in schools. Parents serve as role models and guides in encouraging their children to pursue high educational goals and desires (p. 33). They achieve this by establishing the educational resources on hand in the home and holding particular attitudes and values towards their children's learning.

2.3.3 Parental involvement

Parental involvement is another household characteristic that has been linked to learner performance (Ceballo et al., 2014, p. 116; Yaseen, Zaman, and Rasheed 2017, p. 84). Parent involvement according to Miksic (2015, p. 15) can be defined as how parents support their children in words and actions. Also, Castro, et al., (2015, p. 33) agreed in their study that parent involvement has shown a positive impact on children's academic achievement. Parents' participation in learners' education, both formally and informally, can have social and emotional benefits (McDowall & Schaughency, 2017, p. 348), but globally, certain contextual challenges affect the achievement of learners negatively due to sustainable parental engagement (Humphrey-Taylor, 2015, p. 68).

According to (McKenna & Millen, 2013, p. 9) parental involvement is defined as the ongoing, multidirectional relationships of parents and school constituents that aim to address their children's learning, progress, and means of intervention, both in and out of the school environment. Fernández-Alonso et al. (2017, p. 453) found that learners' belief of parental involvement simulates an important aspect in academic achievements and parents controlling behaviour exhibits a negative effect on their performances. The potential for parental involvement to improve learner achievements is believed to be so important. Federal legislation, such as the No Child Left Behind (NCLB, 2001-2015) and the Every Learner Succeeds Act (2015), were based on the principle that families, educators, and the community must work together to improve teaching and learning (U.S. Department of Education, 2004).

The level of parental involvement has a significant effect on learners' academic performance in geometry, and it has been found that learners whose parents are more engaged at school have a more positive academic achievement (Al-Alwain, 2014, p. 47). Educators in schools serving disadvantaged communities are more likely to have a negative perception of parental involvement; often classifying it as less encouraging and less rewarding in terms of advancing learners' learning (McDowall & Schaughency, 2017, p. 349), while ignoring the potential of parents to supervise learners and partake in school activities. Social cognitive theory suggests that learners absorb messages about appropriate behaviour and socially accepted goals by observing and talking with important people in their lives (p. 48). Based on this assumption, parents have the potential to model positive attitudes and behaviours of their learners toward the school.

Despite attempts to encourage parental involvement in this country, progress is being hampered by factors such as poverty, single-parent households, unemployment and a lack of supportive familial structures (Abrahams, 2013; Karibayeva & Bǒgar, 2014, p. 529; Van Loggenberg, 2013). Parental involvement at the school leads to improvement of learners' attitudes, attendance, safety and security in the school and higher rates of school rules' obedience (Al-Alwain, 2014, p. 48). Ultimately, when there is parental involvement at school activities or conferences, learners become more accountable for their behaviour (p. 49). Learners are more likely to apply themselves and perform better in school when their parents show an interest in their schoolwork, when they assist them with homework and are willing to hold their children accountable for the completion of school assignments. This involvement, in turn, results in an indirect impact of academic performance in geometry.

There was the strongest link found between the geometrical achievement of learners and parental involvement in secondary school (Al-Alwain, 2014, p. 53). More recent studies found similar findings. For example, Wilder (2014, p. 377) indicated that the most important factor that improves academic performance in geometry was the partnership between parents and schools. For example, Fishman and Nickerson (2015, p. 523) found that specific parent invitation to schools as well as specific requests from the learner for geometry homework assistance was the biggest indicator of the importance of parental involvement. There was a positive influence in inviting parents to school to monitor their children's academic performance and learners' improvement in geometry (Simpkins, Fredricks, & Eccles, 2015, p. 614). Although Carpenter, Young, Bowers, and Sander (2016, p. 47) tended to agree that it is a parent's involvement that has a positive impact on learners' achievement, it is not clear whether it is parental aspirations/expectations, parent-child communication, assistance with homework, volunteering at school, or other factors that have the greatest influence.

In South Africa, schools were instructed to engage families in the education of their children and encourage the participation of parents in regular, two-way communications involving learner academic achievement and various school activities (ED.gov 2013, p. 13). The Minister of Basic Education, Motshekga (2013, p. 11) acknowledged that parental involvement is one aspect that needs intervention in South African schools. Mansfield-Barry and Stwayi (2017: 78) argue that such partnerships require that role players "work together to achieve every learner's right to education". Similarly, McKenna and Millen (2013, p. 12) posited that parental involvement includes a combination of parents' voices and presence. Parents' voice also includes a receptiveness on the part of educators and leaders to listen to those beliefs and engage in a multidirectional flow of communication with the parents.

The lack of parental involvement in school activities may also encourage learners to be disruptive. In fact, parents cannot leave the responsibility of disciplining learners to the school only; they should collaborate with the school (De Atouguia, 2014, p. 76). Parental participation helps develop a positive sense of efficacy in learners whose self-esteem is raised and therefore, they manifest high performance in subjects like geometry (Garcia & Santiago, 2017, p. 27; Masabo, Muchopa & Kuoth, 2017, p. 89). It is thus obvious that a lack of parental participation and support in the enforcement of school discipline is likely to influence learner performance in geometry.

Other educators and Principals do not welcome parental involvement at times (Masabo, Muchopa & Kuoth, 2017, p. 90) and they limit it to voluntary social events, fundraising and orientations (Chikudo, 2016, p. 99) and because of this practice, there is likely to be a higher failure rate of learners in geometry in secondary schools. Okeke, (2014, p. 9) pointed out that this could be seen from parents' poor attendance of meetings, failure to keep control of learning support materials that are given to learners, poor matric results, and lack of interest in learners' schoolwork and homework. Therefore, the need to empower educators with family and community involvement skills to enable them to have the capacity to identify the potentials of parents and exploit them for the benefit of the learners and the schools are becoming more relevant (Epstein, 2018). Educators and families must work together to watch for signs of potential problems and address the issues as they arise. This involvement is a key factor in preventing school dropout (Fan & Wolters 2014, p. 22; Wilkins & Bost, 2014, p. 52).

2.4 School environmental factors

According to Shamaki (2015, p. 179) the school learning environment is viewed as the totality of the atmosphere within which the staff and learners function. It is a dynamic and comprehensive picture of all those influences that moulds the physical, emotional, psychological and social life of the members of the school. With regard to this Uhrain (2016, p. 79) maintained that the concept of school learning environment constitutes various strands which include the school location, structure, organizations, interpersonal relationship, available materials, communication patterns, administrative and supervisory practices among others.

2.4.1 Instructional methods

Research indicated that educators' attitude reflects on how they teach, which invariably affects learner's academic performance negatively or positively (Ogembo, Otanga, & Yaki, 2015, p. 39). For example, Ali, Bhagawati and Sarmah (2014, p. 66) admitted that geometry and the teaching and learning of geometry are complex as they require the existence of many cognitive functions simultaneously. Gamlem and Smith (2013, p. 150) emphasized that education is conducted through teaching, learning, assessment and constant monitoring to facilitate the improvement of the performance of learners if it is effectively implemented. For this matter, monitoring of teaching and learning is regarded as a significant leadership aspect of locating weaknesses within the process of teaching and learning to improve instruction and learner performance Du Plessis (2013, p. 79).

A survey conducted by Fabiyi (2017) to 500 senior secondary school learners in Ekiti State in Nigeria, recommended that (p. 83) the identified difficult geometry concepts should be taught by using appropriate educators' methods of instruction and instructional materials. For example, Luneta (2014, p. 48) was of the view that consistent and effective instruction in geometry require educators to develop sound instructional strategies and knowledge of useful sources and activities. This consistency requires geometry educators' professionalism to be able to act appropriately in selecting learning strategies or in explaining geometrical concepts for the learning process at schools (Hidayat, Wahyudin, & Prabawanto, 2018, p. 12).

According to Tshabalala and Ncube (2013, p. 11), the learners' performance in geometry in South Africa is mainly affected by teaching methods, material and the creation of a good foundation of the subject at the lower levels. The lack of learners' conceptual understanding becomes one of the constraints in solving geometric high order thinking skill test items (Alhassora, N. S. A., Abu, M. S., & Abdullah, A. H, 2017, p. 51). Therefore, it is important that educators use teaching methods that take the learners' level of understanding geometry into account (Schoenfeld & Floden, 2014, p. 222). The reason why Clement (2013, p. 82) associated learners' poor performance in geometry with educators' teaching practices, is due to learners' low understanding of the geometric concepts and lack of ability in geometrical connections. Clement noted (p. 83) that educators in South Africa were still applying traditional ways of teaching practice. Out-dated teaching practices and lack of basic content knowledge have resulted in poor teaching standards (Carey et al., 2015, p. 165).

2.4.2 Cooperative learning in geometry classes

The type of learning approach mostly used nowadays is cooperative learning that allows the individual to participate in learning in various ways (Ching and Nunes 2017, p. 65). Successful individuals are emerging as a result of learner-centered learning organized according to the interests, needs, abilities and skills of the learners (Good and Clarke 2017, p. 45). Educational studies focus on approaches that support the active participation of learners, learner-centered education, linked to everyday life, and learners' past experiences. Furthermore, Mtitu (2014, p. 27) lamented that, for effective and efficient teaching, learner-centered methods that require educators to actively involve learners in the teaching and learning process must be applied. Eze, Ezenwafor and Molokwu (2015, p. 95) also concurred with Mtitu and said that to facilitate the process of knowledge transmission, educators should apply appropriate teaching methods that best suit specific objectives and level exit outcomes.

One of the possible reasons for Indonesian learners' low performance in geometry was due to an inappropriate learning model of the geometry learning process Prahmana, Kusumah and Darhim (2017, p. 321). That fact was in line with the results of the interviews conducted with some educators and learners in Karanganyar who stated that the learning of geometry was still using a direct learning model. In that model, learners had little or no chance of being actively involved in the learning process, so that they could develop their social skills and their interpersonal ability. According to Prahmana, Kusumah and Darhim's (2017, p. 405) findings, the cooperative learning model was recommended as one of the learning models that could be used in Indonesia in the learning of geometry. Cooperative learning is an approach with access to group-work and self-exploration (p. 406).

Indeed, it was noted in Chowa, Massa, Ramos and Ansong's (2015, p. 121) study that traditional teaching methods that were used by the schools' education system in Thailand, for example, that of memorising textbook materials influenced learner performance negatively. Whereas, Runisah, Herman and Dahlan (2016, p. 347) stated that researchers recommend that geometry teaching is effective when learners actively participate in the learning process, so geometry educators should use manual activities and interactive groupwork to encourage learners to learn better.

In South Africa, cooperative learning is affected by the large class sizes. According to Reddy (2017: p. 384), the large classes in most South African schools have become a concern in the implementation and effectiveness of cooperative learning. In cooperative learning small groups of learners who differ in ability work together as a group on an academic task.

Advantages of Cooperative learning

Through cooperative learning, learners can establish relations between concept representations, whilst learning geometry (Wernet, 2017, p. 86). Cooperative learning incorporates all kinds of students because it advances learning, fosters friendship and respect. The benefits are greater for students who come from groups that are much more diverse because students depend on every member of the group and they should all work to achieve a goal (Colorín Colorado, 2017, p. 56). In fact, social interaction is an important aspect that opens the opportunity for learners to express their thoughts and ideas which will encourage them to do reflection (Retutas, 2014, p. 43). Notably, learners will be more easily accepted in the school environment especially in class if they are able to interact well especially in learning (p. 44). This is in accordance with the opinion that learners who feel good interact with friends in class and contribute positively to their lessons in class. Social interaction can be a tool for learners to either gain power for themselves or diminish others in the classroom space.

Research findings by Butakor (2016, p. 568) underlined the positive cognitive and affective results of cooperative group instruction. Cooperative learning can play a positive role in building community, trust, and mutual engagement with one another (p. 569). In this way, social interactions play a critical role in learners' identity development (Langer- Osuna, 2018, p. 87). It was noted (p. 88) that cooperative group instruction could enhance learners' geometrical performance, develop friendships between learners, and enhance self-esteem. In addition, groups that function as a cooperative unit tend to outperform individuals (Boling, Holan, Horbatt, Hough, Jean-Louis, Khurana & Spiezio, 2014, p. 49). The more learners discuss geometric proofs, the more comfortable they are with their group members, and the more interactive and effective the activity will be (Boardman et al., 2015, p. 51). The cooperative learning method improves thinking abilities. The quality of cooperative learning in geometry classes is one key variable in the quality of education (p. 52). It also determines the extent to which teaching practices have an impact on learners' academic achievement in geometry.

Ostrom (2015, p. 65) also found that fair mechanisms for decision making were common among well-functioning groups. It improves their communication abilities needed in cooperative learning settings. He further said that the cooperative learning method has recently attracted more scholarly attention than other teaching methods because of its sociological, psychological, educational, and pedagogical benefits.

2.4.3 The quality of geometry educators

Alzhanova-Ericsson, Bergman and Dinnétz (2017, p. 11) asserted that the problem of learners' performance in geometry cannot be isolated from how educators interact with learners in the learning of the subject. It has been well-established in research that educator quality has a direct impact on learner performance (Jimerson & Haddock, 2015, p. 488; Smith, 2008, p. 610; Terhart, 2011, p. 123). Other studies agreed that educator quality in geometry is the one most important factor in predicting learners' achievement (Bear & Jones, 2017, p. 146). For instance, Prahmana, Kusumah and Darhim (2017, p. 343) indicated that an educator's influence in the learning process can impact positively or negatively toward learners' geometry problem-solving skills, independence, and curiosity.

Indeed, the quality of educators' instruction has a direct impact on the learners' achievements (Venkat & Spaull, 2015, p. 121). Alzhanova-Ericsson, et al (2017, p. 12) mentioned that the poor performance of learners in geometry may be influenced by lack of practice, teaching methods, teaching facilities that an educator is using such as a game, computer or instructional media. These do not go in isolation, despite the findings of Suleman, Aslam, and Hussain (2014, p. 142) who argued that well-equipped classes encourage educators to teach learners effectively and positive results in geometry may be imminent. While the engagement of suitable geometrical activities is of great importance, the quality of the educator's instructional method is of equal significance (Jacobi-Vessels et al., 2016, p. 8).

Different researchers have discovered different reasons that cause learners to perform poorly in geometry. Kukogho (2015, p. 75) quoted Professor Mohamed Ibrahim (Professor of Mathematics and President of the Mathematical Association of Nigeria) saying that the poor performance in geometry in Nigeria has been caused by poorly trained educators. Ibrahim was quoted saying that learners had developed "geometrical phobia", which results in fear and failure. According to Ibrahim the dislike of geometry is linked to educators' methodology. He also said most educators in Nigeria cannot use modern technology, such as computers, which are now commonly used in advanced countries.

The quality of geometry educators and teaching methods is a national priority in addressing the quality of education learners receive (Mann, Chamberlin & Graefe, 2017, p. 114). Ramphele (2015, p. 11) stated that quality education originates from quality educators. An educator cannot give what he does not have. Educator characteristics, like educator qualification and experience, are important determinants of learner performance (Kimani, Kara, & Njagi, 2013, p. 27). For example, Abe (2014, p. 10) studied geometry classes and found out that learners taught by educators with high qualifications show considerably higher results compared to the results of learners taught by educators with lower qualifications. Ellerhorst (2014, p. 48) supported this and said that years of experience, degree level or certification type influence learners' performance in geometry.

However, (Couto & Vale 2014, p. 62; Gegbe & Koroma, 2014, p. 240) contradicted the view of the previous researchers, stating that educator qualifications do not influence learner performance. Gegbe and Koroma (2014, p. 241) argued that in order to be a good professional, capable of teaching geometry, it is crucial to have deep knowledge and understanding of geometry and the ability to put to work the strategies which are capable of making the learners learn. In the same way, Kimani, Kara, and Njagi (2013, p. 27) were also in disagreement with the previous researchers and they noticed that more experienced educators do not a make difference in learners' performance.

Browning, Edson, Kimani and Aslan-Tutak (2014, p. 333) recommended designing curriculum experiences in geometry that moved beyond procedural and memorization skills toward developing spatial visualization and problem-solving skills. Oladosu (2014, p. 8) stated that geometry is a central aspect of the school mathematics curriculum which is crucial in the mathematics education of learners from the perspective of providing them with the opportunity to develop spatial awareness and geometric thinking. Educators must be able to select relevant examples and exercises when preparing lessons and must be able to sequence the content of the lesson and select a method for teaching the relevant procedures (Bansilal, Brijlall & Mkhwanazi, 2014, p. 30). Quality educators must be able to acknowledge and reach all the learners on different levels by developing lessons with activities on more than one level in a class (Bleeker, Stols & Van Putten, 2013, p. 66).

According to NCTM (2014, p. 15) quality geometry educators must have a diverse range of definitions for fluency: speed, accuracy, mastery of facts, rapid recall and computation skills are some examples. However, research has shown that learning Euclidean geometry through engaging activities that focus on geometrical understanding, is preferable to learning through collaborative learning (Boaler, Williams & Confer, 2014, p. 124).

2.4.4 Educators' knowledge of geometry

In education, both content (subject matter) and procedural knowledge (pedagogical knowledge) of educators are essential components that play important roles in learners' understanding and achievement. Numerous studies indicated educators' academic skills are significantly correlated with learners' achievement as measured by achievement tests (Campbell & Prew, 2014, p. 419). Fadzil and Saat (2014, p. 111) argued that lack of Pedagogical Content Knowledge (PCK) by the educators as defined by Shulman (1986) and that of Hill, Ball and Schilling (2008) is another important factor influencing learner performance in geometry.

Learners' acquisition of geometric knowledge depends greatly upon the educator's geometrical content knowledge (Couto & Vale, 2014, p. 59). Educator's knowledge and command of the subject are important in the performance of learners in geometry. Several educators avoid the subject due to lack of confidence, ability, and geometrical content and pedagogical knowledge

(Beilock & Maloney, 2015, p. 4). Some educators especially the under-qualified and unqualified educators who teach in overcrowded and non-equipped classrooms do not enjoy teaching geometry (Metzler, 2014, p. 14), so they do not spend much time in this section.

Educators' participation in a geometry methods course corresponded to significant increases in geometry teaching efficacy (Zee & Koomen, 2016, p. 134). Utilizing non-traditional approaches in the geometry classroom such as implementing small-group teaching techniques and addressing individuals' attitudes toward geometry can help lessen geometry anxiety in both learners and educators (Lake & Kelly, 2014, p. 262). Being confident and knowledgeable in the subject matter is also critical in shaping one's attitude toward geometry including the attitudes of educators (Catlioglu et al., 2014, p. 28; Carey, Hill, Devine, & Szücs, 2015, p. 163).

A research conducted by Ellerhorst (2014) in South Africa identified years of experience, degree level, certification type and gender influence learners' performance in geometry. Ellerhorst (2014, p. 16) found these to be contrary to the assumption that these four factors possessed by educators (though a small number) with a few years of experience, lower qualifications and certification affected learners' performance positively.

Although Ellerhorst (2014, p. 21) does not make any suggestion as to why this is the case, based on 40 years of experience in teaching and has held the Head of Department position a probable factor could be a passion for teaching. Passion leads to motivation to improve one's teaching and one cannot teach passion to new educators. Ellerhorst (2014, p. 66) suggests that more research is necessary.

2.4.5 Educators' attitudes, anxiety and beliefs

Some studies exist that examine the relationship between geometry anxiety and its implications for geometry teaching effectiveness (Gresham, 2017, p. 69). The more parsimonious account is that geometry anxious educators may simply not have adequate geometrical knowledge or knowledge for teaching geometry in the first place (Kim, 2014, p. 71; Novak & Tassell, 2017, p. 20). Research by Adeyemi (2015, p. 15) has indicated negative, geometrical beliefs and geometry experience caused by geometry anxiety.

Atnafu (2014, p. 59) made his observation about the attitude of a group of educators in Pakistan. It was found that most of the educators in Pakistan do not have a positive attitude toward teaching. The study made the following recommendations: to improve motivation, reduce anxiety and change the attitude of the geometry educators. The attitude of educators can play a significant role in the way in which geometry is understood by the learners. Carey et al. (2015, p. 187) mentioned that educators with high levels of geometry anxiety use more traditional teaching methods, such as a lecture.

Improving the quality of geometry teaching practice will help reduce educators' geometry anxiety (Beilock & Maloney, 2015, p. 11). By being aware of educators' geometry anxiety and instructional methods that contribute to it or help to reduce it, can better provide opportunities to raise geometry self-efficacy and geometry educators' efficacy (Taylor & Fraser, 2013, p. 297). Several studies investigating educator's efficacy beliefs indicate that beliefs may account for individual differences in educators' effectiveness (Suarez-Pelliconi, Nunez-Pena, & Colome, 2014, p. 60) and that educators' effectiveness is associated with geometry anxiety (Gresham, 2017, p. 70).

Several factors might have had an impact on the formation, development, and continued sustaining of educators' beliefs and attitudes, which in turn affected their approach toward teaching geometry (Dede, 2015, p. 227). Personal experiences with geometry instruction, depth of geometry knowledge, understanding how geometry is conceptualized, and the influence of parents, educators, and peers all play a part in developing confidence or anxiety toward geometry (Campbell & Prew, 2014, p. 421; Peebles & Mendaglio, 2014, p. 1321). Factors such as motivation, geometry anxiety, and the coursework required during educator preparation programs could all influence educators' attitudes and beliefs about geometry. Factors associated with these beliefs include motivation, interest, self-efficacy and confidence, and feelings (Maasepp & Bobis, 2015, p. 89).

The literature highlighted the relationship between knowledge and beliefs and the impact of this relationship on educators' performance and practices (Campbell & Prew, 2014, p. 420; Charalambous, 2015, p. 427). Charalambous (p. 428) investigated the effect of the intersection between two components; educators' beliefs and educators' knowledge on teaching quality and how that impacted educators' performance in teaching geometry. He found that educators who have more geometry content knowledge are positively affected in terms of their pedagogical beliefs, which is interpreted to mean they are more likely to believe their learners can construct geometry concepts based on their own knowledge and that geometry skills should be taught with comprehension and understanding.

The beliefs parents maintain are pertinent to the overall wellness and success of their children (Warren, 2017, p. 3). At times, parents may place unreasonable demands on themselves, their children, or the practice of parenting in general. For example, a parent may think, "My child should always do what I say, and I cannot stand it otherwise." Findings from Hamamci and Bağci (2017, p. 12) have suggested that a relationship exists between family functioning and the degree to which parents hold irrational expectations about their children. The emotional support and responsiveness of parents deteriorates with an increase in irrational beliefs.

2.5 Department of Education based factors

2.5.1 Curriculum Change

Education nowadays cannot be viewed merely as transferring knowledge from educators to learners. In the modern era, education becomes one of the means for preparing learners to encounter every challenge of the 21st century. In response to the global challenges, there have been adjustments in the curriculum of education in Indonesia. Indonesia upgraded its education system by implementing curriculum 2013, which was focusing on the development of highorder thinking skills (HOTS) (Ministry of Education and Culture, 2016, p. 10). Geometry was phased in from primary school up to high schools in which reasoning and proof received the utmost importance at all levels (Retnawati, Kartowagiran, Arlinwibowo, & Sulistyaningsih, 2017, p. 257). Early adaptation of highorder thinking skills development in the Indonesian education system has demonstrated that geometry skills are urgent and relevant to current global needs and challenges (Apino & Retnawati, 2017, p. 6; Jailani, Sugiman, & Apino, 2017, p. 247; Yen & Halili, 2015, p. 41).

Similarly, the National Department of Education of South Africa has had many changes since 1994. These changes were aimed, among other things, to redress past inequalities as stated in the National Curriculum Statement (NCS) policy (2000, p. 4). Due to constant change within the curriculum in the Department of Education, the introduction of NCS propagated a learner-centred approach in focusing on learners' hidden knowledge and the realities of their daily experiences (Bowie, 2014, p. 69).

In a Revised National Curriculum Statement (RNCS), between 2008 and 2013, geometry was omitted from the curriculum and was placed into an optional paper 3 examination (Department of Education (DoE), 2005, p. 6). In 2014, geometry was brought back into the curriculum in the FET phase through the Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education (DBE), 2011d, p. 5). It was once again examined in paper 2 as previously and it again became compulsory.

After that reinstatement of geometry in the FET phase, many studies reported achievement in geometry as particularly problematic (DBE, 2015a, p. 3; DBE, 2015b, p. 5). Due to this change in the curriculum, as a country, we sit in the scenario where there are some educators who struggle with teaching geometry since they do not have a solid grasp of it themselves, and some educators were never taught geometry in school, but now must teach geometry in their own classrooms Dr. Basson, (2015, p. 2). Making geometry optional resulted in many school educators avoiding it, which then limited their learners' exposure to the type of reasoning associated with geometric understanding.

Tshiredo (2013, p. 117) investigated and studied the complexities and constraints experienced in schools in science education because of curriculum change in teaching and learning of science subjects. CAPS whereas, is educator-driven, with content-based topics and themes that are consistent and expressed in plain language that facilitates ease of understanding and use (Bowie et al., 2014, p. 70). South Africa has not yet had a game-changing intervention that alters the essential character of dysfunctionality in most schools, nor has improved the life chances of most learners. Jansen (2014, p. 5) stated that the Department of Basic Education (DBE) had wasted hundreds of millions of Rands on new curricula, systems and, policy changes.

The diagnostic report on the 2014 national examinations was carried out from a sample of grade 12 geometry scripts and found that the lowest average in that sample for the second mathematics paper was in geometry (DBE, 2015, p. 6). The report recommended that learners need to spend much time in solving geometry problems so that their skills in this area can be improved. Learners are unable to prove theorems.

2.5.2 Provision of technology tools to schools

Educators' instructions closely integrated with technology approaches support effective geometry teaching (Cheung & Slavin, 2013, p. 88) and create extraordinary opportunities to individualize instruction for the needs of individual learners (Corcoran & O'Flaherty, 2016a, p. 677). Recent research has shown that educator integration of ICT into a geometry classroom has an impact on learner performance (Hegedus, Tapper, & Dalton, 2016, p. 32). The use of dynamic geometry software helps develop the concept image of shapes because learners can observe how various properties vary or remain unchanged under the digital transformation (Browning, Edson, Kimani & Aslan-Tutak, 2014, p. 336). The reason for the investment is the belief that introducing ICT will improve educator productivity, learner performance in geometry, and prepare learners for a world where technology is an important part of life (OECD, 2015).

Geometry educators from Asian countries like Korea, Singapore and Hong Kong, that were the top-performing counties in the TIMSS 2011 study and again in 2015, integrated computers in the classrooms and it emerged that learner performance in geometry was much higher (Ruthven & Hennesy, 2003, p. 20; Mullis et al., 2012, p. 17). Corcoran and O'Flaherty (2016a, p. 677) emphasized that digital technology helps learners to learn geometry more quickly and accurately. In addition, they mentioned that dynamic graphical, numerical and visual technological applications provide new opportunities for educators and learners to interact, represent, and explore geometry concepts.

The ICT readiness in South Africa (Dutta, Geiger, & Lanvin, 2015, p. 26) is still very low, although there is an emphasis on the inclusion of technology in mathematics education. Therefore, the Department of Basic Education needs to provide all schools with adequate IT infrastructure: PCs and geometry software to enhance geometry learning. This geometry software allows users to construct geometric figures according to Euclidean principles and then dynamically alter those (Hall & Chamblee, 2013, p. 14). In fact, this ability to dynamically manipulate figures saves time, provides a responsive visualization of an object's properties, and allows for immediate visual feedback to the user (Hall & Chamblee, 2013, p. 15). These aspects of enhancing visual representation and spatial visualization, increase learners' cognitive capacities during learning, encourage greater geometrical discourse, and pushes learners to become more geometrical thinkers (Crompton, Grant, & Shraim, 2018, p. 59).

Eickelmann, Gerick & Koop (2016, p. 25) stated some benefits of geometrical software GeoGebra as it makes teaching significant, easy, pleasant, amusing and practical and increases attendance rate of the learners. Similarly, Grant, & Shraim (2018, p. 209) found some potential benefits of ICT to motivate learners, supply a variety of teaching and learning experiences, connect geometry classroom with function to the real world, act as a visual support to allow learners to construct mental images, facilitate educators and learners to representation of geometrical processes concerned in specific number operations or calculations and support the understanding of geometrical ideas.

According to (Trouche & Drijvers 2010 as cited by Zaranis & Synodi, 2016, p. 17) some benefits of using the ICT in teaching and learning of geometry were that learners can connect to experts and have access to global resources, have access to quality learning material, and can improve own knowledge and standard of work. Communication is easier and faster, via the Internet, and learners acquire skills which they can use beyond school, university or the workplace.

2.5.3 Professional Development of educators

Kukogho (2015, p. 84) as cited in Ibrahim highlighted that in Nigeria, the training gap has been minimised by workshops organised by the Mathematical Association of Nigeria (MAN). MAN, organised workshops occasionally to equip geometry educators with the latest techniques on how they can teach geometry effectively in secondary schools. Researchers are interested in professional development programs that aim to develop educators' integration of technology in geometry teaching. According to (Huang & Shimizu, 2016, p. 393) some scholars in China believed that educators' professional development is the process of educator professional growth or continuous updating, evolution and enrichment of educators' internal professional structure.

Van Damme (2015, p. 3) also argued that developing innovative programs and practices for educators' professional development are intended to improve educator practices and, through them, learners' learning and achievement; developing and validating new assessments. Furthermore, Thomas and Palmer (2014, p. 71) highlighted that professional development (PD) practice is best constructed around a supportive community of inquiry that gives educators the opportunity to observe, practice, and reflect on the use of the most effective way that could improve learners’ performance in geometry in the classroom. This assertion was corroborated by the findings reported by Mafukata (2016, p.68-79) who argued that educator-in-service training was at its lowest in South African schools, especially in the sciences such as geometry.

Professional development must be linked to educator knowledge, such as Shulman’s (1986) concept of pedagogical content knowledge (PCK). For example, developing a map of (geometrical) content knowledge for teaching. Ball et al (2008, p.389) differentiated between (a) educators' subject matter knowledge (SMK), which includes pure geometrical knowledge, specialized geometrical knowledge for teaching, and knowledge about how the geometrical topics in the curriculum are related, and (b) educators' PCK, which includes knowledge about learners' geometrical thinking, knowledge about the content and teaching, and knowledge of the curriculum and other instructional materials (Kennedy, 2016, p. 945).

In South Africa, many professional development initiatives commonly underestimated what it took to change their instructional practice (Mogari, 2014, p. 348). As explained in Chapter 1, the transformation in the South African school curriculum has brought many instructional challenges to educators which led to much frustration and demotivation. Educators cannot be effective in the teaching of geometry if they have some inadequacies. The review by Glover et al. (2016, p. 37) of studies of professional development relating to school mathematics showed that very few of the initiatives which met acceptable standards of rigour also led to positive effects on learner attainment. Educators who are not confident about their own ability to teach geometry will have fewer possibilities when making decisions about the teaching approaches to be used. These educators are also not able to apply wide, deep and integrated sets of geometry knowledge and skills in the classroom. Educators need a deep understanding of all aspects of geometry so that they can present and explain geometry concepts and show how they relate to other mathematics topics.

Providing one or more geometry methods courses in education preparation programs has the potential to increase pre-service educator knowledge and skills in geometry, which has been shown to positively influence educator attitudes about geometry (Jong & Hodges, 2015, p. 407; Maasepp & Bobis, 2015, p. 90). Thus, many researchers suggested including courses and programs that emphasize geometry conceptualization in teaching pre-service educators (Harris et al., 2014, p. 94; Jong & Hodges, 2013, p. 100). Their studies emphasized the importance of providing geometry methods courses in education programs to change or evolve negative beliefs about geometry; they are considered as effective interventions in educator preparation programs.

2.6 Learner based factors

2.6.1 Learners' attitude to geometry

According to (Jennison & Beswick, 2014, p. 280) learners' attitudes towards geometry are a factor that has been studied persistently to find out if there is a relationship between learner achievement and attitudes. There are many studies across the world that have investigated learner attitudes towards geometry and also the relationship between attitudes and learner performances (Mahanta, 2014, p. 28; Mensah, Okyere, & Kuranchie, 2013, p. 134; Mutodi & Ngirande, 2014, p. 436). These studies have identified different components of attitudes towards geometry and on how these components affect learner performance. According to Tall (2014, p. 223), learners' emotions play a critical role in geometrical thinking and can have a profound effect on how they make sense of proofs.

Tanzania, as one country within Sub Saharan Africa (SSA), had consistent underperformance of learners in mathematics and science, which made Tanzania lose economic advantages over other countries. According to Bethell (2016, p. 38) for the country within this region (SSA) to benefit from a competitive global economy driven by new technologies, it required a significant improvement in Science, Technology, Engineering and Mathematics (STEM) education. Tanzanian had to change the attitude of the learners in their schools. Attitudes can change and develop with time (Syyeda, 2016, p. 32), and once a positive attitude is formed, it can improve learners' learning.

In a more recent study, Ngussa and Mbuti (2017, p. 170) conducted a study in Arusha, Tanzania, involving secondary school learners. They established a moderate relationship between learners' attitudes and performance when educators use humour as a teaching strategy. They concluded that the enhancement of learners' positive attitude can boost learners' performance in mathematics.

Zan, and Di Martino (2014, p. 572) mentioned that if the self-confidence and attitude of learners towards geometry is low, learners do not believe in themselves and the performance drops.

However, if learners have high self-confidence and believe in their abilities, they can be successful in learning geometry, thus overcoming the fear of failing. These learners are ready to take geometrical challenges which in turn increase their academic achievement. In addition, Belin (2016, p. 176) suggested that a positive attitude enhanced learners' performance throughout their schooling and boosted the learners' self-confidence, values, enjoyment and motivation to learn. This was supported by Brookstein, Hegedus, Dalton, Moniz, and Tapper (2014, p. 233); Tran (2014, p. 432) who conducted research on the relationship between attitude, achievements and performance of learners in geometry and demonstrated that the positive attitudes among learners towards geometry would improve learners' performance. Khun-Inkeeree, Omar-Fauzee, and Othman (2016, p. 89) concurred with this and said that developing a learner's self-confidence may enhance learners' performance in geometry.

Rimm-Kaufman and Sandilos (2015, p. 182) asserted that learners with positive relationships with their educators experienced better academic performance in geometry because they felt accepted. The culture of respecting superiors without questioning their approach might have brought them to an unchallenged status, which has been a hindrance to the performance of learners in geometry (Potari & Ponte, 2017, p. 442). Learners will have higher performance in geometry when creating close, positive, and supportive relationships with their educators than those who have more conflict with their educators (Rimm-Kaufman & Sandilos, 2015, p. 183).

2.6.2 Learner motivation

Learner motivation is an important part of learning. Sumantri and Whardani (2017, p. 118) stated that motivation greatly influences the improvement of learners' learning outcomes. Research has shown the tight relationship between learner motivation and their engagement in learning geometry. For instance, Tas (2016, p. 557) argued that the learning environment and learner motivation toward learning are significant predictive variables of their engagement in learning geometry in high school. Whereas, (Lee et al., 2016, p. 192) argued that learner motivation and engagement in learning geometry play an important role in their geometry achievement performance at school.

According to Mutodi and Ngirande (2014, p.282), many learners fear geometry and feel powerless in the understanding of geometry ideas and regarded geometry as difficult, cold, abstract and in most cultures, it is a largely male-dominant subject. Further studies pointed out different facets of learner motivation which resulted in their engagement in the geometry classroom. Learner interest and enjoyment when learning geometry can significantly increase their engagement in geometry related activities (Lin et al. 2013, p. 941). Learners' mathematics preference is also a good predictor of their engagement in geometry learning in junior high schools (Hsieh et al., 2016, p. 249).

Cordes (2014, p. 247) stated that educators should be able to influence learner performance in geometry by demonstrating care for their learners, patience in their interactions, and an ability to provide learners with a comfortable atmosphere. Similarly, Paul (2014, p. 201) emphasised that educators should strive to work on building positive academic relationships with learners, as well as a positive pedagogical relationship which included a strong knowledge of how learners learn and a strong content knowledge of geometry. When educators provide learners with encouragement, they help offset learner anxiety and boost learner self-esteem (Canfield, 2013, p. 359; Novac, 2016, p. 240). Furthermore, Cordes (p. 248) supported that cultivating a positive environment allows learners comfort in asking questions in geometry classes, and in turn, promotes positive changes in geometry confidence.

Learners who are unsuccessful often surround themselves with other learners who are also struggling or have the same geometrical skill level (Mathai, 2014, p. 348). Although few learners relate their inability to perform to laziness and lack of effort, they still believe that it is their responsibility to change their attitude and succeed (p. 350). When learners can perform at an appropriate academic level in geometry, they feel motivated and are filled with increased academic confidence (Cordes, 2014, p. 249).

2.6.3 Learners misconceptions in geometry

Yang (2017, p. 255) observed that conceptions are positively associated with the academic achievements of learners. This is aligned with the notion that educators need to know the possible reasons that lie behind these misconceptions and take precautions to provide more efficient learning environments (Ojose, 2015, p. 30). According to Makhubele (2014, p. 104), misconceptions and errors result in the emotional disposition of a set of emotions like fear, anxiety, frustration and rage which often threatens both performance and participation in geometry. Gardee and Brodie (2015, p. 36) indicated that educators must avoid re-teaching of a geometry section by simply addressing the errors and misconceptions by utilising the class time more efficiently while teaching which would save time.

Fyfe et al. (2015, p. 52) suggested that geometric concepts are the main problems behind the most important troubles when teaching mathematics. In South Africa, the DBE (2011a; 2012a; 2013; 2014) also concedes that many candidates struggled with certain concepts in the geometry curriculum that required deeper conceptual understanding. In both the 2014 and 2015 NSC diagnostic reports it was reported that many geometry errors were due to incorrect use of terminology and poor knowledge of the basic concepts taught in the junior secondary curriculum (Department of Basic Education, 2014a, p. 21; 2015, p. 23). Learners fail to understand the basic geometry concepts and fail to develop adequate problem-solving skills as cited in Siyepu (2013, p. 577).

Notation and symbols are important aspects of geometry. It is therefore true that understanding the concept requires an understanding of other aspects like notation. However, studies have shown that in many cases, learners use notation incorrectly (Jojo, 2014, p. 172 & Siyepu, 2013, p. 578). In fact, geometry learning requires not only the construction of concepts, but also learning the standard names and notations for those concepts, and the appropriate verbal and geometrical syntax for referring to those concepts in geometrical discourse (Jojo, 2014, p. 171).

There are several misconceptions and difficulties that learners experience when learning about geometry across all stages of schooling (Browning, Edson, Kimani & Aslan-Tutak, 2014, p. 334). Furthermore, (Herholdt & Sapire, 2014, p. 43; Luneta, 2015, p. 1) indicated that errors or misconceptions of learners were other factors that had been extensively researched. Luneta, (p. 5) found that many of the misconceptions by the learners happened because educators and learners operated on different geometric levels (here the author refers to Van Hiele's (1986, p. 211) levels. However, Machaba and Lenyai (2014, p. 535) argued that if challenges related to geometry were not attended to early, learners might have a problem with geometry for the rest of their lives. It is also worth noting that, international and local researchers (Graven & Venkat, 2017, p. 122) pointed out that early intervention is vital in addressing poor learner performance in geometry as it can lead to more complicated and multiple problems if it is not rectified early.

2.6.4 Second language complexity

One of the challenges with many geometry learners is their weakness in the language of geometry. According to (Schulte & Stevens, 2015, p. 370) geometry is often described as a language with its own rules, convention, symbols and syntax seen by many learners to be arbitrary. In fact, the language is not merely a means of communication, but it is also a vehicle of understanding (Planas et al., 2018, p. 196). The vocabulary in geometry is specific and carries meaning, descriptions and even properties. Müller (2014, p. 245) argued that learners must make sense of or create meaning in their language.

Most learners in South Africa who are viewed as non- English language speaking learners underachieve and fail to demonstrate geometry competency (Nero, 2014, p. 221). There was evidence to suggest that the performance of learners in geometry is influenced by language complexity to second language speaking learners (Planas et al., 2018, p. 197). The evidence showed that there is a link between language background and a language of geometry learning owing to the poor performance of learners in geometry (Vukovic & Lesaux, 2013, p. 227).

Language is one of the major causes of marginalization because our educators support some learners while it may disadvantage other learners through the choice of language used in the classroom. Some learners might feel excluded from the classroom practice due to language as a barrier resulting in a social class of learners that has poor participation and less engagement in the classroom due to the difference of school language which is different from home language (Nero, 2014, p. 222). This is strongly supported by Essien et al. (2016, p. 203) who argue that most learners entering secondary schools have very low competency in English. According to Essien et al. (2016, p. 203), very low competency in English influences learner performance in geometry in secondary schools.

Contrarily, Prediger et al. (2015, p. 77) argued that if the learners are forced to learn in the language in which they are not fluent the system will not function at its best and if the children are made to learn in the poorly developed language, the quality and quantity of what is learned from the curriculum will obviously be indigent. Poor cognitive functioning and performance may be a result of improper functioning of the language. In general, communication using the language of geometry requires a strong background in geometrical content and pedagogy, a good command of the English language, well-developed number sense, and the ability to think critically (Riccomini, Smith, Hughes, & Fries, 2015, p. 325).

2.6.5 Transition of learners from primary to secondary school

Research conducted by (Moss, Hawes, Naqvi, & Caswell, 2015, p. 377) in Japan, showed that a learner's level of geometrical understanding in kindergarten is strongly predictive of future academic achievement. The studies discussed the acquisition of foundational geometrical competencies during the early learning years. For instance, the format of a Japanese Lesson Study had been used for nearly a century in Japan and is now globally recognized as a successful method for professional development in mathematics (Groves, Doig, Widjaja, Garner & Palmer, 2013, p. 10). This method enabled educators to continually collaborate with colleagues to restructure their ways of geometrical knowing, develop deep understandings of the concepts, understand underlying goals, and connect the learners' understandings to those goals. Learners' foundational geometry skills play a predictive role in their achievement in mathematics and other disciplines from kindergarten through eleventh grade.

According to Bruce, Flynn and Bennet (2016, p. 331), spatial reasoning abilities are a strong predictor of future geometrical success as higher levels of geometry are spatial in nature. Throughout the review of the literature, it became apparent that educators needed to collaborate with others to help make shifts in their geometrical teaching. The educators involved in the studies by Bruce, Flynn and Bennet (2016, p. 332) and Moss et al. (2015, p. 378), actively participated in geometrical tasks and discussed the tasks with others which enabled them to develop their personal relationships with the geometrical concepts before attempting to share the tasks with their learners. That appeared to be the starting point for creating the kind of learning environment that enables endless geometrical possibilities.

The UK Government also increased the number of specialist educators at the primary level to ensure that all learners have the best start in geometry at primary schools (Spaull and Kotze 2015, p. 14). Fadzil and Saat (2014, p. 213) argue that there is a significant shortage of geometry specialists in primary schools and there is an urgent need to find an effective way to train and employ primary educators with specialist knowledge in geometry, as well as the confidence to teach.

Ali et al. (2014, p. 311) indicated that in South Africa, the poor performance of learners in geometry could be attributed to a number of factors such as the poor foundation of basic knowledge of geometry from their primary stage, lack of willingness and readiness to learn geometry with learning being mostly instrumental. Similarly, Fadzil and Saat (2014, p. 211) indicated that learners' academic performance in geometry declines after the transition from primary school into secondary school and upon this transition, learners receive less social support. Paul (2014, p. 213) also concurred that learners experience major challenges during the transition from primary to secondary school with special regard to geometry learning as it takes time to adapt to the secondary school geometry curriculum. For example, Fadzil and Saat (2014, p. 215) revealed that during a transition from primary school to secondary school, learners develop a gap in relating to the level of the curriculum in geometry they had learned previously in the lower grades. Interest and liking for geometry decrease during this transition.

2.5 Conclusion

The literature review in this chapter provided the researcher with the means of getting to the frontier in this particular field of knowledge. This review of the literature indicated various factors that influence learner performance in geometry. Firstly, the review of the literature revealed that the family educational background, socio-economic status, parental involvement, parental anxiety and beliefs are home base factors that affect learner performance.

Secondly, this section reviewed literature pertinent to school environmental factors. These include teaching and learning of geometry, instructional methods, the quality of educators, educators' knowledge of geometry, anxiety, attitudes and beliefs of educators and the relationship between learners and educators. The size and condition of the classroom also contribute to the academic performance of the learner.

Thirdly, this section reviewed literature pertaining to the Department of Education related to environmental factors. The review covered the effect of curriculum change, provision of ICT to schools and professional development of educators.

Finally, it concluded with a section on the literature review that addresses the variables that are related to learners and geometry achievement. The literature mentioned learner attitude to geometry, learner motivation and engagement, learner misconceptions in geometry, second language complexity and transition of learners from junior to senior classes.

The next chapter will outline the theoretical framework underpinning the study.

CHAPTER 3
THEORETICAL FRAMEWORK

3.1 Introduction

The literature indicating factors that influence learner performance in geometry was reviewed in the previous chapter. This chapter is going to outline the theoretical framework underpinning the study and will also look at educators' pedagogical content knowledge according to the views of Shulman (1986) and (Ball et al., 2008).

3.2 Theoretical framework of the study

The study was guided by a social or realist constructivist tradition that was derived from the work of Vygotsky. This theory describes learning and knowing as a social process where individuals negotiate understanding through experience and discourse with people who share common goals (Vygotsky, 1978, p. 34; Bruner, 1996; von Glasersfeld, 1996; Brophy, 2002). Social constructivism is a sociological theory of knowledge according to which human development is socially situated and knowledge is constructed through interaction with others (Stroet, Opdenakker, Minnaert, (2016, p. 1).

3.2.1 Social constructivist view of learning

Social constructivism assumes that cognitive growth first occurs at a social level and later at the individual level (Vygotsky, 1978, p. 35). This is the reason why Vygotsky proposed the idea of Zone of Proximal Development (ZPD), which stated that a child can work with more capable peers or adults to achieve something that they could not achieve on their own. In contrast to Piaget's understanding of child development, Vygotsky (p. 35) believes that learners can learn from those who are not necessarily of the same age. Within a social constructivist instructional framework, learners are provided opportunities to interact with their peers for the purpose of discussing, generating, and sharing knowledge from other learners who are at different development levels (Amineh & Asl, 2015, 9). Learners, after conceptual understanding, can work independently (p. 45).

3.2.2 Social constructivist view of teaching

According to Christmas, Kudzai and Josiah (2013, p. 371), in geometry teaching the educator should avoid leading learners to a mental cul-de-sac. For example, the tasks given should be challenging to such an extent that mediation by the knowledgeable educator, or peer, is needed. Social constructivist teaching approaches emphasize reciprocal teaching, peer collaboration, cognitive apprenticeships, anchored instruction, and other methods that involve learning with others. Social influences like educators, parents, and peers have a strong impact especially in the adolescent years (Hsiao & Nova, 2016, p. 393). After the learner has attained mastery of the concept with the assistance from others, he/she should be able to do the task independently. This is the point where the learner can start to consolidate what he understands of the concept or topic, and then do practicing or drilling. Christmas et al. (2013, p. 372) also contended that if the ZPD theory is well applied, it can incrementally lead to higher geometry achievement.

Aspects of participation involved teaching in contexts that could be meaningful to learners based on their personal and social history, negotiating, class discussions and small group collaborative learning. Social constructivism emphasizes that learning takes place through interactions with other learners, educators, and the world-at-large (Vygotsky, 1978, p. 36). Learners are believed to be enculturated into their learning community and appropriate knowledge, based on their existing understanding, through their interaction with the immediate learning environment (Ertmer & Newby, 2013, p. 50). This means that learners are encouraged to construct their own understandings and then to validate it, through social negotiation (p. 51).

3.2.3 Social constructivist view of a learner

The learners learn geometry through the active construction of the meaning of geometric concepts. They learn through individual re-organization, representation, and re-construction with peers, elders, and educators (Belbase, 2016, p. 145). Learning takes place when the learners construct and transform external, social activities into internal activities. Instead of learners being receivers of ready-made geometry, they are treated as active participants in the educational process, in which they develop all types of geometrical tools and insights by themselves (Van den Heuvel-Panhuizen & Drijvers, 2014, p. 521). The social environment is the source of knowledge where people construct knowledge when they interact with each other or with their experiences.

Discussion can be promoted by the presentation of specific concepts, problems or scenarios, and is guided by means of effectively directed questions, the introduction and clarification of concepts and information, and references to previously learned material (Fujii, 2016, p. 411).

Some years ago, knowledge was generated through learners applying their minds, whereas nowadays learners must discuss ideas among themselves. The social constructivist theory is based on the idea that the learner builds new knowledge upon the foundation of previously acquired knowledge.

According to Vygotsky (1978, p. 36), learning is a social interaction that plays an elementary role in the process of cognitive development. Learners need to be given the chance to reflect on their correct and incorrect solutions. It is thus very significant that educators do not dismiss wrong or incorrect solutions, but should rather allow the learners to explain and reflect on how they arrived at their solutions. Effective learning of geometry requires that learners understand what they know and need to learn, and this motivation will help them learn more (Bhowmik, 2015, p. 8; Jazim, Anwar & Rahmawati, 2017, p. 579). Social knowledge is known as conventional knowledge because it is created by people over a period of time (Kamii, 2014, p. 72).

Kim (2012:1) pointed out 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. This can happen if learners are part of the process of developing knowledge.

3.2.4 Social constructivist view of an educator

The educator is no longer the central figure in the learning process as learners are supposed to take an active role. According to Amineh & Asl (2015, p. 13) educators who are facilitators in social constructivism first provide support and help for learners, and this support is gradually decreased as learners begin to learn independently. In addition to that, the educator’s role as a facilitator of group work and a manager of the shared learning space that enables argumentative talk is to ensure that ground rules encourage learners to *interact* and *inter-think* (Rahmi, Nadia, Hasibah, & Hidayat, 2017, p. 177). This means that the educator will give the main idea then the learners will get the details. In this thinking, the educator does not teach the detail so that learners will find it difficult to find an understanding of the details (Aljohani, 2017, p. 98). According to Boaler (2015, p. 14), the educator should promote helping learners create a "geometrical mindset" that celebrates mistakes as steps toward improved solutions. Similarly, Meyer (2014, p. 109) suggested that learners choose not only to know how to arrive at answers but what initial questions they have regarding given situations.

The researcher believes that interaction between the learners and the educator, as well as amongst learners, is important. The intensity of communication increased during the completion of group tasks, which confirms that learning flourishes in a social environment where a conversation between learners takes place. The researcher is also of the view that learners cannot be left alone to learn and that an expert, or more capable person, must be available to help with misconceptions or stumbling blocks that may surface during learners' interaction.

3.3 Educators' knowledge models

Governments have turned to regulatory approaches to enhance educators' quality that has led to increased accountability requirements for educators, schools, and initial educator education programs (Australian Institute for Teaching and School Leadership 2015, p. 13). There is evidence from the work of school educators that beliefs about the nature of geometry, geometry teaching and learning, the capacity of learners to learn geometry, and how learners can be engaged in geometry are particularly important to their practice (Beswick 2018, p. 7).

Shulman (1986, 1987) developed a model of educators' knowledge and educational researchers refined and expanded the model to investigate geometry educators' knowledge (GEK). To understand the model chosen and the components of educators' knowledge used in this research, the following sections will depict Shulman's model and a few other influential models that have been developed in recent decades.

3.3.1 Shulman's View of Educators' Knowledge

Shulman (1986) suggested that educator knowledge consists of content knowledge, pedagogical content knowledge, and curricular knowledge. He defined content knowledge as the account and organization of knowledge per se in the mind of the educators. To think properly about content knowledge requires going beyond the knowledge of the facts or concepts of a domain. It requires understanding the structures of the subject matter (p. 9).

In Shulman's view, pedagogical content knowledge goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching that embodies the aspects of content most germane to its reachability (p. 10). It also includes the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations and ways of representing and formulating the subject that make it comprehensible to others (p. 11).

In addition, pedagogical content knowledge includes an understanding of what makes the learning of specific topics easy or difficult, and the knowledge that learners of particular ages and backgrounds bring to learning the most frequently taught topics and lessons. Shulman stated that if learners' preconceptions are misconceptions, as they often are, educators should have strategies to address these misconceptions. Shulman's pedagogical content knowledge is synthesized as the content knowledge of a subject, knowledge of learners' cognition and knowing, and strategies for teaching specific topics and addressing learners' misconceptions.

Finally, Shulman's model of educators' curriculum knowledge encompasses understanding the scope of programs designed for the teaching of particular subjects and topics at a certain level, the variety of available instructional materials in the programs, and "a set of characteristics that serve as both indications and contraindications for the use of particular curricula and materials in particular circumstances" (1986, p. 12). Curriculum knowledge also includes knowledge of alternative curriculum materials for a given subject or topic in a grade. In addition, it includes lateral and vertical curriculum knowledge. Lateral curriculum knowledge "underlies the educator's ability to relate the content of a given course or lesson to topics or issues being discussed simultaneously in other classes" (p. 10). Vertical curriculum knowledge "is familiarity with the topics and issues that have been and will be taught in the same subject area during the preceding and later years in school" (p. 12).

The components in Shulman's model are not dynamic, they are static. However, with the growth of teaching experience and new educational resources such as educational computer software, the components of educators' knowledge will need to be re-conceptualized.

3.3.2 Ball's View of Educators' Knowledge

Ball and her colleagues refined Shulman's (1986, 1987) model and conducted a series of studies on elementary and lower secondary geometry educators' knowledge for teaching. I believe that the third research question of this study would be addressed by Ball's model. She defined subject matter knowledge as “knowledge about mathematics as a discipline, substantive knowledge of geometry concepts, and procedures appreciation of and propensity toward geometry” (p. 390). She believes that educators help learners actively learn geometry. Educators should have a solid understanding of the geometry they teach. Hence, educators should “understand about geometry—where the knowledge comes from and how it is justified, what it means to do geometry, what the connections are between geometry and other domains” (p. 392).

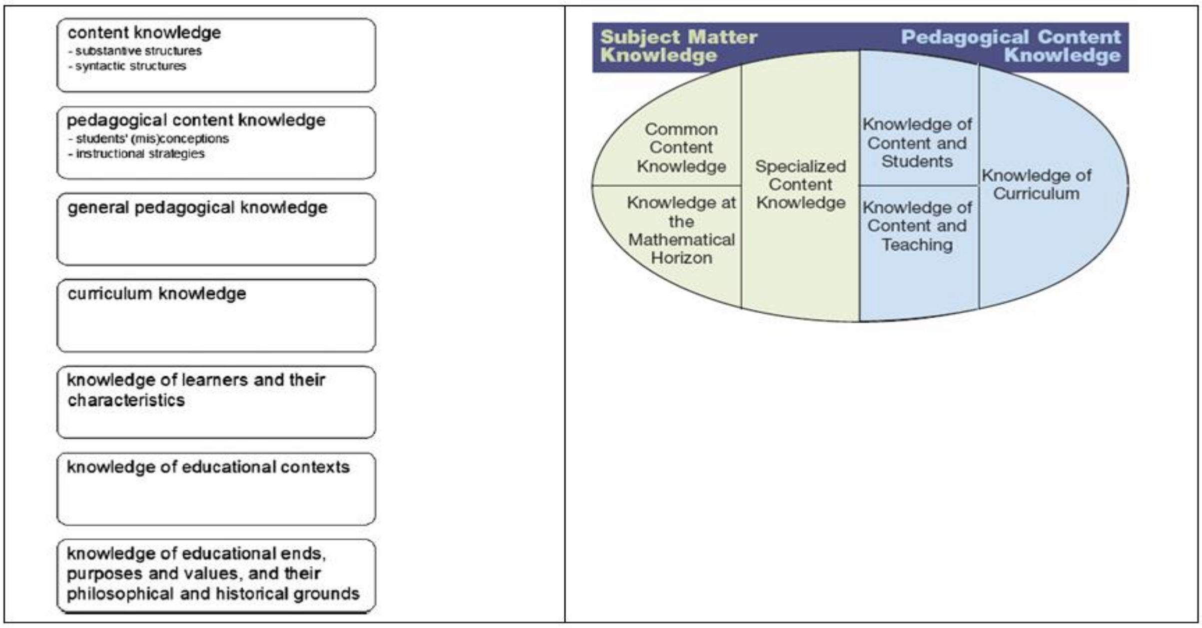

Figure 3.1 Mathematical knowledge for teaching (Ball et al., 2008)

Researchers have supported the notion that strong mathematical content knowledge in geometry is essential for quality teaching in geometry (Ball et al., 2008: 404). Building on the 2008 work of Ball and colleagues, Herbst and Kosko (2014) focused on identifying aspects of Mathematical Knowledge for Teaching high school Geometry (MKT-G). Educators need to apply appropriate instructional strategies to provide learners with opportunities to develop their critical thinking and problem-solving skills. Educators must be able to present subject matter in multiple ways like using story problems, pictures, situations and concrete materials. This knowledge is required to choose the appropriate pedagogical strategy and instructional material for a lesson, to consider which tasks to set and which assessment techniques to use.

The categorization of these types of knowledge and the quantitative measure of their influence on learner learning of geometry have been widely studied internationally (Speer et al., 2015, p. 108) and, in their review of the conceptualizing and evidencing of PCK in geometry education research, Depaepe et al. (2013, p. 12) noted this model as "probably the most influential re-conceptualizations of educator PCK within geometry education" (p. 13). However, Ball and her collaborators acknowledge that these categorizations of educator knowledge can be interpreted as static and distinct (Ball et al., 2008: 389).

Domains of MKT (Ball et al., 2008, p. 390) have been shown to be incorporated and developed through both pre-service and in-service educators' participation in lesson study (Leavy & Hourigan, 2016, p. 161; Ni Shuilleabhain, 2016, p. 212). The MCK category comprises three strands, namely common content knowledge, specialized content knowledge, and knowledge at the horizon (Ball et al., 2008: 403).

3.3.2.1 Common content knowledge (CCK)

Common content knowledge involves knowing central facts, concepts and principles within a relationship. Learners' acquisition of geometric thought depends greatly upon the educator's mathematical content knowledge (Couto & Vale, 2014, p. 58). Content knowledge goes beyond knowledge of the facts or concepts of a domain to understand the structures of the subject matter. In agreement, Nolan, Dempsey, Lovatta and Castel (2015, p. 35) propose that educators must know the content of the subject they teach (e.g. place value, addition and subtraction) thoroughly to be able to present it efficiently, to make the concepts accessible to a wide variety of learners and to engage learners in challenging work.

3.3.2.2 Knowledge at the geometrical horizon (HCK)

Knowledge at the geometrical horizon refers to having knowledge of the subject beyond the years for which an educator is responsible. The value of educators having a deep knowledge base is still recognized as part of their complete knowledge base. This knowledge includes the most useful forms of representation of ideas and interconnectedness of different topics, the most powerful analogies, illustrations, examples, explanations, and demonstrations of the ways of representing and formulating the subject that makes it comprehensible to others (Mosvold & Fauskenger, 2014, p. 311). It informs the educator of the topics covered that lay foundation to what is currently being taught and how the current topic lays foundations for other topics that are still to come.

3.3.2.3 Specialized content knowledge (SCK)

Specialized content knowledge goes beyond common content knowledge. Educators need to have specialized knowledge to know more than just explaining the content but must be able to explain why it is so, why it is worth knowing and how to relate it to other learning outcomes and other disciplines, both in theory and practice. This suggests that the work of teaching requires unique geometrical understanding, reasoning and skill, such as looking for patterns in the errors made by the learner or sizing up whether non-standard procedures are valid and generalizable (Nolan, Dempsey, Lovatta & O'Shea, 2015, p. 35).

Research acknowledges that SCK is an area of interest in the work of teaching (Hill et al., 2005, p. 371; Ball et al., 2008, p. 400; Wilkie, 2015, p. 245) and it makes an educator an effective professional, different from other individuals who have a good understanding of CCK. Some studies have demonstrated the potential of lesson study to develop educator knowledge, for example (Lewis & Perry, 2017, p. 261; Ni Shuilleabhain, 2016, p. 213), impact classroom practices (e.g. Takahashi, 2014, p. 417) and build an educator community (Baricaua Gutierez, 2016, p. 801; Cajkler, Wood, Norton, Peddar, & Xu, 2015, p. 192).

3.4 Pedagogical content knowledge (PCK)

PCK is about effectively communicating a subject to people for whom the content may be new (Loughran et al., 2012, p. 16). While it requires knowledge of what is taught and how it is taught, it also requires knowledge of how learners think and what they understand before they learn the subject matter, as well as how they think while they are learning. There is a foundation of pedagogy within PCK which is general across curriculum areas and should be developed by all educators (Loughran et al., 2012, p. 19; Shulman, 2015, p. 9). These include planning, teaching methods, group work, individual work, questioning, wait time, feedback, modeling, and evaluations. In this model, Ball and her colleagues highlighted particular categories of knowledge within the PCK and subject matter delineations (see Figure 3.1 above). PCK is divided into: Knowledge of Content and students (KCS); Knowledge of Content and teaching (KCT) and Knowledge of the Curriculum (KCC).

3.4.1 Knowledge of content and students (KCS)

Knowledge of content and students (KCS) can be described as the knowledge that integrates knowing about learners and knowing about geometry in a way that enables educators to relate to learners in such a manner that enhances their learning (Nolan et al., 2015, p. 36; Ball et al., 2008, p. 389). Wilkie (2015, p. 246) argued that with this knowledge educators can "attend to how learners typically learn a concept, and to common mistakes and misconceptions" (p. 250). Putnam (2015, p. 24) pointed out that a lack of geometrical context knowledge can impede educators' abilities to notice and analyze learners' geometrical thinking. He said that improved geometrical knowledge can also help educators connect geometry to classroom practice as educators analyze and use new curriculum materials.

According to Ball et al. (2008), educators must also be able to hear and interpret learners' emerging and incomplete thinking as expressed in the ways that pupils use learning (p. 401). The educator should be able to interpret what learners are trying to communicate. South African learners do not only struggle with geometry but also have challenges with literacy (Spaull, 2013, p. 12; Reddy et al., 2015, p. 16). These learners may not be able to explicitly express themselves and the educator should be able to understand and interpret the meaning of their poor expressions through KCS. KCS also includes knowing the misconceptions learners have about geometry and other topics one teaches.

3.4.2 Knowledge of content and teaching (KCT)

According to Ball et al. (2008), knowledge of content and teaching (KCT) is the knowledge that combines knowing about teaching and about geometry. Correspondingly, Wilkie (2015, p. 247) stated that KCT includes knowledge about how to choose appropriate representations and examples, how to build on learners' thinking, and how to address learner errors effectively (p. 249). Schmidt as cited in Glover (2014, p. 18) proposes that geometrical tasks require a piece of sound geometrical knowledge in order to design instruction. For instance, the educator needs to know what teaching strategies to employ where and when, what resources to use and what representations and examples to employ so that learners can learn with understanding (Shulman, 1987, p. 7). Bansilal et al. (2015, p. 34) stated that educators of geometry need to know how to teach geometry that is prescribed in the "basic skills topics" (DBE, 2011, p.13). Learners' acquisition of geometric thought depends greatly upon the educator's geometrical content knowledge (Couto & Vale, 2014, p. 67).

3.4.3 Knowledge of content and curriculum (KCC)

The curriculum can be defined as the full range of programs that are designed for the teaching of a particular subject and its different topics at a given grade (Petrou & Goulding, 2011). The curriculum includes the variety of instructional materials available in relation to these programs (e.g. the national workbooks). An educator needs proper knowledge of the curriculum and a high level of PCK to assure effective teaching (Shulman, 1986, p. 5). KCC is, therefore, the knowledge that pertains to the knowledge, evaluation, adaptation and use of these materials in the teaching and learning of different geometrical concepts (Ball et al., 2008, p. 31).

3.5 Conclusion

The social constructivist theoretical framework underpinning this study was discussed. The researcher believes that interaction between the learners and the educator and amongst learners is important. The researcher is also of the view that learners cannot be left alone to learn and that an expert, or more capable person, must be available to help with misconceptions or stumbling blocks that may surface during learners' interaction. Learners, after conceptual understanding, can work independently. Group work is seen as a necessary component of modern classroom practice.

Pedagogical issues also include consideration of task choices and teaching approaches that foster a climate of support and challenge. Domains of MKT (Ball et al., 2008) have been shown to be incorporated and developed through educators' participation in lesson study.

The next chapter explores the methodology associated with this research and includes a section that outlines the learners and educators who participated in the study, along with ethical considerations, including the role of the researcher. Data-gathering methods discussed include questionnaires, individual and focus group interviews. Finally, the methods and theoretical framework for data analysis are outlined.

CHAPTER 4
RESEARCH METHODOLOGY AND DESIGN

4.1 Introduction

The previous chapter focused on the theoretical framework about the issues related to the factors influencing grade 11 learner performance in geometry. This chapter described, discussed and justified the research design and methodology used in the study, focusing on the description of the research paradigm, the approach, design and data collection techniques used to build an in-depth understanding of the factors that influence learner performance in geometry in the Umlazi District.

The issues of credibility and trustworthiness as well as ethical considerations are also taken into consideration so that the results can be accepted as meaningful contributions for resolving the research issue and for use by other researchers.

4.2. Research Paradigm

The study followed an interpretivist paradigm. Goodwin, and Webb (2014, p. 1) argued that the interpretivist paradigm's emphasis is placed on understanding the individual and his/her interpretation of the world around him/her. The use of an interpretivist paradigm in this research was based on the belief that the participants become actively involved in all the phases of the processes. According to Creswell (2013:20), participants seek understanding of the world in which they live. The interpretivist paradigm allowed me to view the world through the perceptions and experiences of the participants. The researcher used these experiences to construct and interpret his understanding from the gathered data. This was based on the belief that reality is socially constructed. This paradigm tells us that people make their reality by the meanings and interpretations they give to their experiences and that there are multiple truths.

Interpretivist paradigms also influenced the research design of the study. For instance, it was the research methodology underpinning the paradigm that directed me to knowing the kind of questions to ask, what was to be observed and explored, how to gather data and interpret the research findings (Bertram & Christiansen, 2014: 22). In my view, it was the choice of paradigm that laid down the intent, motivation and expectations of the research study. The author used qualitative research methods to gather in depth and first-hand information directly from the participants. Making explicit the ontological, epistemological and axiological positions of the researcher, could allow for a better understanding of the views and actions of others and could also facilitate new ways of seeing and explaining a phenomenon. I then looked at the concepts of ontology, epistemology and axiology.

Ontology is the study of truth and it states that there is no single truth or reality. Reality is created by individuals in groups. Ontology shapes beliefs and values, which are socially constructed. Epistemology is how we come to learn of these multiple beliefs. In this case, an interpretivist epistemology was ideal because it undergirded the fact that meaning, or knowledge is not there to be discovered but is socially constructed. The summary emerges from Ngulube’s (2015) work relative to constructivism that the interpretivist epistemology outlines that knowledge exists, can be found, can be constructed and it can be used. Axiology is a set of principles that guides conduct in each situation and is usually informed by codes of practice (Mertens; Robson; Thomas, as cited in Hearne, 2013, p. 2). Axiology is about a theory of values, such as social justice, efficiency and profit that crucially informs what is researched, and why and how it is researched.

4.3 Research Approach

In this study a qualitative approach was used as it was interpretive, rigorous, reflexive and deep. In the qualitative approach, the researcher could gain an in-depth understanding of participants’ experiences and perspectives on their social reality on the factors influencing learner performance in geometry. Yin (2014, p. 4) argued that the qualitative approach allows the researcher to focus on the case in depth from a real case perspective by keeping the whole. For example, qualitative research supports the interpretivist orientation as it enables the researcher to understand and explore the richness, depth, context and complexity within which participants in the research site operate (Gray, 2014, p. 9).

Similarly, Creswell (2014, p. 25*)* defined qualitative research as an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. As the task of the qualitative researcher was to capture what people say and do due to how they view their world, the information was largely verbal and collated through interviewing, observation, and recording (Gray, 2014, p. 10; Mason, 2009, p. 9). Qualitative research is concerned with mutual meaning-making and understanding how others experience the world (Finlay, 2015, p. 164).

Qualitative research is not a linear process but instead is seen as a dynamic and interactive process (Ravitch & Carl, 2016). Qualitative research has a relational component (Finlay, 2015, p. 165; Ravitch & Carl, 2016, p. 225) where the researcher and participant interact for the researcher to understand the participant's experiences. Qualitative research acknowledges the influence that the research process itself and the resulting role of the researcher may have on the meaning-making process (Ravitch & Carl, 2016, p. 225). As such, data generation in qualitative research generally occurs through direct contact with participants and often involves face-to-face interaction (Creswell, 2014, p. 117). Therefore, I contended that this direct communication and interaction allowed me to gain more insight into the participants' experiences.

The main goal of qualitative methods in this study was to relate or describe incidents or events of individuals in their natural setting such as an organisation, a school, workplace or home. The use of qualitative methods was appropriate because it enabled a rich collection of data from different perspectives (learners, educators and principals) within the school setting. It attempted to make sense of the phenomena in terms of the meanings people bring to them. Furthermore, a qualitative approach was deemed appropriate due to the assertion that qualitative research is often used where the intention is to change the issue being studied or promote solutions to problems.

4.4 Research Instruments

For this study, the interviews were used as the data collection instrument. There were structured interviews, semi-structured interviews and unstructured or in-depth interviews. A set of predetermined questions (Appendix A) were used which were followed up with other questions emerging from the interviews. A mixture of semi-standardized and unstandardized interviews was conducted to collect data from the participants.

4.5 Population of the study

The population comprised of grade 11 learners, mathematics educators, Heads of Department and the Principals of the two secondary schools in the Umlazi District.

4.6 Sampling Procedures

Sampling can be defined as a subdivision of a population that represents the main interest of the study; therefore, it involves the process of selecting who will participate in the study (Koma, 2016). Similarly, Etikan, Musa and Alkassim (2016, p. 1) defined sampling as the process of selecting a representative group from the population under study.

For an individual to be selected in this study, the following criteria had to be met after which the sample population was established:

- Participant must be doing geometry in grade 11 and from one class.
- Participant (educator) must be teaching the geometry class in grade11.
- Participant (HOD) must be supervising mathematics department.
- Participant must be a Principal.

4.7 Sample

A total of 16 participants from the two secondary schools were selected purposively to participate in the interviews where 10 learner were selected from a sample of 50 who completed the questionnaires. Of the selected participants, 10 were learners (five learners from each school); 40% were girls and 60% were boys, 2 were educators, 2 were mathematics Heads of Department and Principals (one participant from each school) as reflected in Table 4.1.

A sample is a subset of elements drawn from a population that will be considered for actual inclusion in the study. According to Bambale (2014, p. 872) a sample is a set of individuals or participants drawn from a larger population to participate in the study based on the qualities the participant possesses.

Table 4.1: The sample size

	Number of respondents
Learners	10
Educators	2
Heads of Department	2
Principals	2
Total respondents	**16**

4.8 Data Collection

4.8.1 Quantitative data collection

The researcher administered the questionnaires to 50 grade 11 geometry learners (25 from each school) who were selected to complete them. The questionnaire is an instrument consisting of a list of questions to which participants need to respond. A simple random sampling technique was used to select the respondents who participated in questionnaires since every grade 11 learner had equal opportunity to participate in the questionnaires. Prior to that, the researcher informed learners to return their completed consent forms into the office of Mathematics Head of Department in their respective schools.

The questionnaire consisted of two sections. Section A required general information of each respondent while section B (see Appendix A) included both closed-ended and open-ended questions that encompassed questions of different variables that were used as the main data gathering tool (Betram & Christiansen, 2014, p. 36).

Closed-ended questions were those questions where respondents were given a choice of responses. According to Singer & Couper (2017, p. 1), closed-ended questions require specific answers and do not easily lead to dialogue or discussion. Whereas, open-ended questions provided learners with an opportunity to reflect on their thoughts. The closed-ended questions were based on a 5- point Likert scale questions and multiple-choice questions whereas open-ended questions requested leaners to give their responses based on their opinions on the questions that seek to identify factors influencing learner performance in geometry in secondary schools.

4.8.2 Qualitative data collection

Data was gathered more in verbal form rather than in the numerical form in this study. The inductive nature of qualitative research allowed me to develop concepts, insights, and understandings from the data collected (Taylor, Bogdan, & DeVault, 2016, p. 231

4.8.2.1 Focus Group Interviews

Two groups of five participants (learners) were selected based on the results of the questionnaires to participate in the focus group interviews. Three top learners and two bottom learners from each school were selected. According to (Naukusha, 2015, p. 156), group interviews are often utilized as a convenient approach to gathering data from several participants at the same time. The focus group interviews allowed the researchers to elicit information from the participants as they were all sharing similar experiences under the same intervention treatment. The data from the interview revealed deeper insights into learners' views of teaching and learning of geometry. For example, Creswell (2012: 43) stated that the qualitative approach in the form of a focus group interview provides rich detailed data from learners' and individual educators' personal experiences.

Focus group interviews took place at the research sites after completed questionnaires were collected. The group setting created dynamic interaction which means more varied responses and opinions could be obtained, and to gain insights on why participants held such views. The interviews were in a semi-structured format and were carried out by asking verbally a series of open-ended questions with guided prompts and follow-up questions.

The main purpose of focus group research was to draw upon learners' attitudes, feelings, beliefs, experiences and reactions in a way that would not be feasible using other methods: for example, one-to-one interviewing, or questionnaire surveys. These attitudes, feelings and beliefs might be partially independent of a group or its social setting but were more likely to be revealed via the social gathering and the interaction within the focus group. For instance, Kreuger and Casey (2015, p. 34) stated that it is from the interaction of the group that the data will emerge because the participants interact with each other rather than the interviewer, such that the views of the participants emerge.

During the focus group interview, the researcher needed to promote debate by asking open-ended questions. Focus groups are particularly useful when there are power differences between the participants and decision-makers and to expose a diverse range of meanings on their experiences in geometry (Kreuger and Casey, 2015, p. 35). Sometimes the researcher needed to probe for details or moved the discussion forward when the conversation was drifting or reached a minor conclusion. The researcher had to keep the session focused and sometimes had deliberately steered the conversation back on course.

The focus group interview allows participants to take the initiative and it afforded the researcher an opportunity to gain a larger amount of information in a shorter period. The researcher had to ensure that everyone was participating and also had a chance to speak. The interaction also enabled participants to ask questions to each other, as well as to re-evaluate and reconsider their own understandings of their specific experiences in geometry. All participants developed trust and the group managed to explore solutions to a particular problem as a unit rather than as individuals. Learners were asked to avoid giving personal opinions in order not to influence participants towards any particular position or opinion.

4.8.2.2 Individual Interviews

After completing focus group interviews, individual, semi-structured, face-to-face and open-ended interviews were conducted with each educator. The one-to-one interview with the educator was described as 'a powerful method of data collection' because it provided a one-to-one interaction between the interviewer and the interviewee. Punch and Oancea (2014, p. 32) point out that the interview is the most prominent data collection tool in qualitative research because it helps in exploring peoples' perceptions, definitions of situations and construction of reality.

The individual interviews with the geometry educators revealed the main interest that were not only on what educators were teaching but on how they were doing it and why? According to Bertram & Christiansen (2014, p. 59) it is possible to get in-depth or more detailed information from an interview as the researcher can ask to follow up questions. The researcher posed questions that were interested in establishing factors that influence learner performance in geometry, rather than their own performance. All interviews were video-recorded, audio-recorded and transcribed verbatim.

4.9 Data Analysis

Data analysis is the process of systematically inspecting, modelling, sorting and labelling data with the intention of making sense of it and to discover useful information that could be used to draw conclusions and support decision-making. Qualitative approach was dominant in this study since the sampling size was small. Only 50 learners were given the questionnaires to complete.

4.9.1 Quantitative data analysis

After completing the data collection process, the researcher checked for completeness of the questionnaire before embarking on compiling and coding the data. The quantitative data referred to the recorded data of the structured questionnaire that was presented according to the various sections and subsections of the questionnaires (see Appendix A). The data was presented by means of graphs. Each presentation of data provided an indication of numerical scores and percentages according to related categories in order to provide an overview of the particular grouping of data. Data analysis in this study involved breaking down the data into manageable patterns or categories in order to examine closely and compare for relations, similarities and differences.

4.9.1.1 Multiple Choice section

This section of the questionnaire was specifically checking on learners' background knowledge of geometry and misconceptions. The multiple-choice section was marked, and results analysed to identify certain factor patterns. The percentage of each response (a) to (e) for the entire group on a particular question was calculated and then entered into a spreadsheet.

4.9.1.2 The Likert scale

The Likert scale is an ordered, one-dimensional scale from which respondents chose one option that best aligned with their view. A 5- point scale was used with strongly agree (SA), agree (A), not sure (NS), disagree (DA) and strongly disagree (SD). The following example presents a 5- point Likert scale that was used.

Table 4.3: A sample of the Likert scale

Items	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Socio-economic status of the family influences the behaviour of the learners thus influencing their performance.					

4.9.1.2.1 Home related items

Three items were extracted from the home related variables in the questionnaire (see Appendix A). According to the responses, family assistance, socioeconomic status and parental educational background were determined to be the most predictors of geometry achievement.

4.9.1.2.2 School related items

On the school-related variables, three items were extracted from the questionnaire. According to the responses of the respondents the variables were determined to be factors influencing learner performance in geometry. The variables were: instructional methods, educator's attitudes towards geometry and professional development of educators.

4.9.1.2.3 Learner related items

The responses of learners indicated that most of them do not like geometry. The responses also showed that the majority lacked the foundation of basic geometric concepts.

4.9.2 Qualitative data analysis

Qualitative data analysis can be described as the process of making sense from research participants' views and opinions of situations, corresponding patterns, themes, categories, and regular similarities. Analysis of the data was guided by an interpretive paradigm by means of which I aimed to view the context in which it was set and the subjective viewpoints of the participants. Social constructivism emphasizes that learning takes place through interactions with other learners, educators, and the world at large (Vygotsky, 1978, p. 36). The focus here was on what the participants said (Punch & Oancea, 2014, p. 15).

Qualitative data from open-ended questions were organized into themes and presented for discussion. Open-ended questions were used during interviews for their ability to allow participants and researchers to reflect on the experiences discussed and to respond to new ideas that emerge in the interviews Oduol (2014, p. 143). Qualitative data analysis is a search for general statements about relationships among categories of data.

According to (Patton, 2014, p. 24) qualitative data analysis may include both inductive and deductive processes, however, this study employed an inductive approach. Content analysis techniques were used in the analysis of qualitative data obtained through the interview. For example, the content analysis involved my reading of transcripts, highlighting of similar words, phrases and ideas used in the text and thereafter assigning labels. The qualitative content analysis involved the following procedures:

1) **Recording of data** was done by audio recording on a digital voice recorder, while audio recording on another tape recorder served as a backup for electronic failure and faults; and

to ensure that all voices could be heard. Taking notes served as further backup and provided the context to the interviews.

2) **Verbatim transcription** of the responses from the interview commenced as soon as possible. All interviews were transcribed as shown in Appendixes F to I and line-by-line analysis was used in chronological order from the first question to the last. Verbatim transcripts of the interviews were compiled for analysis and interpretation. The data collected was analysed using some themes and sub-themes from the responses given by the participants to bring out the main issues on the factors influencing learner performance in geometry in grade 11. The researcher used transcribing, coding, categorizing and themes to analyse data collected from the educators and learners from the two schools selected. Different parts of the data are marked with appropriate labels or 'codes' to identify them for further analysis.

3) The entire transcribed text was firstly thoroughly read to obtain an overall and comprehensive impression of the content and context before the abstraction process of coding began. Labels assigned to specific units or segments of related meanings were identified within the transcripts. The transcribed text was arranged in meaningful themes and categories. As progress was made with the analysis, further sub-themes and subcategories were included to identify meaning connections, relationships and trends. The coding process for the transcripts consisted of three steps which are described below:

- **Open coding**

  The first stage was open coding, which entailed reading and re-reading the data in order to have an idea of how patterns could be clustered and coded. Open response results were read and reread to immerse in the data, and a phrase describing the meaning of those texts was formulated. Following the focus group interviews, transcripts were then read and reread, and audio recordings were listened to several times to immerse me (as the researcher) in the data collected. Open coding involves naming the identified patterns or categories of expression, breaking them down into discreet parts, closely examining them and comparing them for similarities and differences. In this study, I conceptualised the data by highlighting the clustered patterns or themes in different colours.

- **Axial coding**

  Axial coding was done by reviewing and examining the initial codes that were identified during the previous procedure outlined above. Categories and patterns were identified during this step and organised in terms of causality, context and coherence. Diverging instances of the identified patterns, trends and themes were noted from the narratives of the participants and they gave new meanings to my understanding of the text.

- **Selective coding**

  I listened to the audio recordings of both the focus group interviews and the face-to-face, semi-structured interviews while following along with the transcripts to determine a significant statement that was essential to the essence of factors influencing learner performance in geometry. This process provided me with data immersion so that I could be as close to the participants' experience with the phenomenon as possible. Selective coding as the third and final coding procedure involved selective scanning of all codes that were identified for comparison, contrast and linkage to the research topic (question) as well as for a central theme or "key linkage" that might occur.

4) Related codes were then listed in categories according to the research objectives (par. 1.5, p. 4) and theoretical framework (par. 3.2, p. 42).

5) The qualitative analysis process for this research was concluded by the description of thematic relationships and patterns of relevance to the research. The thematic relationships and patterns identified during the interpretation process contributed to the development of an appropriate instrument for the quantitative phase of this research.

The process of qualitative analysis outlined above served as a framework to ensure that the initial data (semi-structured interviews) were systematised by a thematic organisation to form part of the data that were connected to and combined with the quantitative data.

4.10 Data Quality issues

4.10.1 Validity

In order to ensure the investigative rigour of this study, validity and reliability were considered. Validity is defined as the appropriateness, truthfulness, correctness, meaningfulness, and usefulness of the specific inferences researchers make based on the data they collect. According to Koonin (2014, p. 75) validity aims to ensure the research measured what it proposed to measure. In my research, the process of triangulation added value to the validity of the study as themes and ultimately conclusions were based on multiple sources of data. The interviews used in my research assisted in ensuring triangulation.

In my study, I use the direct words from the participant without correcting grammar or tense to support validity of data.

4.10.2 Reliability

Reliability is when the same instrument is used at different times but always gives the same results. In other words, the instrument is repeatable and consistent (Creswell, 2010, p.215). To ensure reliability of the data collected in this study, the content of the questionnaires and interviews went through verification from an independent body who is knowledgeable in geometry to ascertain the degree to which the content of the test items and interviews were in harmony with the intended purpose.

4.10.3 Credibility

Credibility is, according to (Polit & Beck, 2012) the truth of the data or the participants' views and their interpretation of such data or views by the researcher. In ensuring credibility of the study, I provide in the proceeding chapter the participants' direct quotes during the interactions which were audio and video recorded. This is, in qualitative research, recommended by Cope (2014, p. 89).

4.10.4 Dependability

Bilsch (2005) as cited in Anney (2014, p. 266) explained that dependability refers to the stability of findings over time. Dependability involves participants evaluating the findings and the interpretation and recommendations of the study to make sure that they are all supported by the data received from the informants of the study. Educators of the selected schools were informed of the findings and recommendations. They had to scrutinize the report to check whether it emanated from the data collected from them.

4.10.5 Confirmability

Polit and Beck (2012, p.101) define confirmability as the researcher's ability to demonstrate that the data represent the participants' responses and not the researcher's biases. To ensure confirmability, the researcher described in the subsequent chapter how conclusions and interpretations were established and exemplify that the findings were derived directly from the data by providing rich quotes from the participants as recommended by Cope (2014, p. 90).

4.11 Ethical Issues

Ethics are norms and standards of conduct that distinguish between right and wrong and they help to determine the difference between the acceptable and non-acceptable behaviours. This study strived to abide by the ethical considerations for research conducted in South Africa and ensured that ethical procedures were followed to protect and respect the rights of the participants. Ethical clearance to conduct the research was sought from the Head of School in the university and obtained from the School of Education Human Ethics Committee. All the procedures of collecting data were explained to them so that they would know beforehand that this was not going to disrupt the normal teaching and learning activities of the schools.

4.11.1 Informed consent

A written informed consent form with accurate and complete information about the goal of the investigation was provided to participants. To ensure that participants fully comprehended the details of the investigation, the information was read to them, and they were given an opportunity to ask questions. I then distributed the consent forms to the learners who were willing to participate to give to their parents. The instruction was that if the parents needed clarity, they were free to call me at any time and I would visit them in their homes to further clarify the content. Participants were given time (a week) to think about their participation in this research, about their role as participants and about the information to share. No one would criticize a learner for his/her decision. Arrangements of date and time schedules would be drawn and agreed upon together with research participants.

Participants were under no obligation to return the consent form if their parents or they themselves did not want to participate. Learners were to submit their completed consent forms to the office of mathematics Head of Department. A sample of an informed consent letter sent to parents is attached (cf. Appendix F). Although informed consent letters were sent to parents, learners were under no obligation to participate even if the parents signed the forms. Learners were made aware that they were at liberty to withdraw at any stage of the research.

4.11.2 Confidentiality

It was explained to all the participants that confidentiality would be maintained before and throughout the study. To promote confidentiality, information provided by the participants, particularly personal information, was protected and not made available to anyone other than the researcher. Banegas and de Castro (2015, p. 58) propose that ethical considerations involve collaboration, anonymity and confidentiality. The data collected in this research would be used for the purpose of this research only.

The consent forms were kept separately from the data, as surnames of the parents appeared on these forms. The data collected from the participants were always kept under safe conditions. The researcher reassured the participants that their real names would be kept anonymous and all data gathered would not be associated with their real names to avoid identification. Alternatively, the researcher ascribed a number or symbol to a participant's data to ensure that the data remain anonymous and confidential. The researcher assured all participants that no person, except the researcher and the study leader would be able to access the raw data.

4.11.3 Avoidance of harm

I had an ethical obligation to protect participants within all possible reasonable limits from any form of physical discomfort that might have emerged from the research project. According to Babbie and Mouton (2007, p.27), the ethical rule of social research is that it must bring no harm to participants. Everything we do in life can possibly harm someone and therefore I had to weigh the risks against the importance and possible benefits of the specific research project.

Questionnaires were administered to learners and interviews were conducted with 10 learners, 2 geometry educators, 2 Heads of Department and 2 Principals. Validity, reliability and trustworthiness of the study were also unpacked and ethical issues were taken into consideration.

4.12 Conclusion

This chapter addressed the research design and methodology of the investigation that was conducted in two secondary schools in the Umlazi District. A detailed description of the study samples and instruments used was discussed. This chapter also outlined the conjunction between the interpretivist paradigm and qualitative methods. It indicated a tight connection between the interpretivist paradigm and qualitative methodology as one methodological approach used in collecting data.

In this chapter, I also described the analysis of the data. The recorded focus group interviews with the learners and individual interviews with the educator were transcribed, analysed and coded to themes. Description of the developmental patterns was done in terms of the similarities of responses. The next chapter will present the analysis of data and interpretation.

CHAPTER 5

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

5.1 Introduction

Chapter 4 presented a variety of research methodology issues that were utilised in this study. The chapter outlined the connection between the interpretivist paradigm and qualitative methods.

This chapter aimed at providing a thematic analysis of qualitative data to answer the three primary research questions, which are as follows:

1) What are the factors that influence learners' performance in geometry?
2) How do environmental factors (home, school, Department of Education) contribute to learner understanding in geometry?
3) How can environmental factors be adapted to improve learner performance?

In the quest to answer the above research questions this chapter presented a more detailed discussion of each of the themes and sub-themes emerged in Chapter 4. Relevant quotations and excerpts from the interview transcriptions and reflections were also included. This was followed by a discussion of each theme and subtheme in relation to reviewed literature on the topic.

5.2 Demographic and Biographic information

Section A of the questionnaire required the respondents to complete the section regarding their gender, age, and home language (see Appendix A). The biographical and demographical information of the respondents would assist the researcher to obtain a picture and overview of the study population and to compile a profile of the study population so that comparisons between different groups relevant to this study would be drawn.

Figure 5.1 indicates the demographic and biographic information of respondents who completed the questionnaires.

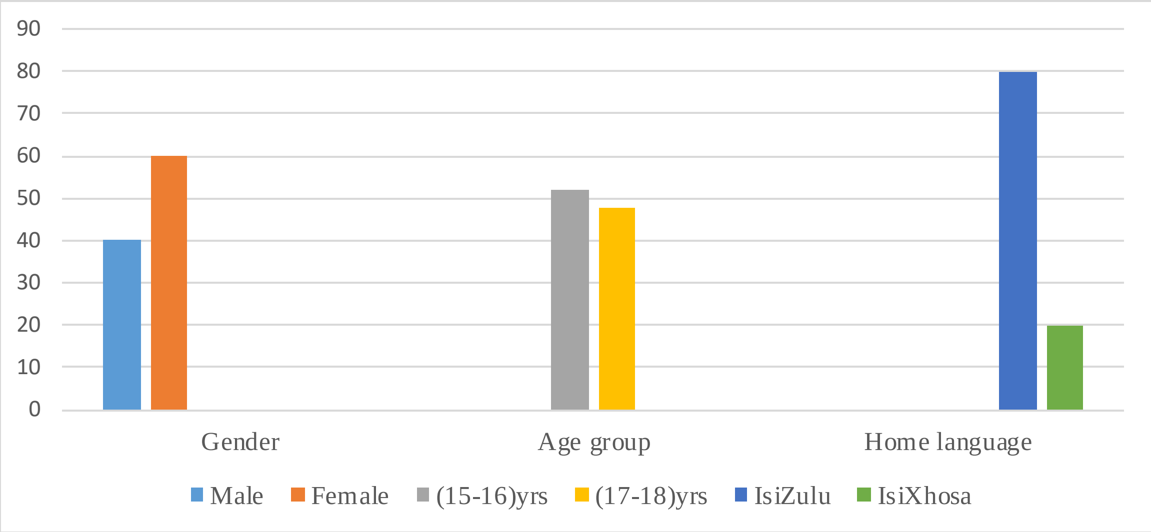

Figure 5.1: Demographic and biographic information of learners

All the respondents completed Section A. Figure 5.1 indicates that the sample constituted more females than males as there were 30 (60%) females and 20 (40%) males. Concerning age, 26 (52%) were in the age group of (15 – 16) and 24 (48%) were in the age group of (17 – 18) years. Most learners were using IsiZulu as their home language as they occupied 40 (80%) of the sample while 10 (20%) were IsiXhosa speaking learners.

5.3. Quantitative data presentation

5.3.1 Multiple choice section

Table 5.1 represents all the responses of learners on multiple-choice questions. Correct responses were highlighted.

Table 5.1: Multiple choice spreadsheet

Item	A	B	C	D	E	Correct Answer in %	Incorrect Answer in %
1.1 The shape of a triangles			**50**			**100**	0
1.2 The shape of a circle				**50**		**100**	0
1.3 Perpendicular lines	**17**	4	8		21	**34**	66
1.4 Area of a rectangle	8	2	**36**	3	1	**72**	28
1.5 Sum of angles of a triangle	17	4	**12**	16	1	**24**	76
1.6 Pythagoras theorem	5	**40**	1		4	**80**	20
1.7 Parallel lines	**22**	10		8	10	**44**	56
1.8 An equilateral triangle	**38**		4	2	6	**76**	24
1.9 Properties of a parallelogram	4	**30**		10	6	**60**	40
1.10 Properties of a rectangle	4	**18**	5	8	15	**36**	64
1.11 Angle subtended by a diameter	20	3	12	**12**	3	**24**	76
1.12 Properties of trapezoids	2	2	6	**38**	2	**76**	24

Table 5.1 shows that most learners struggled with the knowledge of the theorems pertaining to the sum of triangles and that of the diameter of circles which was evident by their lowest achievement of 24% in question 1.5 and question 1.11 respectively. However, all respondents responded correctly in question 1.1 and 1.2 which indicated that they have the knowledge of shapes of geometric figures (for example, triangles and circles). Learners also have some challenges with parallel lines and perpendicular lines. Prior knowledge of geometric basic concepts is lacking.

5.3.2 Likert scale

5.3.2.1 Home relate items

The graphs present all the responses in percentage. In this section, those uncovered patterns and the ways in which they contribute to learner performance were discussed.

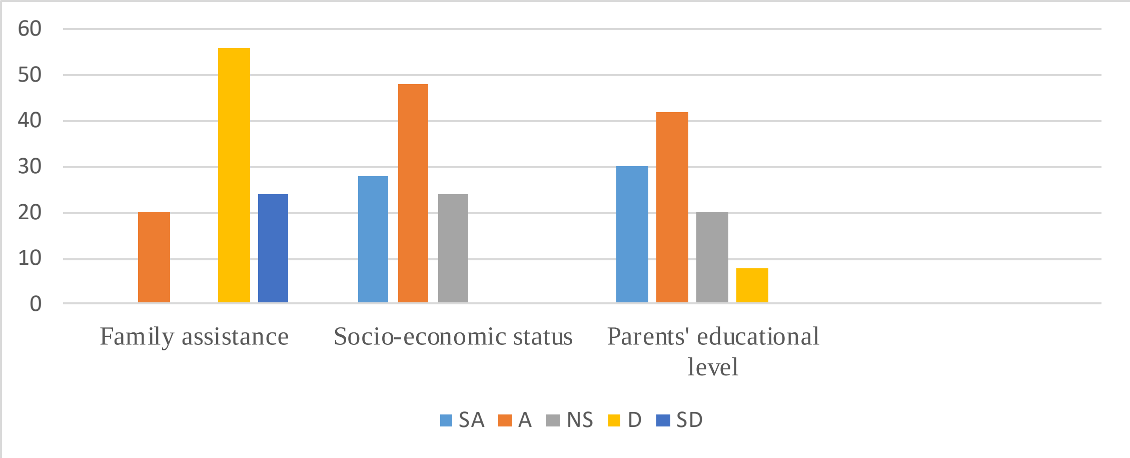

Figure 5.2: Home-related variables

Figure 5.2 shows that 10 (20%) of the respondents agreed that they get assistance at home, 28 (56%) disagreed and 12 (24%) strongly disagreed. This means most learners do not receive assistance with geometry homework at home.

Socio-economic status was determined to be a predictor of geometry achievement. Figure 5.2 also shows that 14 (28%) of the respondents strongly agreed and 24 (48%) agreed that the socioeconomic status of the families influences their behaviour thus eventually influencing their performance at school while 12 (24%) were not sure whether they are affected or not.

Figure 5.2 also indicates that 15 (30%) of the respondents strongly agreed and 21 (42%) agreed that the parents' level of education influences their performance in geometry because some parents did not do geometry at school and therefore do not know geometry. Of the respondents, 10 (20%) were not sure and 4 (8%) disagreed that parents' educational background does influence their performance.

5.3.2.2 School related items

Figure 5.3 shows the graphical representation of the data for the school-related variables.

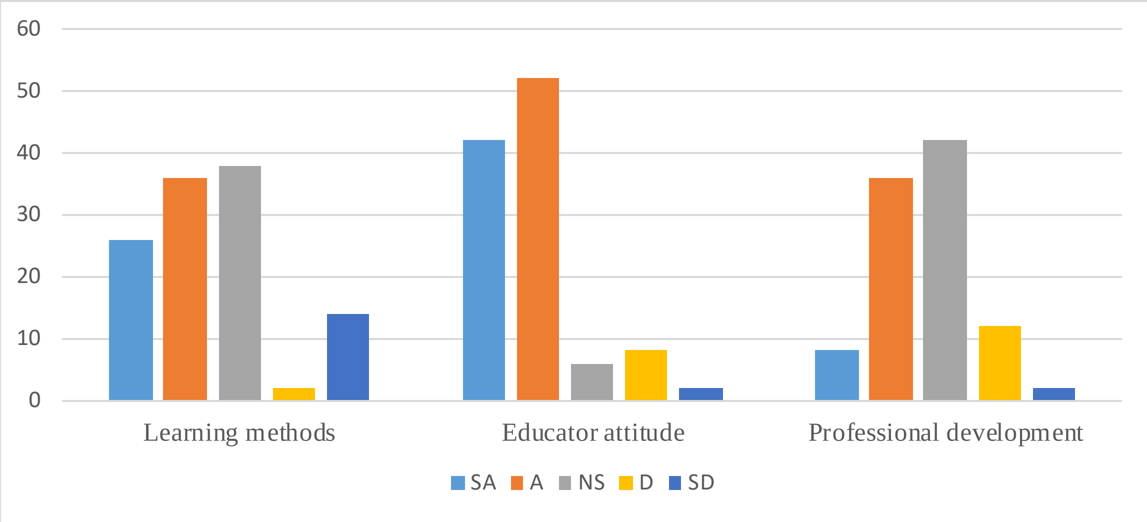

Figure 5.3: School-related variables

Figure 5.3 shows that 13 (26%) strongly agreed and 18 (36%) agreed that a learner-centered approach improves learner understanding of geometry. Whereas, 1 (2%) disagreed and 7 (14%) strongly disagreed that participatory learning enables learners to work on their own easily. The other 15 (30%) were uncertain.

Most of the learners agreed that educators' attitudes towards geometry influence learner performance. This was shown by 21 (42%) respondents who strongly agreed and 26 (52%) who agreed to this issue. The achievement of learners depends on the attitude of an educator. If an educator has a positive attitude towards geometry, the learner performance improves. Similarly, the negative attitude of an educator impacts negatively on the performance of the learners. The (6%) was not sure while 4 (8%) disagreed and 1 (2%) strongly agreed that educators' attitudes towards geometry influence learner performance.

Figure 5.3 also indicates that 4 (8%) strongly agreed, 18 (36%) agreed, 6 (12%) disagreed and 1 (2%) strongly disagreed that the lack of professional development of educators in geometry affects learner performance. Most of the respondents were not sure whether there was a lack of professional development of educators or not.

5.3.2.3 Learner related items

Figure 5.4 shows a graphical representation of the data.

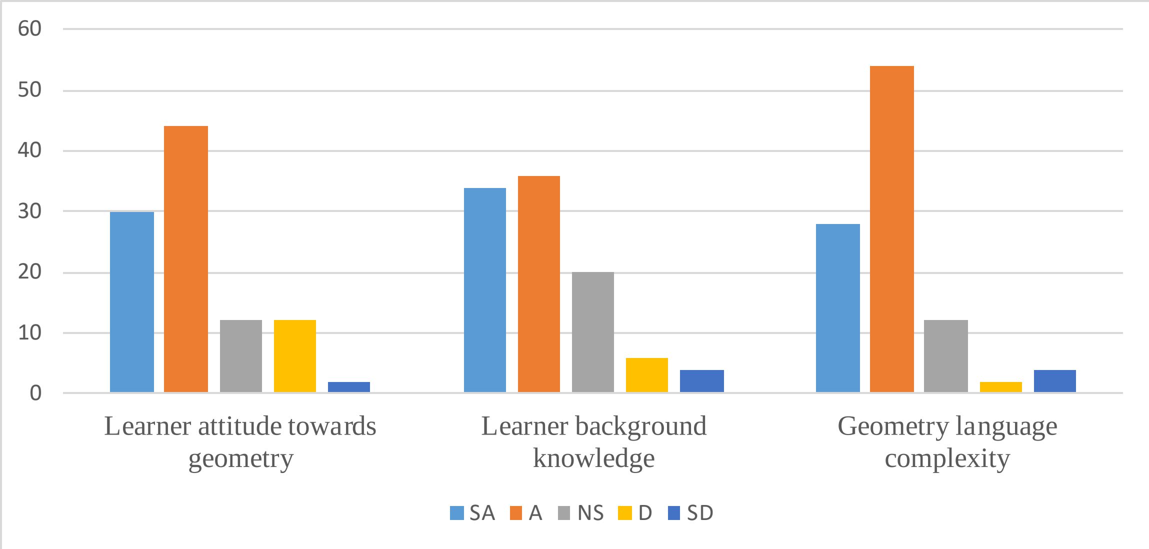

Figure 5.4: Learner-related variables

Figure 5.4 shows that 15 (30%) of the responses strongly disagreed, 22 (44%) agreed that the learners' attitude and fear of geometry influence learner performance. The minority of respondents responded differently where 6 (12%) disagreed, 1 (2%) strongly disagreed that attitude and fear contribute to the poor performance of learners whereas 6 (12%) were uncertain.

Figure 5.4 also shows that most participants agreed that the background knowledge of learners from lower classes influence learner understanding of geometry. This was indicated by 17 (34%) of the responses who strongly agreed and 18 (36%) agreed that the lack of a proper foundation in the lower classes makes learners fail to cope with the deductive approach of geometry in grade 11. Only 3 (6%) disagreed, 2 (4%) strongly disagreed while 10 (20%) were not sure.

Most learners struggle with the language of geometry which is the reason why 14 (28%) in figure 5.4 strongly agreed and 27 (54%) agreed that geometry language is a barrier to their learning of geometry. Although 6 (12%) indicated that they are not sure, 1 (2%) disagreed and 2 (4%) strongly disagreed that geometry language is a challenge to the understanding of geometry concepts.

5.4 Labelling of participants

As was stated in paragraph (4.7) of the previous chapter the sample of the study consisted of 10 grade 11 geometry learners, 2 grade 11 geometry educators, 2 mathematics Heads of Department and 2 Principals. For this study, the researcher referred to the participants by codes with respect to their schools. For example (L1ScA, L2ScA, L3ScA, L4ScA and L5ScA) was indicated for 5 learners in school A and (L1ScB, L2ScB, L3ScB, L4ScB and L5ScB) was coded for the 5 learners in school B. All participants were coded as shown in table 5.2.

Table 5.2: Coding of participants

Participants	School A	School B
Learners	L1ScA, L2ScA, L3ScA, L4ScA and L5ScA	L1ScB, L2ScB, L3ScB, L4ScB and L5ScB
Educators	EdScA	EdScB
Heads of Departments	HODScA	HODScB
Principals	PrScA	PrScB

5.5 Development of Themes

When analysing results of the open response prompts, the focus group interviews, and the semi-structured, face-to-face interviews, I developed open codes for the purpose of theme development. This strategy involved the coding of data, dividing the text into small units (phrases, sentences), assigning a label to each unit, and then grouping the codes into themes (Creswell, 2012, p. 208). The analytical process entails reducing the volume of the information, sorting out significant from irrelevant facts, identifying patterns and trends, and constructing a framework for communicating the essence of what was revealed by the data.

Simultaneously, as the data was being transcribed and translated, I found myself identifying patterns of expressions that alerted me to be aware of similar or divergent themes as more data unfolded. Results of both the open response prompt and focus group interviews, and the open codes discovered, informed me of the themes developing from the data. The researcher looked at the quotations in the transcripts that support the theme in the data. I read carefully through the transcripts to try to gain an overall understanding of each session. I started identifying themes, looking for the most common responses to questions, by highlighting the overlap between categories on the framework and identified data connections or patterns that could answer research questions.

Table 5.3: Patterns and categories

THEMES			
Home environmental factors **Sub-theme 1:** Family educational background. Categories • Socio-economic status. **Sub-theme 2:** Parental involvement. Categories • Parents do not monitor children's work • Parents are not supportive.	**School environmental factors** **Sub-theme 1:** Teaching Strategies Categories • Learner-centred • Participatory method **Sub-theme 2:** Geometry educators' knowledge Categories • Educators upgrading themselves • Educators' attitude and motivation. • Educators' content knowledge	**DoE environmental factors** **Sub-theme1:** Professional development of educators. Categories • IQMS • Training of educators **Sub-theme 2:** Resources and facilities. Categories • Lack of resources	**Learner environmental factors** **Sub-theme 1:** Geometry background knowledge Categories • Learners struggling **Sub-theme 2:** Attitude motivation and fear toward geometry Categories • Lack of interest • Very difficult and confusing. • Laziness

5.6 Discussion of the findings from the structured interviews

An interview schedule was prepared for this part of the study, using information drawn from the literature review and the findings from the qualitative section (the narratives). This section seeks to answer the research questions of the study.

5.6.1 Answering research question 1

What are the factors that influence learners' performance in geometry?

5.6.1.1 Parental educational background

Most respondents agreed that the educational attainment of parent had an influence in the performance of their learners. They mentioned the fact that most parents did not know geometry, therefore could not manage to assist their children with geometry homework. The following question was asked: "*Do parents manage to assist learners with geometry homework*"? The response from L2ScA indicated that educational attainment of parents served as an indicator of attitudes and values which parents create for their children. Educated parents used to create a home environment that promotes learning desire among children.

L2ScA: *"Most of our parents, unfortunately, did not finish their school themselves and some did not even do geometry when they were still at school. Therefore, they struggle with geometry home works and eventually get angry when you ask for assistance".*

L3ScB: *"Most of the time I am assisted by university students who were doing geometry at high schools".*

HODScB: *"Parents do not have a clue of geometry unless they are educated. Most did not do it themselves. They do not know how they can assist their children with geometry. Also parents criticize their children for not being good in geometry. They are the ones that lead to learners hating geometry".*

Even though research showed that the level of parental education had a significant impact on a learners' ability to learn at home and influenced the way they interact, learn and perform in class narratives from research participants varied. The Head of the Department of school A disagreed and argued that not all parents were uneducated, but were running away from their responsibility of assisting their children with homework by deliberately avoiding engagements that had to do with the child's educational matters.

Despite these conflicting views, it was clear that a continuous lack of support and motivation by parents at home, irrespective of the reasons, resulted in learners being distracted and losing focus on their schoolwork. Although parents were expected to play a significant role in the cognitive, social and emotional development of learners, the participating educators argued that certain family dynamics were continually affecting learner performance. The researcher further asked a question that seeks to understand the type of home-based challenges that influence learner performance. The respondents responded thus:

L5ScB: *"Some of us are raised by grandmothers who are not working. We only survive on their government pensions. We cannot get all the necessary educational resources at home as we please. However, those who still have parents, the majority of them are not working either. They don't have income. Therefore, we struggling when it comes to financial support".*

Learners from different socio-economic backgrounds were influenced differently based upon parental socio-economic factors and affordability. Letsoalo et al. (2017, p. 177) indicated that the socio-economic factors, such as family income were found to be a factor influencing learner performance. The educators agreed that low-income parents were less involved in their children's education than high-income parents. One Head of Department (HODScA) argued that:

"Socio-economic issues contribute to the poor performance of these learners. The majority of parents is not working and they are not even able to pay minimal school fees required for their children. This causes them to withdraw from participating in school affairs. Learners don't get proper guidance where they live. Some learners do not stay with their parents, there are no good role models in the area, no job opportunities, bad parental attitudes and beliefs and a failure to receive positive career counselling".

5.6.1.2 Parental involvement

The interviewer asked the respondents if there was any impact on the improvement of learner performance in geometry resulting from the parental involvement in their respective schools. Respondents revealed that learners were not getting enough support from their parents in terms of supervising and monitoring of their children's work. The responses of the participants indicated that learner performance was positively associated with parents' willingness to control the homework process by insisting that homework is completed. The issue of parental support/ assistance to learners with homework was indeed one of the most common forms of parental involvement in enhancing their performance. The participants lamented that:

HODScA: *"Their parents are not supportive. Learners would be performing better should there was a strong connection and partnership between parents and the school".*

PrScA: *"Ideally every parent is supposed to monitor the work of his child but sadly, our parents do not check the work. In the case of a learner not staying with parents, someone from the family must be taking all the responsibilities on their behalf".*

It was reported that some learners resided with extended family members or grandparents who for varied reasons did not invest in their education. Similarly, EdScB explained that although extended family members (especially grandmothers) provided a solid structure for some children in the absence of their biological parents but were either incapable of assisting or unwilling to assist learners with their schooling, especially when it comes to homework as he stated that: "*When these children are with grannies they do not take things seriously, because grannies do not follow up on them, which has negative implications on their abilities to perform.*"

The Principal of school A argued that in her school, even the biological parents did not bother about the educational needs of their children, because they were unable to grasp the purpose of schooling. Furthermore, she explained that many parents in the community under study exhibited an uncaring attitude towards education and sent children to school not to learn, but to liberate themselves from the burden and responsibility of having the youngsters around them all the time. This statement indicated that there was a very little contribution by some parents in terms of assisting learners with homework.

5.6.1.3 Teaching strategies

One Head of Department stated that some educators did not put as much effort into geometry as they did to the other sections of mathematics. Furthermore, she alluded to the fact that some learners used to come to her office complaining that they did not understand when the educator was teaching geometry. HODScA argued that the teaching strategies that an educator was using might not be effective enough for learning. Educators were asked to state the types of teaching strategies that they would use to develop a clear understanding of the application of theorems and how they would apply those teaching strategies. Educators responded as follows:

EdScA: *"I would use a learner-centred method. I would look at the basic fundamental understanding of learners that are part of the theorem. I would then let learners investigate every concept up until they find the conclusion".*

An educator emphasized that learner-centred methods allowed learners to work in groups. Working in groups helped his learners to develop team skills and it also improved their communication abilities that were needed in cooperative learning settings. According to EdScA the learner-centred method was one of the most effective method in increasing learners' achievement in geometry. It allowed learners to develop their personal, social and psychological skills. The other educator said:

EdScB: *"I would use a participatory method. When I teach theorems, I usually say to learners, let them calculate. After their calculations, I go back and say let us make sense of our answers from their random calculation. It is when I make an aspect to a theorem".*

The educator from school B recommended a participatory method even though some learners sometimes became inactive when they found difficulties in deriving a geometric concept. The two strategies required the involvement of learners in their learning process and it allowed individuals to participate in learning in every direction in a cooperative learning style. However, different teaching strategies should also be employed in teaching and learning so that an educator would be able to get a clear understanding of individual challenges in the class and intervene accordingly.

5.6.1.4 Geometry educators' knowledge

Being successful in geometry involves the ability to understanding one's current state of knowledge, build on it and improve it. Where necessary an educator had to seek extra support from the other educators within the school, from the subject advisor or network with educators from other schools. It contributes greatly to the improvement of learner performance in geometry. The researcher asked the Heads of Department: "*What are the challenges you experience in managing educators who teach geometry"?*

HODScA: *"Bad attitude towards geometry. Some don't like it themselves. Some novice educators do not teach this section at all because they are not comfortable with it since they passed grade 12 when the geometry section was optional".*

This kind of attitude of educators was costing the lives of learners. It was clear that they were not competent enough to teach geometry effectively at the grade 11 level. The other Head of Department said:

HODScB: *"When I do the staffing plan, some educators hardly accept the duty loads that includes grade 11 mathematics because of geometry embedded in it".*

The responses of both Heads of Departments above indicated that some educators of geometry did not have confidence in the teaching of geometry. When the educators were asked if they had ever furthered their educational level beyond their educators' training college educational level which they had already attained, both participants indicated that there was nothing that motivated them to further their studies.

EdScA: *"I obtained my BEd in 1998 and after that, I did my BEd Hons that I completed in 2006. I was demotivated by the fact that even if you further your studies, your salary notch does not increase. You just get a once-off 'thank you cheque' instead. You are also not guaranteed of getting promotions at the end of the day".*

EdScB: "*No, I had never upgraded myself, I don't have money and time to do that*".

From the above narratives, it was noted that the unavailability of monetary benefits demotivated educators from upgrading themselves. Apart from the fringe benefits that an educator may get upon upgrading himself, is the knowledge development/ capacitation. An educator needs to be knowledgeable and competent in his or her subject to be trusted by learners. This could be achieved by ongoing learning. Competent geometry educators provide a roadmap to guide learners to an organized understanding of geometrical concepts, to critical thinking, and ultimately to geometrical achievement.

5.6.1.5 Professional development of educators.

Both Heads of Department agreed that professional development helps educators network with fellow educators to mentor and support each other in the teaching of geometry. The following question was posed to the HODs: *In what ways do you influence mathematics educators to improve learners' performance in geometry?*

HODScA: *"Some learners come to me complaining that other educators do not unpack geometry well enough such that it is easily grasped. I organise a professional development workshop to capacitate educators on their teaching strategies for to that particular topic".*

HODScB: *"Yes, educators of geometry need to be trained and be developed on how to teach geometry effectively. As we have IQMS for educator development, we look at the areas of concern or the performance standard where an educator has some challenges, and develop that educator accordingly. We also forward those recommendations to DoE for further development, which sometimes they don't attend to".*

Interviewer: *How does the curriculum change influence learner performance in geometry in grade11?*

Both Heads of Department emphasised on the significance of professional development of educators that addresses changes in the curriculum. HODSc A argued that it was important for educators to familiarise themselves with curriculum change before it could have a negative effect on learner performance. The Principal of school A agreed to that and said:

PrScA: *"There are very few content-based workshops organised by our District officials. However, I encourage educators to attend workshops because of the depth of information that is cascaded in the workshops. Sharing of ideas on questioning techniques and the use of better teaching approaches with experienced educators can add value and equip the understanding of educators in geometry". I strongly believe that content-based professional workshops can improve learner performance in geometry".*

5.6.1.6 Provision of resources

The inadequate provision of resources in the teaching and learning of geometry was of great concern raised by respondents. Geometry educators reiterated that poorly resourced schools lead, in some cases, to poor quality of teaching and learning and therefore to the poor performance of learners. The learners also had the feeling that the limited number of teaching and learning resources in their schools was negatively affecting their learning as they did not have a variety of sources to refer to. When the researcher asked the participants: *How is your school resourced in terms of the learning of geometry?* Their responses indicated that there were insufficient teaching and learning resources in the schools.

L5ScB: "*Only textbook and an educator*".

L3ScB: "*Since the school does not have computers, we only use the textbooks. We are unable to google and get a more and wider knowledge of geometry using the internet at school. I usually go to the community library after school to use free Wi-Fi and get more information online*".

The above quotes were in contrast with the statement made by the Principal of school A, who argued that all necessary learning resources were provided for in her school. Her response came after the following question was posed to the Principals: *How do you ensure that teaching and learning improve learners' performance in geometry?* She responded thus:

"Firstly, by making sure that educators are in class teaching and learners learning. By also ensuring that learners have all necessary resources like textbooks, worksheets etc. to make learning effective. My core responsibility as a principal is a smooth running and the overall functioning of the school. I supervise educators, evaluate their performance, assign them to classrooms, create teaching schedules, provide them with necessary resources and make recommendations".

5.6.1.7 Prior knowledge of learners

Respondents picked up poor background knowledge in geometry as the cause of poor performance in geometry. The basic knowledge of geometric concepts in lower secondary level was the key factor which determined good performance of the learners in the senior classes. When learners were asked: *How does it feel to do geometry in grade 11 class*?

L1ScA: *"It feels very difficult and frustrating to do geometry especially if you do not have good background knowledge of it. Those frustrations and complications have led us to hate geometry and we do not enjoy learning it at all".*

L5ScB: *"Geometry is a very difficult and tricky section of mathematics if you do not have a basic understanding of geometry. It calls for hard work and more and more practice every day".*

The above view of learners suggested that geometry learners were poorly prepared in the lower grades for senior grades. In other words, learners lacked proper foundation and background knowledge of geometry. The literature reviewed in Chapter 2 (par 2.7.5) provided insight on the geometrical capabilities young learners can potentially achieve when presented with appropriate learning opportunities (Moss et al., 2015, p. 377; Mulligan, 2015, p. 653).

Both educators lamented that grade11 learners' lack of basic geometrical knowledge was retarding their success. The participants mentioned the need for team teaching and networking between geometry educators of junior grades and educators of senior classes in the secondary schools. The following question was posed to educators: *Learners tend to experience problems* *in understanding geometrical concepts such as angles, quadrilaterals, theorems etc. How can we turn the situations around?*

EdScA: *"I would focus on ensuring that the previous work and concepts that was done in lower classes are revised. I would address the issue of the lack of previous knowledge".*
EdScB: *"Learners are promoted to the next class without sufficiently knowing the geometric concepts. I would fill the gaps and lay proper foundations so that I can build on that. The exposure to geometry in lower classes is not properly founded. Once if they can get basics right, things would change".*

The Head of the Department of school A alluded to the need of team- teaching participants that educators in junior classes should work collaboratively with educators of senior classes. Whereas, HODScB emphasized the necessity of professional development to equip the lower grades educators to meet the level of required standards at grade 11 and 12.

The Heads of Department from the two schools were required to give their views on the causes of poor performance in geometry and the following question was posed to them: "*Is there anything you would like to tell me about the causes of the poor performance of grade 11 learners in geometry in your school"?*

HODScA: *"Yes, geometry educators in secondary schools should not work in isolation. There should be a connection and teamwork between GET educators and FET educators so that there are continuity and expansion of knowledge to the learners as they move to high grades."*

HODScB: *"I think learners background knowledge of geometry is letting them down. I think the District officials should organise professional development workshops of educators to capacitate geometry educators. The Department of Education must also make sure before employing a mathematics educator especially in a high school that he is thoroughly checked and screened to ensure that he is suitable, competent and qualified to teach all the sections contained in high school mathematics".*

5.6.1.8 Learners' attitude, motivation and fear toward geometry

Most respondents were of the view that anxiety and fear of geometry are the causes of poor performance. They pointed out that attitudes and values which parents use promote hatred and a lack of desire towards geometry. The learners were asked about their perception of geometry.

L3ScA: *"My mom told me that geometry is difficult. I must avoid mathematics because of geometry in it. She did not finish school because of mathematics. It is not for me".*

That parents' statement was intending to develop a fear even before the learner could do it. It is imperative that parents support their children in their education. The other participants responded that:

L15ScB: *"It is very tricky. Difficult concepts to understand. We can only understand it if there is a diagram given to refer."*

The responses below were indications that some learners lack interest and motivation in geometry and therefore have developed negative attitudes towards it. The seriousness attached to the lack of motivation for the learners has led them to regret why they chose mathematics in grade 10. Learners' responses indicated that geometry is difficult and they do not enjoy it. The follow-up question was posed to learners*: If you were to be given another opportunity to choose subject combinations as you did in grade 10, would you choose the package with mathematics where you will do geometry?*

L2ScA: *"If I would be given another opportunity to choose my subject combinations, I would change and take Mathematical Literacy because I don't like geometry".*

Educator of school A pointed out that there was evidence that even strong learners of geometry could feel daunted and overwhelmed when there is too much information at once and not enough time to practise. It is a good idea to chunk material into smaller steps so that learners can understand and master one step before moving to the next.

Interviewer: *What are the challenges that influence learners' performance in geometry*? This question was posed to the Heads of Department. The HOD from school B stated that learners have low enthusiasm and willingness to perform tasks, as shown by some learners who are not doing their homework. All the respondents (100%) agreed that learners show a negative attitude towards their educators and the subject:

HODScB: *"I think some learners have an attitude towards geometry. They just don't like it. They feel it is difficult".*

Therefore, the challenge was on how to motivate learners to want to study and learn aspects in geometry and how to teach them in a stimulating and understandable manner. It is no surprise that confidence was a huge factor in learners' anxiety towards geometry. Previous negative experiences with the subject can lead to a negative and defeatist attitude. This is in line with Zan, and Di Martino's (2014, p. 572) findings as stated in the literature (par 2.7.1) that if the self-confidence and attitude of learners towards geometry is low, the performance drops. The Head of the Department from school A responded thus:

HODScA: "*Educators have an important role in the learning system to attract learner motivation. Motivation is the internal and external factors that stimulate desire and energy in learners to be continually interested and committed to learning something.* The *positive attitude of educators creates a positive direction to learners for the learning of geometry".*

Educator support enhances learner performance. For example, when educators show support, care and concern for their learners, they are more likely to respect an educator, behave in the class and perform in his/her subject which was confirmed by Rimm-Kaufman and Sandilos (2015, p. 182) that learners with positive relationships with their educators experienced more academic performance in geometry because they felt accepted. When educators shout at learners, blame them, or aggressively discipline them, those learners often show less concern and respect for their educators.

Learner's achievement depends on their interest, attitudes and seriousness in the subject matter. Learner related factors include geometry anxiety, prior knowledge of learners and motivation in the learning of geometry. Findings have confirmed that attitude and geometry anxiety is linked to poor geometry performance and can make teaching of geometry a daily struggle. Broadly, the learners' performance in certain subjects like geometry depends on the educator's attitude towards the subject.

5.6.2 Answering research question 2

How do environmental factors (home, school, Department of Education) contribute to learner understanding in geometry?

5.6.2.1 Parental educational background

Parents had some difficulties in assisting their children with homework as they were not familiar with the modern style of learning geometry. The combination of different geometry techniques and different approaches to teaching and learning created dissonance between some parents and children during homework. Differences between parents' understandings of geometry and how educators expected learners to solve geometry problems led to a range of tensions, experienced by some parents as disempowering. HODScA stated that:

"Parents who struggled to support their children with homework feel embarrassed, confused, frustrated, and left behind. This resulted in some being reluctant to assist their children with homework, which sometimes manifested in parents avoiding geometry, and even hiding from children during homework time".

Parental educational background also signified the socio-economic status or prestige that was good for the children's education. Letsoalo et al. (2017, p. 177) argued that the wealthier family can create a better background by hiring private tutors to assist the child with geometry. For example, wealthy families are able to pay for extra tuition organized by private organizations to enrich their children with geometry. Learners whose parents have a higher level of education, a more prestigious occupation, or greater income tended to have higher performance than learners whose parents have a lower standing on such socio-economic status indicators. This study was also in line with findings of (Mohammadpour, 2013, p. 507; Tsai & Yang, 2015, p. 123; Visser et al., 2015, p. 48) who disclosed learners who have access to educational resources at home, tended to perform better in geometry than those who did not.

This research confirmed that the parental socioeconomic status impacted negatively in the achievement levels of learners in geometry in secondary schools in the Umlazi District. In Chapter 2 section 2.3.1 of this study, Sonali (2017, p. 44) stated that learners from low socio-economic status have greater academic stress and therefore have low performance in geometry than those with high socio-economic (SES) status.

5.6.2.2 Parental involvement

The results showed that parental support was associated positively with learners' performance in geometry. This could be realized through payment for extra tuition, buying textbooks, involvement in school activities such as attending Parent-Teacher Association meetings, helping with homework, and counselling. Parental involvement relates to learners' achievement in situations whereby learners whose parents participate in their education by going to their schools to check the progress report were performing better than their counterparts. The Principal of school B argued:

"We really encounter a lot of problems when it comes to parents' engagement. Our parents are very ignorant. They are not supportive. They don't attend to school meetings. They just don't care what is happening with their children at school".

There was a substantial influence of parents on their children's educational aspirations which is much stronger than that of peers. It was quite evident from the study that parents played a major role in the academic achievement and career orientation of their children. The lack of parental involvement in the school activities influenced learners' performance. This was confirmed by (Al-Alwain, 2014, p. 47) in the literature of this study (par. 2.4.3) that the level of parental involvement has a significant effect on learners' academic performance in geometry, and it had been found that learners whose parents were more engaged at school, had more positive academic achievement.

Home-based parental support involves diverse activities outside of school for example, creating a place for children to study, monitor and check the work of the child and course selection. Parents' fear in homework involvement, however, was consistently based on their own abilities that a parent with inadequate skills, knowledge and information could not offer effective assistance to the child.

5.6.2.3 Teaching strategies

It was indicated in the narratives that both educators were using a cooperative style of learning (in the form of learner-centred approach and participatory learning). Langer- Osuna (2018, p. 87) stated that cooperative learning plays a significant role in developing critical thinking, building community, trust, and mutual engagement with one another. Learners could interact with each other to explore, discover and analyse in order to advance their knowledge in geometry. Effective teaching and learning occur when learners are actively involved in class activity. Continued collaboration in groups and discussions, that is, educator-learner discussions and learner-learner discussions assisted learners to share ideas and individual learners to benchmark their own ideas against other learners' ideas. The more learners discuss geometric proofs, the more comfortable they are with their group members, and the more interactive and effective the activity will be (Boardman et al., 2015, p. 51).

The quality of educators' strategies has a direct impact on the learner's achievement therefore it is important that educators use teaching methods that will take the level of learners' understanding into account. Educators had to acknowledge that learners in a geometry classroom were diverse. Every learner had different ways of learning, abilities, readiness, and interests. The educators needed to be aware of individual needs of a learner and interchange their teaching approaches. There was a need to design and apply appropriate instructional strategies to provide learners with opportunities to improve their critical thinking abilities and problem- solving skills as was stated by Luneta (2014, p. 48).

5.6.2.4 Geometry educators' knowledge

It was noted in the interviews with HODScB that some learners complained to the school management that some educators were not putting as much effort in the teaching of geometry as they did to other sections of mathematics. One of the key components of educator competence is a sound pedagogical knowledge of educators. This is in line with the findings of Metzler (2014, p. 14) that most educators do not enjoy teaching geometry, so they do not spend much time in this section. Similarly, this was concurred by Beilock & Maloney (2015, p. 4) that several educators avoid the subject due to lack of confidence, ability, and geometrical content and pedagogical knowledge.

The educators' knowledge is of vital importance which includes the ability to identify learners' sources of misconceptions and to predict their thinking processes. Educators must know not only the content they teach but also how learners' knowledge of geometry is developed and structured; how to manage internal and external representations of geometrical concepts; how to make learners' understanding of geometry visible; and how to diagnose learner misunderstandings and misconceptions, correct them and guide them in reconstructing complex conceptual knowledge of geometry Ball et al. (2008, p.391). Some educators lacked passion in geometry.

5.6.2.5 Professional development of educators

Professional development of educators in geometry is important. It was noted that some educators do not like geometry and educators with poor subject knowledge would, no doubt, contribute to learners failing geometry. The teaching of geometry is very demanding and requires a thorough understanding of the subject matter and best teaching approaches. The on-going professional development of educators is imperative in equipping, supporting and re-skilling educators to teach geometry in the 21st century. This assertion was corroborated by Mogari (2014, p. 348) that educators need a deep understanding of all aspects of geometry so that they can present and explain geometry concepts and show how they relate to other mathematics topics.

Implementation of the Intrgrated Quality Management System (IQMS) as a professional development model in South Africa would improve educators' knowledge. IQMS is a process by which educators review, renew and extend their commitment as change agents to the moral purposes of teaching; and by which they acquire and develop their knowledge, skills and attitudes. Similarly, Msomi et al. (2014, p. 798) in examining educators' responses to the IQMS implementation and demands suggest that, inter alia, educators are provided with opportunities to improve their teaching skills through in-service training or workshops. However, educators are very reluctant to adopt the implementation of IQMS.

5.6.2.6 Provision of resources and facilities

Learning resources are important because they can significantly increase learners' interest in learning. Resources change the attitude of learners and support learners' learning. The lack of resources did not allow an educator to use learner oriented teaching learning in classroom despite his wish to do so. For example, a worksheet may provide a learner with important opportunities to practice a new skill gained in class. The use of resources assists in the learning process by allowing the learner to explore the knowledge independently as well as providing repetition.

HODScA lamented in his interview with the researcher that visualisation was the way learners could master and grasp geometry because they could see what an educator was talking about. If learning and teaching are done through the media, the learners' performance in geometry would improve. Some schools have poor infrastructure, to the extent that some of the classrooms do not have electricity but the use of resources will be necessary.

5.6.2.7 Learners' background knowledge of geometry

The learners could not assimilate or relate new geometrical concepts and principles to previously learned geometrical structures. That was in line with Reddy et al.'s (2015, p. 23) findings that if learners lack the pre-requisite knowledge of geometry from the lower grades, that lack of basic knowledge will impact negatively on learner achievement by limiting academic performance. Learners were not taught the basic concepts of geometry in previous grades.

The literature suggested that children's early geometrical skills were strong predictors of future geometrical abilities. This implies that geometry education in the early years needs to be valued by educators, with effort being made to understand how to provide optimum learning opportunities reflected by the needs and understanding of the learners. A strong focus on laying a good foundation in lower classes was necessary to ensure that future performance of learners in geometry at grade 11 level is improved.

Ali et al. (2014, p. 311) concurred in their findings (par 2.7.5) that the poor performance of learners in geometry could be attributed to poor foundation of basic knowledge of geometry from their primary stage. However, it was not inevitable that many learners suffer a decline in their motivation and performance when they move to secondary school. This will depend on the efficacy of the educator who was teaching them in the previous classes. Learners who were taught by educators with a low sense of efficacy do show a decline in their performance after the transition to secondary school. In contrast, learners who were taught by educators with a high sense of efficacy show some positive change.

5.6.2.8 Learners' attitude, motivation and fear toward geometry

Most secondary school learners had negative feelings in geometry, and believed that geometry was difficult and incomprehensible. This was supported by Ganal & Guiab (2014, p.25) that lack of interest and negative attitudes towards geometry were problems that should be encountered by learners in learning geometry, because geometry was regarded as obscure and a difficult subject. Learners had a negative attitude, and a lack of willingness and readiness to learn geometry.

Educators and Heads of Department agreed that laziness of the learners played a vital role in the poor performance of geometry. Most failures in secondary schools in geometry were not caused by the insufficient or inadequate instructions only but also by active resistance by learners. Learners lacked independence and self-practice. They could not practice geometry on their own at home as they used to do it when they were offered it at school.

5.6.3 Answering research question 3

How can the environmental factors be adapted to improve learner performance?

5.6.3.1 Parental educational background

Parents play a crucial role in the progression of the education of their children. Educators should exhibit the same behaviour and treatment on all learners and parents irrespective of their socio-economic status. It was noted in the literature that parent who have better educational level are treated differently. This may cause parents to withdraw from school activities.

5.6.3.2 Parental involvement

By welcoming the community into the school, opportunities are opened for the learners to be more engaged in their own education. Community and business leaders can see what is being taught and find opportunities to engage learners in activities that are relevant in the real world. They should have a good relationship with the educators to monitor how the learners are making progress. One of the main factors directly influencing learner performance and engagement in school is parental support. If parents take an active role in the learner's education, he or she will most likely remain in school Foley et al. (2014, p.164). If the parents value education, they may encourage the learner to exceed expectations.

Parents need to be aware of their own emotional state and attitudes while dealing with children in their academic matters. The kinds of interaction parents have with their children and the identifiable patterns of caretaking greatly affect their children's academic performance.

When parents show an interest in their children's education and cherish high expectations for their performance, they encourage positive attitudes that are the keys to high achievement. A positive attitude to learning goes together with good behaviour and is responsible for encouraging hard work which is a pre-requisite for high levels of performance.

5.6.3.3 Teaching strategies

Educators must be able to present subject matter in multiple ways. Even though it was found that both educators were mainly using a learner-centred approach, educators need to adopt a combination of approaches since visual representations also enhance spatial understanding and verbal representations promote geometrical terminology and geometrical language development. Different learners learn well by different learning models. The suggested approaches or strategies may go a long way in developing positive attitudes of learners towards learning geometry.

In a learner-centred approach, educators need to learn how to differentiate instruction. Improvement of performance in geometry by all learners requires effective geometry teaching methods in class. This was confirmed in the literature (par. 2.5.2) of this study by Luneta (2014, p. 48) that she was of the view that appropriate educators' methods of instructions and effective instructional materials in geometry require educators to develop sound instructional strategies and knowledge of useful sources and activities.

5.6.3.4 Geometry educators' knowledge

Educators should improve on their educator subject content knowledge in geometry. Additionally, an educator must be aware and understand the theory of Ball et al. (2008) pertaining to Mathematical Knowledge for Teaching high school Geometry (MKT-G). Educational research has identified three core components of educator's knowledge which are subject matter knowledge, pedagogical content knowledge, and generic pedagogical knowledge.

5.6.3.5 Professional development of educators

Professional development workshops for educators are significant in shaping, developing, and equipping educators to deal with challenges concerning geometry teaching. They also include the enhancement of confidence, the improvement of skills and continuous updating and deepening of the subject knowledge. This would ensure that curriculum delivery gaps are filled.

Educators must value the importance of the Integrated Quality Management System (IQMS) as the programme was designed for developing educators to their areas of concerns. This was confirmed by Dixon Excell and Linington (2014, p. 411) on (par. 2.6.3) of this study that in South Africa many professional development initiatives are commonly underestimated and ignored what effect they can have to change instructional practice. This ongoing training for educators can have a direct impact on learners' performance.

5.6.3.6 Provision of resources and facilities

Pairing learning of geometry with technological tools of Web 2.0 allows learners to collaboratively investigate geometric objects, properties, and relations and develop a flexible understanding of geometry. It was mentioned in the literature (par 2.6.2) that the aspects of enhancing visual representation and spatial visualization, increase learners' cognitive capacities during learning, encourage greater geometrical discourse, and pushes learners to become more geometrical thinkers (Crompton, Grant, & Shraim, 2018, p. 59). Moreover, Eickelmann, Gerick & Koop (2016, p. 25) stated some benefits of geometrical software as it makes teaching significant, easy, pleasant, amusing, practical and increases the attendance rate of the learners.

Figure 5.2 Effective educational video

For educators to achieve this goal and help their learners use technological tools strategically, they must learn how to use these tools themselves by learning with them. This calls for carefully designed professional development experiences that help educators learn actively and in turn improve their classroom practice. In collaborative dynamic-geometry environments, learners can improve their collaborative practices while working with other learners. This confirms the theory of social constructivism as was discussed in Chapter 3 (section 3.2).

5.6.3.7 Learners' background knowledge of geometry

Effective collaboration and team teaching amongst professionals within the lower classes in the GET phase and FET phase in secondary school to address the gaps and diverse needs of the learners and educators can contribute significantly to the effective transition of learners into these phases. The study by Bruce et al. (2015, p. 331) in (par 2.7.5) reiterated the need for educators to provide adequate time for learners to discuss and explore geometrical concepts. They also emphasized the importance of educators discussing their classroom environment with other colleagues.

The possibilities of developing new teaching strategies within a collaborative co-teaching environment would raise the benefits to help learners. Adaptation of social constructivism would allow learners to retrieve prior knowledge when it is needed. Abstraction is fundamental to geometry as it gives geometry both its power and its scope and is the mechanism through which secondary school geometry is built upon from primary school geometry.

5.6.3.8 Learners' attitude, motivation and fear toward geometry

Learners' attitudes need to be fostered throughout the process of teaching and learning in order to have a good achievement. A positive attitude towards the subjects will encourage a learner to learn the subject much better. To achieve this, educators should provide learners with regular confidence-building exercises that look challenging but enable all learners to do well. Educators should create a safe and comfortable environment, where learners can freely express their thoughts and ideas. Learners' attitudes can also be improved by creating an effective learning environment where knowledge is constructed by learners.

In addition, it will boost learners' confidence and self-efficacy thereby decreasing anxiety and fear, as learners feel more relaxed and accepted. This space for learners invites active participation and allows for the development of learners' self-confidence. Giving learners opportunities to practise and master essential skills for computational fluency is essential: when learners do not have the basic skills at hand, their working memories are taxed which can be both distracting and discouraging. It is beneficial for learners to practise mental geometry and basic geometry skills regularly, incorporating them into games and warm-up activities.

5.7 Conclusion

This chapter focused on an analysis of the qualitative data. The themes that emerged from the structured interviews also relate directly to the conceptual framework of this study and are used to consolidate the concluding arguments of this study in the following chapter. This chapter presented the findings from data collected through interviews. Finally, a detailed discussion of the findings was presented. In the next chapter, a summary of findings, recommendations and conclusion of the study will be presented.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The previous chapter focused on the discussion of the findings of the empirical study, the literature analysis and the categories and main themes that emerged from the research data were highlighted.

Chapter 6 contains the summary, conclusions and recommendations of the study and suggestions for further research. The first part of Chapter 6 focuses on presenting a summary of the literature review and the empirical study. This is followed by a synthesis of the research findings and a discussion of the conclusions of the study as they relate to the research questions. The recommendations of the study are explained, and the chapter ends with a review of the limitations of the study, conclusions and suggestions for further research.

6.2 Summary of the research findings

6.2.1 What are the factors that influence learners' performance in geometry?

Factors affecting learner performance were diverse. The categories and the main themes (see Chapter 5, section 5.6.1.1 to section 5.6.1.8) that emerged from the interviews with the participants described their views on the factors that influence learner performance in geometry in secondary schools. Based on the findings of the study, it could be concluded that the following were factors influencing learner performance:

6.2.1.1 Home environmental factors

Family educational level influenced learner performance as one learner (L2Sc A) indicated that most parents did not finish school themselves and some did not do geometry when they were still at school. Therefore, they struggled with geometry homework unless they get assistance from outside. For example, some learners were assisted by university students who were doing geometry at high school.

Socio-economic status of the families was the barrier in giving the support that parents were supposed to give to their children. Most parents were not working, and some of them were not living with their parents because of social issues and some were raised by grandmothers.

Parental involvement was lacking. There was a disconnection between parents and the schools. According to (McKenna & Millen, 2013, p. 9) parental involvement is defined as the ongoing, multidirectional relationships of parents and school constituents that aim to address their children's learning, progress, and means of intervention, both in and out of the school environment.

6.2.1.2 School environmental factors

Teaching strategies should be designed such that they emphasize that learning takes place through interactions with other learners, educators, and the world-at-large. The two educators affirmed that cooperative learning was better because it has aspects of participation and involved teaching in contexts that could be meaningful to learners based on their personal and social history, negotiating, class discussions, small group collaborative learning with projects and tasks, and valuing meaningful activity over correct answers.

Geometry educators' knowledge was below the required standard. For example, some educators passed grade 11 when geometry was optional (examined as paper 3) in the National Curriculum Statement (NCS). Therefore, those educators were not competent enough to teach geometry at grade 11. Educators did not have enough workshops to equip them on how to teach geometry, and content knowledge improvement.

6.2.1.3 Department of Education environmental factors

Lack of professional development workshops for educators was retarding educational progress. Geometry educators must know not only the content they teach but also how learners' knowledge of geometry is developed and structured; how to manage internal and external representations of geometrical concepts; how to make learners' understanding of geometry visible; and how to diagnose learner misunderstandings and misconceptions, correct them and guide them in reconstructing complex conceptual knowledge of geometry.

Lack of resources and facilities was one-factor affecting learner performance in the sense that some schools did not have resources to make teaching and learning of geometry enjoyable to learners. The learning environment, such as infrastructure and facilities was not conducive to learning and teaching geometry. There was nothing that was stimulating interest to learners, instead, lessons were boring in the absence of resources. The findings of the study reveal that some schools are only using textbooks and previous question papers.

6.2.1.4 Learner related factors

Lack of background knowledge was impacting negatively on learner performance. Learners were poorly prepared in the lower grades for senior grades. Educators raised concerns that learners encounter difficulties in secondary schools if basic skills in geometry are lacking. Prior knowledge facilitates memory for incoming information because it provides a structure into which the new information can be integrated.

Tshabalala and Ncube (2013, p. 11) in the reviewed literature indicated in (par. 2.5.2) that learners' performance in geometry is mainly affected by grounding a good foundation of the subject at the lower levels. Therefore, it was important that educators use teaching methods that take the learners' level of understanding geometry into account in a way that the knowledge received could be retrieved.

As was indicated in the literature (par. 2.4.4.2) learner motivation and engagement in learning geometry play an important role in their geometry achievement performance at school (Lee et al., 2016, p. 192). If learners are not motivated, they will feel scared and powerless and perceive that geometry is difficult.

Educators as motivators did not play their role to increase learners' interest in learning. Learners with more educator support had more enjoyment, interest, hope, pride, relief and less anxiety. If the self-confidence and attitude of learners towards geometry is low, the performance also drops. This was confirmed by Belin (2016, p. 176) who suggested that a positive attitude enhanced learners' performance throughout their schooling and had boosted learner's self-confidence, values, enjoyment and motivation to learn.

From data examination in Chapter 5, the study established the effects of home environmental factors, school environmental factors, learner related factors and Department of Education environmental factors. The findings were consistent with the literature reviewed in Chapter 2 and were supported by the theoretical framework as elucidated in Chapter 3 which aided answering the research questions.

6.2.2 How do environmental factors contribute to learner understanding in geometry?

6.2.2.1 Home environmental factors

Family educational level: Differences between parents' understandings of geometry and how educators expected learners to solve geometry problems led to a range of tensions, experienced by some parents as disempowering. HODScA stated that:

"Parents who struggled to support their children with homework feel embarrassed, confused, frustrated, and left behind. This resulted in some being reluctant to assist their children with homework, which sometimes manifested in parents avoiding geometry, and even hiding from children during homework time".

Socio-economic status: Some families cannot afford to buy necessary learning material such as the set of instruments, calculators, books and computers for their learners to develop their understanding in a healthy home environment.

Parental involvement: In Chapter 5 section 5.6.2.2 one principal argued that some parents are not supportive.

6.2.2.2 School environmental factors

Teaching strategies: The quality of educators' strategies has a direct impact on the learner's achievement therefore it is important that educators use teaching methods that will take the level of learners' understanding into account. Educators are critical determinants of learners' learning and educational progress and they must, therefore, be well trained to use effective teaching practices.

Geometry educators' knowledge: Lack of extra support from the management contributed to the poor performance of learners. One educator indicated that he was not getting the support from the management in the school and the only support he was getting, was from the subject advisor.

6.2.2.3 Department of Education environmental factors

Lack of professional development workshops: Continued professional development training workshops in CAPS education would be beneficial not only for educators but also for learners.

Lack of resources and facilities: Resources change the attitude of learners and support learners' learning. The lack of resources did not allow an educator to use learner oriented teaching learning in classroom despite his wish to do so.

6.2.2.4 Learner related factors

Lack of background knowledge: The findings of the study section 5.6.3.8 revealed that most of the respondents agreed that learners had a negative attitude toward geometry. The lack of learners' interest and enjoyment when learning geometry can significantly reduce their engagement in geometry related activities.

6.2.3 How can environmental factors be adapted to improve learner performance?

6.2.3.1 Home environmental factors

Family educational level: Parents should be enlightened on the importance of their involvement in the education of their children and its attendant benefit in the performance of learners.

Parental involvement: It is important for schools to keep in mind parents' cultural and economic differences because misunderstandings in these areas can create a disconnection within the parent-school relationship and negatively impact parent involvement.

6.2.3.2 School environmental factors

Teaching strategies: A shift from an educator-centred to a learner-centred approach is a recognition that learning should be focusing on learners' needs. Social constructivism emphasizes that learning takes place through interactions with other learners, educators, and the world-at-large (Vygotsky, 1978, p. 36).

Geometry educators' knowledge: Educators must be aware and understand the theory of Ball et al. (2008) pertaining to Mathematical Knowledge for Teaching high school Geometry (MKT-G) as it was stated in theoretical framework chapter section 3.3.2. Ball et al., (2008, p. 389) focused on four components of pre-service educators' knowledge: "subject matter knowledge, knowledge about teaching and learning, knowledge about learners and knowledge about context" (p. 390).

6.2.3.3 Department of Education environmental factors

Lack of professional development workshops: Professional development can help overcome shortcomings that may have been part of educators' education and training and keep educators abreast of new knowledge and practices in the field of geometry.

Lack of resources and facilities: The Department officials had to ensure that all necessary resources were available to educators. Resources play a very significant role in fostering interest to learners, which would eventually improve their performance.

6.2.3.4 Learner related factors

Lack of background knowledge: I was indicated in Chapter 5 section 5.6.3.7 that effective collaboration and team teaching amongst professionals within the lower classes in the GET phase and FET phase in secondary school to address the gaps and diverse needs of the learners and educators can contribute significantly to the effective transition of learners into these phases.

6.3 Methodology

A qualitative approach was employed by this study. Creswell (2015, p. 231) pointed out that qualitative research has limited generalizability and it only provides soft data. Furthermore, he mentioned that qualitative research (p. 232) is only investigating a limited number of participants which is highly subjective. Although the collection and analysis of data for this study were time-consuming, the researcher still opted for this approach to be part of this study's research design. The sampled participants were audio and video recorded during the interviews. The interviews were individual, in-depth interviews and focus group interviews.

6.4 Summary of findings from the literature review

The literature study covered in Chapter 2 helped the researcher to understand the contextual nature of the research problem. The cited international countries were compared to South Africa in terms of the factors influencing learner performance in geometry in their respective schooling systems. This was done to determine how successfully they managed to handle them in their schools to adapt these experiences in South African schools.

The theoretical framework was presented in Chapter 3. The theoretical framework of this study was inspired by the interpretivist paradigm grounded in social constructivism. The perspective of social constructivism is based on the argument that reality is constructed through human activity and that people construct their understanding and knowledge of the world through experiences (Bhowmik, 2014, p. 8; Jazim, Anwar & Rahmawati, 2017, p. 579).

6.5 Limitations of the study

The study had several limitations that should be taken into consideration when interpreting the results. Firstly, the sample involved a few participants. A convenience sample was used by the researcher due to proximity and access to the data needed for the study, as a result, the findings of this study may not be generalized to larger populations.

Secondly, the study was limited to grade 11 learners only, geometry educators, mathematics Heads of Departments and principals of the two selected schools. In other words, the study excluded stakeholders such as parents, circuit managers and school governing bodies among others. The omission of these stakeholders limited the quality of the results of this study.

Thirdly, the study was conducted in one District and in two schools which might have influenced the findings of this study. Had this been conducted in two or more different schools, it would have provided a good picture of the factors influencing grade 11 learner performance in geometry.

Lastly, interviews were the main source of data collection. The use of a test at the end of teaching would have been comparatively more informative. Information from the test could have strengthened the data gathered.

6.6 Recommendations

Notwithstanding its limitations, this study does suggest that creating a conducive learning environment to enhance the learning of geometry can improve learner performance in geometry. Therefore, in consideration of the findings of this study, the following recommendations are made:

6.6.1 Recommendations to parents

i. The study recommended that good school-community participation, as well as active parental involvement in the education of learners, should be developed and maintained to enjoy its attendant benefits which ultimately will lead to an improvement in the performance of learners in geometry and other subjects. All stakeholders in the fraternity of education have their role to play in the development and shaping the future of learners. A full commitment from these role players will significantly enhance learner performance in geometry, thereby ensuring quality education in the province of KwaZulu-Natal.

ii. Parents should not distance themselves from their children's education, because that will affect the learners academically. However, they should spend more time encouraging learners to believe in themselves and see geometry as any other subject. Parents should supervise their children to complete their schoolwork and homework. The Principals of schools should devise strategies of parental involvement activities in the school.

iii. Parents need to be supportive and fully involved in the education of their children. At home, learners must be assisted emotionally, psychologically, financially and physically with their schoolwork. This is a motivational tool that will boost the self-esteem of a learner, thus improving the performance.

6.6.2 Recommendations to educators

i. The study recommended that proper guidance and counselling units should be set up in the schools to guide and counsel learners on their educational, personal and social issues affecting them. This will help them to change their views about geometry and improve their performance in it.

ii. Educators should create a positive attitude that will cultivate interest and motivation towards geometry that will change their perception that geometry is very difficult. They should develop a sense of 'willingness' to learn. By including motivational strategies in learning activities such as: scoring, prizes, competitions and praise. The learners will be keen to learn if they know there will be repetition and a price tag.

iii. Educators need to be knowledgeable, skilled and trained to deliver high-quality education. Geometry educators of grade11 should not work in isolation. They need to work in collaboration with educators in the lower classes but not leave out the Heads of Department whose core duties are to monitor the work coverage ensuring that effective teaching and learning is taking place.

iv. The study recommended that Principals of schools should develop strong techniques and skills to manage headship roles especially supervision of teaching activities in their schools by utilizing effective supervisory strategies that work well in their schools. The senior managers of the school (the Principals and Deputy Principals) should provide the educators with all the support and necessary teaching and learning resources. Outsourcing experts or specialists from other sectors responsible for guiding learners towards geometry in lower grades should be initiated or enhanced.

6.6.3 Recommendations to Provincial District officials

i. The study recommended that the Provincial District officials need to provide relevant and compulsory professional development programmes to enhance educators' capacity to aspiring and serving school. Educators are significant in learners' education and they must, therefore, be well trained to use effective teaching practices. Provision of qualified and adequately trained geometry educators can improve the performance of secondary school learners in the Umlazi District. It is therefore recommended that educators undertake high-quality training to improve their qualifications throughout their careers to keep abreast and update their knowledge.

ii. Encouragement and motivation of educators by the provincial district would contribute to positive learner achievement in geometry. By demonstrating an enjoyment and appreciation of geometry, educators can encourage a healthy relationship with the subject and if educators are not quite comfortable with geometry themselves, a good idea is to invest in professional development. Learning how and why to teach geometry in ways that build understanding and excitement can help reduce geometry anxiety in educators themselves.

iii. The study also recommends that the District officials should provide the schools with all the resources timeously that are needed in the teaching and learning of geometry, for example, human, physical and financial resources. The Department of Education should provide ICT and geometry software to schools. The use of ICT can make learners grasp geometrical concepts easier and has positive motivational effects on learners in geometry.

6.6.4 Recommendations to learners

The study recommended that learners must be encouraged to actively participate in classroom activities to have an enjoyable and satisfying learning outcome.

6.7 Future Research

The study was limited to only learners, educators, Heads of Department and Principals of the two participating schools selected for this study. It was also confined to secondary schools in the Umlazi District. To intensify the study, the researcher is recommending a similar study on the factors influencing grade 11 learners' performance in geometry in secondary schools to be conducted considering the following:

i. A study conducted in a significantly increased sample size to make a wider contribution in this area of research. Studies that draw a sample from a vastly different stakeholder population (for example parents, circuit managers and school governing bodies among others) are needed to evaluate the generalizability of results.

ii. A study that compares the performance of grade 11 learners in geometry in the rural areas schools and urban areas schools.

iii. A study that compares the performance of grade 11 learners in geometry in different Districts or Provinces.

6.8 Conclusion

Based on the major findings presented above the following conclusions were drawn:
There were several intermingled factors that were detrimental to low performance of secondary school learners in geometry. The improvement of learner performance depended on the parents, learners themselves, educators, Principals and the Department of Education. All of them had

to work together towards a common goal of ensuring improvement in the learner performance in geometry. The outcome of such commitment from everyone would significantly enhance learner performance in geometry, thereby ensuring the promotion of quality education in South Africa.

The parents' meaningful engagement with quality time for assisting their children to learn at home, due to parents' socioeconomic status in terms of education, occupation and annual income was another pertinent cause of their low performance. Parents should spend more time encouraging learners to believe in themselves and see geometry as any other subject. The perspective of parental involvement in the school activities had a significant influence on the performance of their learners in geometry.

The under-recognition of learners' interest with their pre-existing level of knowledge and skills towards geometrical concepts were the major determining factors of lower achievement in geometry. From the results, it could be seen that the cultivation of a good learning atmosphere by the educators could be key in trying to develop a better attitude from the learners. How educators were communicating with learners was important. Negative explanation about geometry from the educators, parents and other persons created frustration and anxiety in geometry learners.

The significance of cooperative learning as peer interactions has important educational and practical value to learner development. Positive peer relationships could not only assist learners with their learning and development in a useful way, but also enhance high self-esteem. Social constructivists attached great importance to the effective use of peer relationships with children's emotional and social development. Educators should adopt a variety of ways to design peer relationship to enhance learners' learning.

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APPENDIX A

Geometry Learners' Questionnaire

Thank you for volunteering to participate in this study. This questionnaire aims at getting your opinion pertaining to the factors influencing learner performance in geometry in secondary schools .I want to assure you that the information you share, is for research purpose only and will be treated with confidentiality.

SECTION A: General Information

1. The response to the following interview items will be indicated by ticking [√] in the appropriate space provided or by filling in the missing information.

1.1 Gender:

M	**F**

1.2 Age group

15-16	17-18	19-20	21-22

1.3 Home Language

IsiZulu	IsiXhosa	Sesotho	English	Other

SECTION B: Factors that influence learner performance in geometry.

Instructions

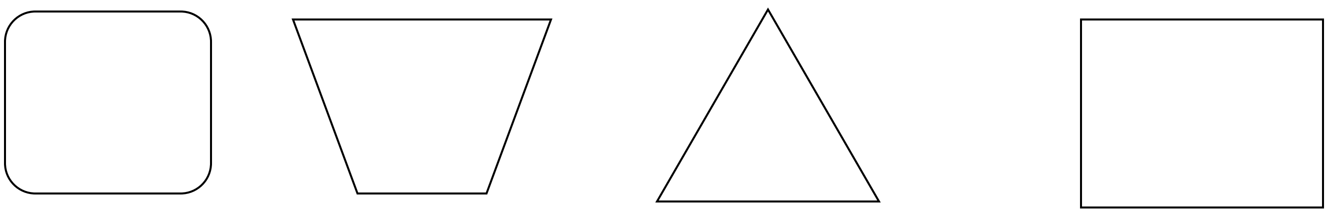
1. Section B consist of Questionnaire A and Questionnaire B
2. Questionnaire A consist of 15 questions and Questionnaire B consist of 30 questions.
3. Answer all questions.
4. Your name is **NOT** required

QUESTIONNAIRE A

1. For each statement below, answers are given. Choose and circle the most appropriate answer.

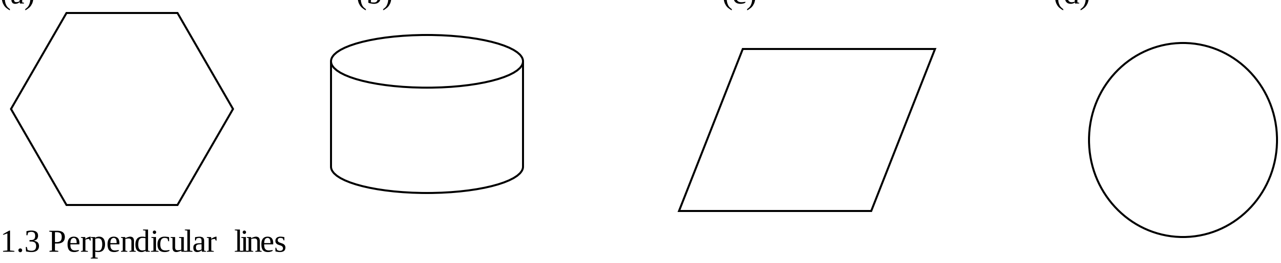
1.1 Identify a triangle from the following shapes.

(a) (b) (c) (d)



1.2 Of the following shapes, which one is a circle?

(a) (b) (c) (d)



1.3 Perpendicular lines

a) Intersect to form four right angles
b) Intersect to form two acute and two obtuse angles

c) Do not intersect at all

d) Intersect to form four acute angles

e) None of the above

1.4 The area of a rectangle with length 3cm and width 12cm is

a) $18cm^2$

b) $72cm^2$

c) $36cm^2$

d) $15cm^2$

e) $30cm^2$

1.5 In triangle ABC, $\hat{A} = 48^0$ and $\hat{C} = 24^0$. What type of triangle is triangle ABC?

a) Acute-angle

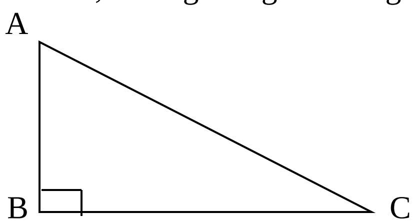
b) Equilateral

c) Obtuse-angled

d) Isosceles

e) Right-angled

1.6 If triangle ABC below, is a right-angled triangle and not an isosceles triangle:



Which statement is correct?

a) $BC^2 = AC^2 + AB^2$

b) $AC^2 = BC^2 + AB^2$

c) $\hat{A} = \hat{C}$

d) $\hat{A} + \hat{C} = 180^0$

e) AB = BC

1.7 Parallel lines are lines

a) In the same plane which never meet

b) Which never lie in the same plane and never meet

c) Which always form angles of 90 degrees when they meet

d) Which have the same length

e) None of the above

1.8 An equilateral triangle has

a) All three sides the same length

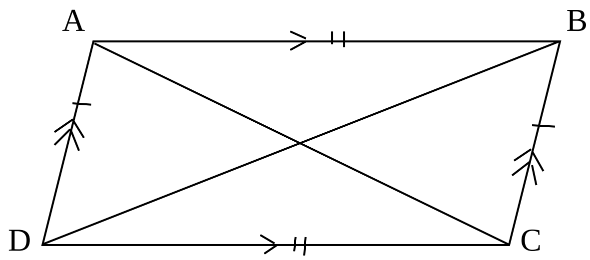
b) One obtuse angle

c) Two angles having the same measurement and the third with different measurement

d) All the three sides of different lengths

e) All three angles of different measure.

1.9 Given that ABCD is a parallelogram, which of the following statements is true?



a) ABCD is equiangular

b) Triangle ABD is congruent to triangle CDB

c) The perimeter of ABCD is four times the length of AB

d) AC is the same length as BD

e) All of the above are true.

1.10 The plane figure produced by drawing all points exactly 6 cm from a given point is a

a) Circle with a diameter of 6cm

b) Square with a side of 6cm

c) Sphere with a diameter of 6cm

d) Cylinder 6cm high and 6cm wide

e) Circle with a radius of 6cm.

1.11 Which is true?

a) All the properties of rectangles are properties of all squares

b) All properties of squares are properties of all rectangles

c) All properties of rectangles are properties of all parallelograms

d) All properties of squares are properties of all parallelograms

e) None of (a)-(d)

1.12 What do all rectangles have that some parallelograms do not have?

a) Opposite sides equal

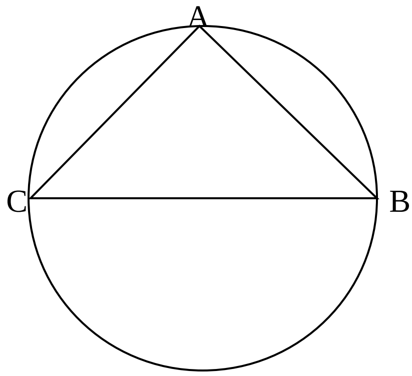
b) Diagonals equal

c) Opposite sides parallel

d) Opposite angles equal

e) None of (a)-(d)

1.13. In the figure below BC is a diameter. Which answer is true?



a) BÂC is an acute angle.

b) AC is a radius.

c) ABC is a cyclic quadrilateral.

d) AC is perpendicular to AB

e) Angle B is an obtuse angle.

1.14 Which property is true for ALL trapezoids?

a) Opposite angles are supplementary

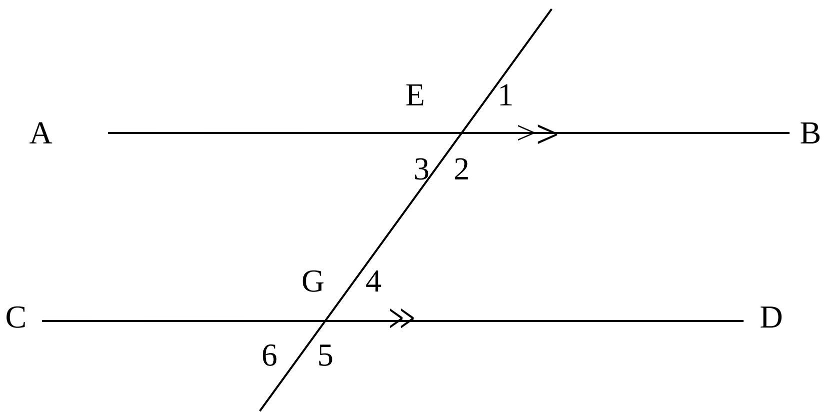
b) Opposite angles are equal

c) Only two opposite side are equal

d) Only two opposite are parallel

e) All angle are equal

1.15 AB is parallel CD and they are cut by a transversal line at E and G respectively.



Which one in the following answers is correct?

a) Ê3 and Ĝ4 are co-interior angles.

b) Ê3 + Ĝ4 = 180^0, sum of co-interior angles.

c) Ê3 = Ĝ6 corresponding angles.

d) Ê1 = Ĝ6, both equal to Ĝ5

e) Ê2 = Ĝ5 , alternate angles equal

QUESTIONNAIRE B

2. Please give your true response by making a tick (√) to all questions.

B1

2.1	**SCHOOL RELATED VARIABLES**	**Strongly Agree**	**Agree**	**Not Sure**	**Disagree**	**Strongly Disagree**
2.1.1	There are enough geometry textbooks for learners in the ratio 1:1 in my school.					
2.1.2	The school provides scientific calculators to learners.					
2.1.3	Each learner has a geometrical set of instruments.					
2.1.4	Using participatory learning approach in learning geometry enables learners to do their assignments with easy.					
2.1.5	Your school does have chalkboard set of instruments to make geometrical drawings					
2.1.6	Extra support from the educator influence learners' performance in Geometry.					
2.1.7	Lack of professional development of educators in geometry affects learner performance in geometry.					
2.1.8	My educator use to cultivate a positive environment that allows us to ask questions in geometry classes.					
2.1.9	Learning media like televisions make the learning of geometry easier.					
2.1.10	Educators' attitude towards geometry influence a learner performance.					

B2

2.2	HOME RELATED VARIABLES	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2.2.1	The family assist me with geometry home works and assignments.					
2.2.2	My parents afford to pay for extra tuition that helps me improve geometry.					
2.2.3	Parental attitude, ignorance and expectations influence learner performance in geometry.					
2.2.4	There is a good partnership between my parents and the schools.					
2.2.5	Culture contributes to learner understanding of geometry.					
2.2.6	The exposure of learners to negative role model influence learners' performance in geometry.					
2.2.7	Socio-economic status of the family influence the behaviour of the learners thus influencing their performance.					
2.2.8	The use of televisions at home in the learning of geometry influence learners' performance.					

B3

2.3	DEPARTMENT OF EDUCATION RELATED VARIABLES	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2.3.1	Constant change within the curriculum influence learners' performance in geometry.					
2.3.2	The use of ICT-based media has implications for learners' motivation in the learning of geometry.					
2.3.3	A delay on appointment of educators' impact negatively to learner performance.					
2.3.4	Transfers of educators to other schools affects teaching and learning of geometry.					
2.3.5	Saturday's or/and Winter school influence learner performance in geometry.					
2.3.6	System of promotions of learners in schools hamper the smooth acquisition of geometry knowledge.					

B4

2.4	LEARNER RELATED VARIABLES	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2.4.1	Anxiety and fear towards geometry influence learner performance.					
2.4.2	The background knowledge of learners from primary school influence learners' understanding.					
2.4.3	Psychological impact of the topic geometry influences learner's performance.					
2.4.4	Memorization helps in the learning of geometry					
2.4.5	Learners have mathematical instruments for drawings in geometry.					
2.4.6	One of the challenges with many geometry learners is their weakness in the language of geometry.					
2.4.7	Using Discussion methods in teaching geometry ensures learners grasp geometry concepts					
2.4.8	Using cooperative learning approach in teaching geometry ensures learners grasp geometry concepts					

APPENDIX B

Interview Schedule For Learners

Hello

My name is Musawenkosi Zamisa and I am conducting a research on the factors that influence learners' performance in Geometry.

I am pleased to meet you. I would like to ask you a few questions on the factors that influence learners' performance in Geometry.

1. What is it like to be in a geometry class?

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2. How would you describe your relationship with your geometry educator?

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3. How do you practice geometry in your spare time?

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4. Who is assisting you with geometry except your educator at school?

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5. Do you have Mathematics set of instruments?

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6. How is your school resourced in terms of the learning of geometry?

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7. What kind of support do you receive from your parents regarding your school work?

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8. Have you ever participated in any Saturday or winter classes in the past two years?

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9. How often do you get geometry homework?

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10. Do you have geometry textbook?

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THANK YOU FOR YOUR TIME !!!

APPENDIX C

Interview Questions Posed to Geometry Educators

Hello

My name is Musawenkosi Zamisa and I am conducting a research on the factors that influence learners' performance in Geometry.

I am pleased to meet you. I would like to ask you a few questions on the factors that influence learners' performance 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 an educator 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. How do you know that the teaching methods you use are effective?

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

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7. How does the second language complexity influence learner performance in geometry?

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8. Do you enjoy teaching geometry in grade 11?

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9. Do you receive any support from the subject head or the Head of Department?

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10. Have you furthered your educational levels beyond your teachers' training college educational level which you had already attained?

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THANK YOU FOR YOUR TIME!!!

APPENDIX D

Interview Schedule For Heads of Departments for Mathematics

Hello

My name is Musawenkosi Zamisa and I am conducting a research on the factors that influence learners' performance in Geometry.

I am pleased to meet you. I would like to ask you a few questions on the factors that influence learners' performance 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 in geometry?

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

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4. In what way does professional development of educators influence learner performance in geometry?

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

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6. What are the challenges that influence learners' performance in geometry?

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7. Does parent involvement improve learner 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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10. How do you manage the situation where a learner does not respect the educator?

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THANK YOU FOR YOUR TIME!!!

APPENDIX E

Interview Schedule for Principals

Hello

My name is Musawenkosi Zamisa and I am conducting a research on the factors that influence learners' performance in Geometry.

I am pleased to meet you. I would like to ask you a few questions on the factors that influence learners' performance in Geometry.

1. How do you ensure that teaching and learning improves learners' performance in geometry?

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

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3. How do you manage curricular issues to improve grade 11 geometry performance?

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4. What strategies do you use to ensure that mathematics HOD performs maximally to improve geometry performance?

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5. How does educator-pupil ratio (PPN) influence the learner performance in geometry?

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6. In your school, how many grade 11 mathematics learners are there in each class?

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7. How does the curriculum change influence learner performance in geometry in grade11?

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8. What are the strategies that you use to capacitate the grade 11 educators improve geometry?

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9. What role do parents play in ensuring better performance to the geometry learners?

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10. How do you ensure that an educator is adequately qualified to teach geometry even before he is appointed to your school?

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THANK YOU FOR YOUR TIME !!!

APPENDIX F

Verbatim Information on Interviews with learners

The interviews were conducted with two focus groups from two schools in the Umlazi District.

Interviewer: Good morning? 1

Respondents: Morning Sir. 2

Interviewer: Can we start now? 3

Respondents: Yes we are ready 4

Question 1

Interviewer: **How does it feel to do geometry in grade 11 class?** 5

L1ScA: It feels very difficult and frustrating to do geometry especially if you do not have good background knowledge of it. Those frustrations and complications have led them to hate geometry and they do not enjoy learning it at all. 6

L5ScB: Geometry is a very difficult and tricky section of mathematics if you do not have the basics of geometrical understanding. It calls for hard work and practice every day. 7

Question 2

Interviewer: **How would you describe your relationship with your geometry educator?** 8

L1ScA: Our educator is very good. He is not irritated if you ask questions. If you need more explanation, he can help you at his spare time. 9

L1ScB: Our relationship is very good with our educator because he is always available to encourage us to go an extra mile, even though geometry is difficult. 10

Question 3

Interviewer: **How do you practice geometry in your spare time?** 11

L5ScA: We use previous question papers. 12

L3ScB: Our educator use to give us previous question papers to practice geometry. 13

Question 4

Interviewer: **Who is assisting you with geometry except your educator at school?** 14

L5ScA: We have a study group. We help each other. 15

L3ScA: I attend classes organised by another school nearby. The educator there is willing to assist us. 16

L3ScB: Most of the time I am assisted by university learners who were doing geometry at high schools. 17

Question 5

Interviewer: **Do you have Mathematics set of instruments and when do you use them?** 18

L3ScA: We do have mathematics set of instruments but we don't always use them. 19

L1ScB: We use them when we draw figures and measuring the sizes of angles and lengths. 20

Question 6

Interviewer: **How is your school resourced in terms of the learning of geometry?** 21

L2ScA: Sometimes our educator make use of a computer when he wants to display a neat and accurate diagram. He would project it onto a wall so that we can all see. 22

L5ScB: Only textbook and an educator. 23

L3ScB: We only use the textbooks and since the school does not have computers and internet. We cannot google and get more and wider knowledge of geometry but after school I use to go to the community library for free Wi-Fi because there is a lot of information online 24

Question 7

Interviewer: **What kind of support do you receive from your parents regarding your educational matters?** 25

L2ScA: Most of our parents unfortunately did not finish their school themselves and some did not even do geometry when they were still at school. Therefore, they struggle with geometry home works and eventually get angry. 26

L5ScB: Some of us are raised by grandmothers who are not working. We only survive on their government pensions. However, those who still have parents, the majority of them are not working neither. There is no income. Therefore, we really struggling when it comes to financial issues. 27

Question 8

Interviewer: **What can you say about your perception of geometry?** 28

L3ScA: It is very confusing. We can only understand it if there is a diagram given to refer. 29

L15ScB: It is very tricky. Difficult concepts to understand. 30

Question 9

Interviewer: **How often do you get geometry home works? Do you cope with them?** 31

L5ScA: We get home works almost every day. 32

L2ScA: We try to do them together after school. 32

L5ScB: Every day. Yah, we cope at times. 33

Question 10

Interviewer: **If you were to be given another opportunity to choose subject combinations like you did in grade 10, would choose the combination with mathematics where you will do geometry?** 34

L2ScA**:** I would change and take Mathematics Literacy because I don't like geometry. 35

L1ScB: Geometry does not only teach you to calculate and measure but it also teaches how to manage your life on the outside world. Mathematics helps with the understanding of getting the solutions to the problem in general. 36

APPENDIX G

Verbatim Information on Interviews with Educators

Interviewer: Good morning? 37

Respondents: Morning Sir. 38

Interviewer: Can we start now? 39

Respondents: Yes we I am ready 40

Question 1

Interviewer: Learners tend to experience problems in understanding geometrical concepts such as angles, quadrilaterals, theorems etc. How can we turn the situations around? 41

EdScA: I would focus on ensuring that the previous work and concepts done in lower classes is revised. I would address the issue of the lack of previous knowledge. 42

EdScB: I would fill the gaps and lay a proper foundations so that I can build on that. The exposure to geometry in lower classes is not properly founded. Once if they can get basics right, things would change. 43

Question 2

Interviewer: One of the problems with many geometry learners, is their weakness in the language of geometry. What can we do to improve this situation? 44

EdScA: Yes, language of geometry is a barrier in the learning of geometry. I would start by being indirect. I would simplify it by incorporating ICT in the teaching of geometry. Integrating ICT programme with other teaching methods would make the learning of geometry interesting. Exposing learners to visual study. 45

EdScB: Yah, English as a second language will always cause a problem. We can improve by making simple, straight forward language that is straight to the point. 46

Question 3

Interviewer: Geometry riders tend to combine several figures like triangles, circles, rectangle etc. What methods can an educator use to assist learners to see relationships of these figures? 47

EdScA: I would divide the theorem into broken aspects. Create an investigation that will lead a learner to discover the truth from the theorem. 48

EdScB: When you teach geometry given a combination of theorems in one figure, an educator must break it into parts rather than looking at it holistically. Check what the learners know and expand from it when going to the entire question. 49

Question 4

Interviewer: What strategies would you use to develop a clear understanding of the application of a theorem? 50

EdScA: I would look at the basic fundamental understanding of learners that are part of the theorem. I would let learners investigate each and every concept up until they find the conclusion. 51

EdScB: When I teach theorems, I usually say to learners, let them calculate. After their calculations I go back and say let us make sense of our answers from their random calculation. It is when I make aspect to a theorem. 52

Question 5

Interviewer: How do you know that the teaching methods you use are effective? 53

EdScA: The only way to measure whether the outcome is being achieved, is by assessment. When learners perform better in the assessment, it shows that the teaching methods were effective. 54

EdScB: It would be judged by the responses of the learners being able to do the required task. I teach and give them exercise to check their level of understanding. The assessment tells you if what you taught was understood or not. 55

Question 6

Interviewer: What learners support materials would educators use to simplify mastery of geometrical concepts? 56

EdScA: I use a well prepared worksheets. A worksheet that is user-friendly. A worksheet must guide a learner from the known to the unknown. 57

EdScB: Making use of programme sketchpad makes it easy to do drawings. I also use highlighters to mark to indicate similarities and differences in a given figure. 58

Question 7

Interviewer: How does the second language complexity influence learner performance in geometry?

EdScA: Language of geometry has nothing to do with the concepts of geometry. I never see language being a barrier to geometry. 59

EdScB: Learners struggle to understand geometrical concepts. They spend much time trying to understand what is being asked and make sense of it. 60

Question 8

Interviewer: Do you enjoy teaching geometry in grade 11? 61

EdScA: Absolutely yes I enjoy it. I like it. It geometry a very interactive study. 62

EdScB: To be honest, I am not comfortable with geometry. I use to get someone to do that section for me. 63

Question 9

Interviewer: Do you receive any support from the subject head or the Head of Department? 64

EdScA: I do receive enough support. 65

EdScB: Most support is from the subject advisor. He is the one who organise workshop and give us the teaching materials. 66

Question 10

Interviewer: Have you furthered your educational level beyond your educators' training college educational level which you had already attained? 67

EdScA: I obtained my Bed in 1998 and after that I did my Bed Hons that I completed in 2006. I was demotivated by the fact that even if you further your studies, you don't get more money, you don't get promotions at the end. 68

EdScB: No, I had never upgraded myself, I don't have money and time to do that. 69

THANK YOU FOR YOUR TIME!!!

APPENDIX H

Verbatim Information on Interviews with Heads of Department

Interviewer: Good morning? 70

Respondents: Morning Sir. 71

Interviewer: Can we start now? 72

Respondents: Yes I am ready 73

Question 1

Interviewer: How do you encourage learners to perform better in geometry? 74

HODScA:I use to say to my learners practice makes perfect. When they practice geometry, they will eventually master certain concepts of geometry and improve. 75

HODScB: It is all about practice, practice, and practice using lots of past question papers.Leaners should also encourage their parents to be involved to their learning practices because parents are distancing themselves from school activities. It is not that they are illiterate but they don’t want to take a responsibility of their children’s education. 76

Question 2

Interviewer: In what ways do you influence mathematics educators to improve learners’ performance in geometry? 77

HODScA: There are school based workshops organized by my department which look into addressing challenges that geometry educators are experiencing. I network and invite best performing geometry educators from other schools to come and capacitate my educators. 78

HODScB: I send them to workshops set by the department of education. I always encourage them to go to workshops because of the depth of information they might get there when experienced educators cascade it. 79

Question 3

Interviewer: What are the challenges you experience in managing educators who teach geometry? 80

HODScA: Bad attitude towards geometry. 81

HODScB: When I do the staffing plan, some educators hardly accept the duty loads with grade 11 mathematics because of geometry embedded in it. 82

Question 4

Interviewer: In what way does professional development of educators influence learner performance in geometry? 83

HODScA: Some learners come to me complaining that other educators do not unpack geometry well enough such that it is easily grasped. I develop that educator on the teaching strategies that he/she can use 84

HODScB: As we have IQMS for teacher development, we look at the performance standard where an educator has a challenge and develop them around that area. It improves the level of content knowledge of an educator. 85

Question 5

Interviewer: How would you rate the performance of learners in geometry as compared to other sections like algebra/ trigonometry? 86

HODScA: In my school learners perform better in geometry as compared to other sections, the reason being that we teach them concepts thoroughly in grade 10. 87

HODScB: Yah, the performance in geometry in my school is always poorer. Learners would say paper 1 was okay but paper 2 was a bit difficult. 88

Question 6

Interviewer: What are the challenges that influence learners' performance in geometry?

HODScA: Socioeconomic issues contribute to poor performance of these learners. They don't get proper guidance where live. Some learners do not stay with their parents, there are no good role models in the area, no job opportunities, bad parental attitudes and beliefs and a failure to receive positive career counselling. 90

HODScB: I think some learners have attitude towards geometry. They just don't like it. They feel it is difficult. 91

Question 7

Interviewer: Does parent involvement improve learner performance in geometry? 92

HODScA: Their parents are not supportive. Learners would be performing better should there was a strong connection and partnership between them and the school. 93

HODScB: Parents do not have a clue of geometry, unless they are educated. Most did not do it themselves. They do not know how they can assist their children with geometry. In addition, parents criticize their children for not being good in geometry. They are the once that lead to learners hating geometry. 94

Question 8

Interviewer: Are there any ways in which learners can learn and grasp geometrical concepts with ease? 95

HODScA: Visualisation is the way learners can master and grasp geometry because they can see what an educator is talking about. 96

HODScB: I think their background knowledge is letting them down. I think an educator should fill the gabs and lay a proper foundation so that he can build on that. 97

Question 9

Interviewer: Is there anything else you would like to tell me which could a cause of poor performance in the grade 11 geometry learners? 98

HODScA: Yes, geometry educators in the secondary schools should not work in isolation. There should be a connection and teamwork between GET educators and FET educators so that there is continuity and expansion of knowledge to the learners as they move to high grades. 99

HODScB: Yes, educators of geometry need to be trained and developed on how to teach geometry effectively. There is a lack of professional development of geometry educators in our District. 100

THANK YOU FOR YOUR TIME!!!

APPENDIX I

Verbatim Information on Interviews with the Principals

Interviewer: Good morning? 101

Respondents: Morning Sir. 102

Interviewer: Can we start now? 103

Respondents: Yes, I am ready 104

Question 1

Interviewer: How do you ensure that teaching and learning improves learners' performance in geometry? 105

PriScA: Firstly, by making sure that educators are in class teaching and learners learning. Also by making sure learners have all necessary resources like textbooks, worksheets etc. to make learning effective. My core responsibility as a principal is a smooth running and the overall functioning of the school. I supervise educators, evaluate their performance, assign them to classrooms, create teaching schedules, provide them with necessary resources and make recommendations. 106

PriScB: We do so by organising extra classes. 107

Question 2

Interviewer: How do you encourage HOD to motivate geometry educators? 108

PriScA: We encourage HODs to be available to educators for support at all times. 109

PriScB: In our school we have an incentives of R1000 should an educator get 100% in subjects like Mathematics. 110

Question 3

Interviewer: How do you manage curricular issues to improve grade 11 geometry performance? 111

PriScA: We make sure that educators via the HOD do go to workshops and trainings where current issue are discussed. It is important for educators to attend those workshops in order to know what to deliver in the classroom and to be sure what is taught is in line with the guidelines of mathematics. 112

PriScB: We normally require educators to submit ATPs to check the work coverage. 113

Question 4

Interviewer: What strategies do you use to ensure that mathematics HOD performs maximally to improve geometry performance? 114

PriScA: We make sure that we network with the best performing schools and also by getting the assistance from the subject advisor. 115

PriScB: When an HOD does the duty loads, he must consider carefully the strengths and qualifications of educators. The educator must have measured in mathematics in order to teach geometry. 116

Question 5

Interviewer: How does educator-pupil ratio (PPN) influence the learner performance in geometry? 117

PriScA: It has a huge negative impact. Educators are unable to do individual attention because of the number of learners have. Unfortunately my school cannot afford to get an SGB paid educator to reduce the loads of educators. 118

PriScB: If there are more learners than educators, obviously teaching and learning will be affected because educators would not be efficient enough in an expected level. 119

Question 6

Interviewer: In your school, how many grade 11 geometry learners are there in each class? 120

PriScA: Tjoo! The average number of learners is 60 in one class. Actually this number tells that we are supposed to have two classes but because of the lack of floor space, we had no choice but to combine learners into one class. However, this number not conducive to effective teaching and learning. 121

PriScB: Average of 50 per class which is not conducive to teach geometry effectively. 122

Question 7

Interviewer: How does the curriculum change influence learner performance in geometry in grade11? 123

PriScA: Very few content based workshops organised but I encourage educators to attend workshops because the types of questioning techniques and the manner of teaching strategies has changed. We hope that the depth of information they might get there when experienced educators cascade it can help the learners because some learners are not ready and adapted to these kind of techniques. 125

PriScB: In our school, educators do not have much of the problem. They are in line with what is happening because of the workshops they attend. 126

Question 8

Interviewer: What are the strategies that you use to capacitate the grade 11 educators improve geometry? 127

PriScA: They go workshops and when they come back they cascade that information the HOD

PriScB: Educators go to workshops. 128

Question 9

Interviewer: What role do parents play in ensuring better performance to the geometry learners? 129

PriScA: "Ideally every parent is supposed to monitor the work of his child but sadly, our parents do not check the work. In the case of a learners not staying with parents, someone from the family must do that on their behalf". 130

PriScB: We really encounter a lot of problems when it comes to parents' involvement. Our parents are very ignorant. They are not supportive. They just don't care what is happening with their children at school. 131

Question 10

Interviewer: How do you ensure that an educator is adequately qualified to teach geometry even before he is appointed to your school? 132

PriScA: Before the educator is appointed, the department of Education checks the qualifications. Over and above our school verifies that indeed an educator does have those qualifications. 133

PriScB: We interview the educator. We also check the level of competence and the degree of his content knowledge by taking him to the classroom and give him a chance to teach a certain concept. 134

THANK YOU FOR YOUR TIME!!!

School Letters

27 Bramcote Road
Cato Manor
4091
15 September 2018

The Principal School

Sir / Madam

REQUEST FOR CONDUCTING A RESEARCH AT YOUR SCHOOL

I am Musawenkosi Zamisa, a Master student at the University of KwaZulu-Natal. I have chosen your school to conduct a research on the performance of learners in Geometry. The topic of my study is: Exploring the factors influencing grade 11 learner performance in geometry in two high schools in the umlazi district. I am kindly requesting your mathematics educators, learners and a principal to participate in the study. The purpose of the study is to understand underlying factors leading to the decline in learner performance in geometry in high schools.

The study will focus on home based, school based and Department of Education based factors. All information gathered shall be completely confidential and anonymous. No names or the name of the institution will be disclosed. The data will be generated through questionnaires and semi structured interviews at the time that is convenient to the participants.

For more information and questions about the study, you are free to contact me at: Cell: 0795298006/ 0837935080 or Email: musazamisa5@gmail.com

My supervisor: Prof. V. Mudaly Tel: (031) 260 3534 or Fax: (031) 260 1598 or Email: mudalyv@ukzn.ac.za
Co-supervisor: Ms. E. Dowlath Tel: (031) 260 3534 or Fax: (031) 260 1598 or Email: dowlath@ukzn.ac.za

Yours Faithfully

Mr. PM Zamisa

P.O. Box 3051 1
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Tel: (031) 264 1744
Fax: (031) 264 1694
E-mail:
chestervilleext.sec@gmail.com

UMKHUMBANE SECONDARY SCHOOL

17 September 2018

To Whom It May Concern

This note serves to confirm that Mr P.M Zamisa who is currently doing his Masters Degree with the Ukzn has been granted permission to use our school as his research site.

Yours faithfully

UMKHUMBANE SECONDARY SCHOOL

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CHESTERVILLE

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4091
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Principal: N,B, Ngobese,
Deputy Princípal Administration: W.S ,Makhoba,
Deputy Principai Academic: C.B. Gumede,

WIGGINS SECONDARY SCHOOL

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261 2237 Fax No.: 261 2238
Cell phone: 0829281010

16 / 09/ 2018

The University of KwaZulu-Natal
School of Humanities
Edgewood Campus

Sir/ Madam

We, at the above mentioned school received an application from Mr. PM. Zamisa who is doing a Master's degree at UKZN this year (2018). We understood the content of his research study and confirm that the school is granting him a permission to conduct his study at this school.

Thank you

Yours sincerely

.... School

Mrs MP Sithole

Principal

KZN DEPT. EDUCATION & CULTURE
WIGGINS SECONDARY SCHOOL
School Stamp
P.O. BOX 30942, MAYVILLE 4058
TEL: 031 261 2237 FAX: 031 261 2238

Ethical Clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

1 October 2018

Mr Paulos Musawenkosi Zamisa 981191975
School of Education
Howard College Campus

Dear Mr Zamisa

Protocol reference number: HSS/1216/018M
Project title: **An investigation of the factors that influence learner performance in Geometry in two high schools in the Umlazi District**

Full Approval — Expedited Application In response to your application received 16 August 208, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted FULL APPROVAL.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....

Professor Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committe

EXPLORING THE FACTORS INFLUENCING GRADE 11 LEARNER PERFORMANCE IN GEOMETRY IN TWO HIGH SCHOOLS IN THE UMLAZI DISTRICT

ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Mzomwe Yahya Mazana, Calkin Suero Montero, Respickius Olifage Casmir. "Investigating Students' Attitude towards Learning Mathematics", International Electronic Journal of Mathematics Education, 2018 Publication	<1%
2	Yen-Ruey Kuo, Hsiao-Lin Tuan, Chi-Chin Chin. "The Influence of Inquiry-Based Teaching on Male and Female Students' Motivation and Engagement", Research in Science Education, 2018 Publication	<1%
3	E. Mechlova, M. Malcik. "ICT in changes of learning theories", 2012 IEEE 10th International Conference on Emerging eLearning Technologies and Applications (ICETA), 2012 Publication	<1%
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Date: 09 September

To whom it may concern

This is to certify that the Master's Dissertation: Exploring the Factor's Influencing Grade 11 Learner Performance in Geometry in Two High Schools in the Umlazi District written by Paulus Musawenkosi Zamisa has been edited by me for language.

Please contact me should you require any further information.

Kind Regards

Angela Bryan

angelakirbybryan@gmail.com

0832983312