Exploring the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry

Xoliswa Dlamini

(209504923)

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Supervisor: Prof Jayaluxmi Naidoo

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# ABSTRACT

This research study explored challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. This research study was conducted in a school situated in the city of Pietermaritzburg, KwaZulu-Natal, South Africa to understand factors that shape learner's experiences towards learning angles associated with parallel lines in geometry. This research study was framed within the social constructivist theory which guided and examined the systematic explanation of the experiences of Grade 8 learners when learning angles associated with parallel lines in geometry, by following certain principles outlined by the social constructivist theory. This research study was situated within the interpretivist paradigm and focused on an explanatory qualitative case study to, explore learners' experiences and get an in- depth understanding of the challenges they are experiencing when learning angles associated with parallel lines in geometry.

This research study used inductive data analysis and evaluation process to sort data generated from the 36 purposely selected Grade 8 learners. The process of data analysis and evaluation was done through the use of Curriculum Assessment Policy Statements (CAPS document), questionnaire, worksheet and the semi-structured interview schedule. The findings of this research study confirmed that there are challenges experienced by 8 learners when learning angles associated with parallel lines in geometry. It was recommended that this research study be conducted at a larger number of diverse schools across the country, to explore more challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

DECLARATION

The work described in this research study was conducted under the School Education at the University of KwaZulu-Natal from February 2018 to January 2021, through the supervision of Professor Jayaluxmi Naidoo. The original work presented by the author of this research study has not otherwise been submitted in any other form for any degree or diploma to any tertiary institution and where there was a use of the work of other scholars, it was duly acknowledged within the text.

[redacted]

02 July 2021

Xoliswa Dlamini **Date**

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Professor J. Naidoo **Date**

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I just want to thank God for loving me, it has been a very difficult journey. I lost my father "TIDDO" who always pushed me to be the best of the best. After my father, we then lost our grandfather while we were still mourning and again, we lost our only uncle who was always there for us from day one when our father passed on. Just like everyone, I experienced lot of challenges in everywhere of my life including coming from my death bed due to Covid-19. Through it all, God has never left me and was using everyone to push me and believing in me. This journey was driven by the book of Romans 8:28 from the Bible which reads: "And we know that God causes everything to work together for the good of those who love God and are called according to his purpose for them". This book reminded me that everything that was happening and will still be happening, works together for my good. I would like to further extend words of gratitude to the following people for playing a very important role in this research study:

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TABLE OF CONTENTS

CHAPTER 3

CHAPTER 4

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This research study sought to explore challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. Furthermore, this research study was conducted to respond to the research questions that motivated carrying out this research study. This chapter aims to discuss the purpose, provides a full description of the background of this research study and the objectives of this research study. It further presents the problem statement, rationale and the definition of the necessary concepts of this research study. This chapter concludes with a summary of the overview of the thesis.

1.2 BACKGROUND AND THE PROBLEM STATEMENT

This research study was motivated by the continuous declaration of poor mathematics performance in South Africa and the label of being among the worst mathematics performance in the world (Jojo, 2019). According to Malatji (2019), the high failure rate attained by South Africa is of great concern as learners of South Africa are regarded to be incompetent in mathematics. This regard limits opportunities for learners to access and complete University and weakens the labour force of the country (Nogozo, 2019).

This research study then looked at one of the topics within mathematics that is leading to a high failure rate, which is geometry (Yudianto, 2018). This research study explored the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry because, learners experience so many challenges and have poor understanding of geometric concepts which leads to poor performance (Bot, 2018). Furthermore, geometry is considered to be the most challenging and difficult concept in mathematics (Naidoo, 2020). According to the Further Education and Training Annual Teaching Plans, geometry contributes 66,6% of the mathematics examination paper 2. This acknowledged that learners can improve their overall mathematics performance if they have better meaning and understanding of their geometric concepts.

It was for these reasons that this research study explored the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in order to find solutions in understanding how and why learners are experiencing these challenges.

1.3 LOCATION OF THE STUDY

This research study was situated in one of the schools in the Umgungundlovu district situated in Pietermaritzburg, KwaZulu-Natal, South Africa.

1.4 RATIONALE FOR THE STUDY

The Report from the National Senior Certificate Diagnostic Report Part 1 of 2019 outlined that, there is a decline of performance in mathematics. This was noted when the achievement of the first two entry levels of passing mathematics which are Level 2 and Level 3 declined in the year 2019. This decline indicated that, there are challenges in learning of mathematics. This is evident from Table 1.1 which shows the decline in comparison from previous years.

Table 1.1: Overall achievement rate in Mathematics adapted from the report on the National Senior Certificate Diagnosis Part 1 of 2019, Department of Basic Education (2019, p. 177)

YEAR	No. Wrote	No. Achieved at 30% & above	% Achieved at 30% & above	No. Achieved at 40% & above	% Achieved at 40% & above
2015	263 903	129 481	49,1	84 297	31,9
2016	265 912	136 011	51,1	89 119	33,5
2017	245 103	127 197	51,9	86 096	35,1
2018	233 858	135 638	58,0	86 874	37,1
2019	222 034	121 179	54,6	77 751	35,0

According to the National Diagnostic Report 2019 for the pass percentage of 30%, learners' performance was 58% in 2018 and declined to 54, 6% in 2019. The pass percentage of 40% achieved by learners also declined from 37, 1% in 2018 to 35% in 2019.

The National Diagnostic Report stated that, some of the reason behind the decline in learner performance in mathematic according to the Department of Basic Education (2019, p. 177) are:

1. A lack of understanding of basic concepts across some topics in the curriculum.
2. Learners are not exposed to the complex and problem solving questions across all topics from the curriculum of the earlier grades.

The report further outlined that in geometry, learners are experiencing the following challenges (Department of Basic Education 2019, p. 200-201):

1. There is less time allocated on the teaching of Euclidean geometry in all grades.
2. Teachers are not covering the basic work thoroughly.
3. Learners are not accompanying statements with reasons.
4. Learners are incorrectly writing or giving incomplete reasons or naming angles incorrectly.
5. Learner's show poor understanding of angles associated with parallel lines where they fail to mention that corresponding angles are equal, alternate angles are equal and the sum of the co-interior angles is 180^0.
6. Learners cannot differentiate between alternate and corresponding angles.

These findings were used as the basis to further study challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. When you study the national diagnostic report, it indicates that most of the challenges learners experience when writing their final National Senior Certificate examinations are as a result of the challenges that were not dealt with in the earlier grades (Department of Basic Education, 2019). Since this research study is exploring challenges experienced by learners when learning angles associated with parallel lines in geometry, it was important for the researcher to outline what is expected from the teacher and the learner during the process of teaching and learning. This research study is supported by Good and Lavigne (2017) when they stated that for a successful process of learning in a classroom situation, a teacher must be fully aware that in a classroom situation there is diversity. Learners are individually unique and possess different levels of capabilities in terms of learning abilities.

According to the Guidelines to diversity by Department of Basic Education (2011, p. 2), when teaching and learning is taking place:

- There must be an understanding of diversity within the classroom.
- There must be an understanding that people are unique in their own way.
- There must be an observation that learners come from different socio-economic, language, cultural, religious, ethnic, racial, gender, sexual orientation, ability groups etc. All these learners come to school with different experiences and one purpose, to learn.
- Curriculum differentiation delivery must be ensured in order to enable access to learning for all.
- There must be a variation of approaches used for the delivery of content to accommodate all learners.

This is why this research study was framed within the social constructivist theory as supported by Piaget (1967) and Bruner (1996). Vygotsky (1978) also mentioned that there are three categories of problem solving abilities which emphasised the notion of the possibility of different kinds of learners that are found in the classroom situation. In order to understand how learners are learning angles associated with parallel lines in geometry and how they are experiencing challenges when learning angles associated with parallel lines in geometry, this research study was supported by the theory of social constructivist theory because one of the successful aspects of learning is through social interactions within the classroom and outside the classroom (Engelbrecht, 2015). A teacher is expected to be fully aware that every learner in a classroom context is unique and possesses his or her own level of capacity in terms of learning abilities (Good, 2017). This means that, there must be learner-teacher and learner to learner interaction in a classroom situation.

1.5 PURPOSE OF THE STUDY

The results found from this research study are expected to help all stakeholders to recognise the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. The purpose of this research study is three fold. The first part is to explore challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. The second part is to explore how Grade 8 learners experience challenges when learning angles associated with parallel lines in geometry. The third part is to understand the reasons resulting in Grade 8 learners experiencing challenges when learning angles associated with parallel lines in geometry.

In this research study the importance of prior knowledge, socio interactions, anxiety and attitude towards mathematics was included as an underlying factor that influences learners to experience challenges when learning angles associated with parallel lines in geometry.

This research study aspires to provide an in-depth insight into the experiences of Grade 8 learners and the challenges they experience when learning angles associated with parallel lines in geometry. Furthermore, this research study aims to respond to the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

1.6 OBJECTIVES OF THE STUDY

The objectives of this research study are:

a) To explore challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

b) To examine how Grade 8 learners experience challenges when learning angles associated with parallel lines in geometry.

c) To understand why Grade 8 learners experience challenges when learning angles associated with parallel lines in geometry.

1.7 RESEARCH QUESTIONS

Research questions addressed by this research study are twofold:

1. What challenges do Grade 8 learners experience when learning angles associated with parallel lines in geometry?
2. How and why do Grade 8 learners experience challenges when learning angles associated with parallel lines in geometry?

1.8 RESEARCH METHODS

This research study intended to explore challenges experienced by Grade 8 learners when learning angles associated with parallel lines.

1.8.1. Research Paradigm

This research study was situated within the interpretivist paradigm in order to consider multiple viewpoints and experiences of different individuals from different social backgrounds (Paul Victor, 2016). This research study was framed within the ambits of the social constructivist theory in order to understand learner's challenges through their social experiences and their social interactions(Bull, 2013).

1.8.2. Research Approach

A qualitative research approach was used in this research study because, the researcher wanted to understand the experiences of learners and uncover their reality during the process of teaching and learning (Chen, 2016). This qualitative research approach employed a case study methodology in order to generate data and used Yin's (2009) 6 stages of the processes for a case study research methodology.

Research Sampling

This research study used a purposive sampling method so as not to generalise the findings to a wider population (Barratt, 2015). A reviewed research traditions table (Gentles, 2015) was used to guide the selection process for the sampling.

Data Collection

Data collected in this research study was qualitative in nature and was collected from learners' experience through 4 data collection instruments.

- **Curriculum Assessment Policy Statement Document (CAPS Document)**

The curriculum Assessment Policy Statement document was used to check what learners need to know for the current grade, their existing knowledge and what is expected to be covered for the gradual movement as they learn about the angles associated with parallel lines in geometry.

- **Questionnaire**

A Questionnaire was used to obtain the profile of learners and information concerning their prior knowledge (see appendix F).

- **Worksheets**

All participants were assessed in order to ascertain their level of understanding of angles associated with parallel lines in geometry. These worksheets were used to identify the challenges learners were experiencing when learning angles associated with parallel lines in geometry individually and amongst other learners in a form of group work (see appendix G & H).

- **Semi-structured interview**

A semi- structured interview was used in order to attain a flexible two way communication between the researcher and the participant (Pathak, 2016) (see appendix I). Participants were given an opportunity to explain their responses, experiences and perceptions freely. Interviews were recorded by the use of a voice recorder and all participants provided permission to be recorded (see appendix C).

Data Analysis

An inductive data analysis process was used in this research study through the guiding procedures of a data evaluation process table method as outlined by Naidoo (2018).

Ethical Consideration

Ethical Consideration is briefly discussed in Chapter 4 and the following were outlined:

- Gate keeper's permission was granted (see appendix D).
- Approval from the University of KwaZulu-Natal to conduct this research study was obtained and a protocol reference number was given (see appendix E).
- Informed consent was provided to both learners and parents/guardians (see appendix B & C).

- Confidentiality was maintained and participants were assured of their anonymity through the use of pseudonyms.
- Right to withdraw without fear of academic exclusion was explained to the participants.
- Assessing risk of harm was implemented to ensure non-maleficence.
- Deception in this research study was avoided.
- Debriefing was done prior to the implementation of the study and throughout the research study.
- Worksheet and Interview questions were piloted.
- Honesty and Integrity in this research study were maintained.

1.9 DEFINITION OF THE CONCEPTS USED IN THIS RESEARCH STUDY

In this study, there was use of various terms that could have different contextual meanings, or could be written differently. For these reasons, the researcher provided explanation of the meanings of these terms within the context of this research study.

Geometry

According to Naidoo and Kapofu (2020, p. 2), geometry involves learning about the geometric properties (points, lines, planes, angles, different shapes and dimensions) of a figure that do not change when the figure is revolved or transformed.

Learning in mathematics

This research study was framed within the ambits of the social constructivist's theory which defines learning as the process of mental construction whereby learners construct their new knowledge, meaning and understanding onto an existing constructed knowledge, meaning and understanding (Bozkurt, 2017). Learning mathematics is a process where learners are placed in a problem solving situation to solve and create solutions that are not immediately obvious to deepen their own meaning and understanding (Permatasari, 2016).

Levels of geometric thinking

This research study aimed to explore the level of learners' geometric thinking based on van Hiele's theory. The van Hiele's theory of the levels of geometric thinking suggest that learners experience geometric learning progress through numerous levels (Recognition/ Visualisation, Analysis, Abstraction, Deduction and Rigor) of geometric thinking in order to understand why many learners experience challenges in geometry.

Basic knowledge and skills

Geometry equips learners with certain abilities of knowledge and basic skills that play an important role in mathematics' learning and performance (Hawes, 2019). This basic knowledge and skills involves critical thinking skills and problem solving skills which are an essential part of learning geometry in mathematics.

Misconceptions

Ay (2017), defines misconceptions as a kind of misunderstanding and misinterpretation which is derived from inaccurate meanings. Misconceptions can emerge from any incorrect existing knowledge to newly introduced knowledge, hence it is important to assess leaners' prior knowledge before introducing new concepts.

Language Barrier

In this research study the language barrier is the inability to understand the language used by the teacher which causes learners to experience confusion and misconceptions when learning (Cheok, 2017). In most cases, the language used in a classroom situation is not the learners' mother tongue language but is according to the stipulations by the Department of Education. This is an additional factor that could lead to the language of instruction being a barrier to successful teaching and learning.

Visualisation

According to Thohirudin, Maryati and Dwirahayu (2017), visualisation gives learners opportunities to observe different transformations of diagrams and enhance their geometric abilities. Learning of geometric concepts must incorporate technology (Sfiso, 2017) which allows learners to interact with the teacher and one another which supports learners to explore what is learnt on their own abilities (Thohirudin, 2017).

1.10 STRUCTURE OF THE THESIS

This research study is organised according to the following 6 chapters:

Chapter 1 – Introduction: Chapter 1 introduces the reader to the background of this research study and highlights the significance of understanding Grade 8 learners' challenges when learning angles associated with parallel lines in geometry.

This chapter also presents the significance of learners deriving knowledge and understanding on their own through social interactions. The rationale for conducting this study, the purpose, specific objectives, research questions and relevant definitions for this study are outlined in this chapter.

Chapter 2 – Literature Review: Chapter 2 presents writings that address challenges learners' experienced and explores the necessary skills and strategies for learning angles associated with parallel lines in geometry. The literature associated with the history of geometry and its concepts is also presented in this chapter. This research study also focused on the learning of mathematics, the geometry curriculum for Grade 8 learners and angles associated with parallel lines in geometry and the importance of the gradual movement, levels of geometric thinking, basic knowledge and skills, misconceptions, language barriers and the importance of visualisation when learning angles associated with parallel lines in geometry.

Chapter 3 –Theoretical Framework: This chapter looked at the theory that was related to the exploration of the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. The social constructivist theory was discussed in detail which included how this framework framed this research study.

Chapter 4 –Research Methodology: This chapter presented in detail the empirical processes for this research study. The selected research methodology for this research study was outlined and included research design, sampling procedures, data collection methods, data collection instruments, data processing, data analysis procedures, ethical considerations and issues of validity and trustworthiness. In addition, the limitations of this study are also included in this chapter.

Chapter 5 –Data presentation, analysis and discussion of the findings: This chapter introduces raw data collected and analysed data by the use of tables, the reviewed literature and the selected framework for this research study.

Chapter 6 – Findings, discussions, conclusion, limitations and recommendations: This chapter summarises the purpose of this research study, methodology used for this research study and presents the summary of the main findings which respond to the research questions. A discussion of significant research findings, limitations, recommendations and the conclusion is included in this chapter.

1.11 CONCLUSION

In this chapter, introduction, background and the problem statement of this research study is presented. Furthermore, this chapter outline the location of the study, rationale, purpose, objectives, research questions, research methods, definitions of the concepts used that guided this research study. In addition, this chapter briefly highlighted the structure of this thesis. The next chapter focusses on the literature review that guided this research study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In Chapter 1, the researcher presented the purpose of the study, provided a full description of the background of the study and the objectives of the study. Furthermore, Chapter 1 presented the problem statement, rationale, definition necessary concepts of this research study and concluded with a summary of the overview of the thesis. Chapter 2 seeks to present the review of the literature done by other scholars on learners' challenges in the learning of angles associated with parallel lines in geometry. South Africa has been labelled as one of the countries that has the worst education system in comparison with other developing countries, particularly in Africa (Cloete, 2016).

The Department of Basic Education has been revising and implementing policies to improve the education system in South Africa. In 2005, the National Curriculum Statement was revised and implemented in order to improve the education system in South Africa (Spaull, 2015). In 2012, Curriculum Assessment Policy Statements (CAPS) was implemented subsequent to the Annual National Assessments (ANA) which was implemented in 2011 to standardise assessments in schools (Kallaway, 2012). In addition to all these implementations and revisions of policies, South Africa has been also participating in various international tests such as the Trends in International Mathematics and Sciences Study (TIMSS) (Moodley, 2013). According to researchers in the field (Alex, 2017; Moodley 2013; Spaull, 2013), the findings from the Annual National Assessments (ANA) and the Trends in International Mathematics and Sciences Study (TIMSS) indicated that South Africa has the lowest performance in both Mathematics and Science and thus reveals that South African learners are not competent with respect to the level of testing.

It is for these above-mentioned reasons that the conducting of this research study was to discover the challenges that learners experience when learning mathematics specifically angles associated with parallel lines in geometry. The focus of this study is on the challenges learners experience when learning angles associated with parallel lines in geometry.

There are numerous research studies done on geometry focusing on different content to improve teaching and learning of geometry (Bokosmaty, Sweller & Kalyuga, 2015; Casa, Fermender, Gavin & Carroll 2017; In'am & Hajar, 2017; Moss, Hawes, Naqvi & Caswell 2015; Mulligan, 2015; Sinclair & Bruce, 2015).

Other studies have focused on mathematics where researchers focus on the language of learning mathematics (O'Halloran, 2015), teaching and learning mathematics (Bryant, 2016, Furner, 2017, & Goos, Vale, & Stillman, 2017), improving the pass rate in mathematics (Bakri, 2017).

However, limited studies have been done around the challenges Grade 8 learners experience when learning angles associated with parallel lines in geometry. Hence, this research study closes the gap by engaging in critical arguments by other scholars in relation to the literature on learning of mathematics at school level, geometry within the Grade 8 curriculum, learners' misconceptions on geometry, the levels of geometric thinking, learners' perception of concepts in geometry, language as a learning barrier when learning geometry in mathematics, exploring basic knowledge and skills in geometry and visualisation used to promote the understanding of concepts in geometry.

2.2 THE LEARNING OF MATHEMATICS AT THE SCHOOL LEVEL

According to Qvortrup, Wiberg, Christensen and Hansbol (2016), a learner is someone who can learn individually and from others in different ways in order to acquire knowledge and understanding of certain things and the world at large. In addition, learning involves transformation of knowledge, beliefs and how one sees things in order to behave differently than before (Kalule, 2016). Furthermore, learning depends on the knowledge learners possess with the help of a more knowledgeable other teacher or any other (Τσώνη, 2020). The effectiveness of learning can be achieved when learners integrate their prior knowledge and experiences to new experiences including the concepts and ideas into the existing knowledge (Fiorella, 2016).

The teacher is expected to be fully aware that every learner in a classroom context is unique and possesses his or her own level of capacity in terms of learning abilities (Good, 2017). This means that there must be learner-teacher interaction.

The absence of such classroom interaction results in a teaching and learning environment that does not support learner-centeredness, as recommended in schools by the Department of Education (Engelbrecht, 2015).

Numerous theorists theorised the learning of mathematics in mathematics education. It is significant to recognise mathematics learning discovered by such theorists in this research study since they encompass aspects to be known and understood about mathematics learning.

In Vygotsky's (1978) discovery of mathematics learning, thinking and problem-solving ability fall into three categories. Firstly, there are learners who can handle problem-solving independently; secondly, those that handle with assistance and lastly, those who cannot handle even with assistance (Vygotsky, 1978). This possibly means that mathematics classrooms could belong into any of these categories since learners respond differently to tests or examinations assigned to them. A second aspect Vygotsky (1978) explained is the Zone of Proximal Development (ZPD) whereby the term 'zone' refers to the area of exploration for which the student is cognitively prepared but requires help and social interaction to fully develop (Vygotsky, 1978). A more experienced peer (Vygotsky, 1978) is able scaffold for support in understanding of knowledge. The collaborative learning and the scaffolding strategy is supporting intellectual knowledge and skills of learners (Vygotsky, 1978).

Considering that this research study focuses on the challenges experienced by learners when learning angles associated with parallel lines in geometry and how and why Grade 8 mathematics learners learn angles associated with parallel lines in geometry, some learners require social interaction with peers to gain more insight of aspects being learnt. Similarly, (Bin-Tahir, 2020) mentioned that, learners need to verbally interact with others on learning tasks, exchange opinions, explain concepts, teach others and present their own understanding and meaning. The theory by Bruner insisted on the significance of a child's environment, the social environment in particular. This aspect is very important in teaching and learning of geometry in mathematics.

According to Bruner (1960) what is learnt earlier must clearly provide a general picture of what is learnt in the later stage. This provides the distinction between Bruner and Vygotsky's theory. Important areas of teaching and learning should not be compromised nor be postponed (Bruner, 1960).

Furthermore, any content can be taught effectively to any learner at any stage of development. This attests to Bruner's (1960, p. 13) idea of the spiral curriculum which states; "A curriculum as it develops, should revisit the basic ideas repeatedly, building upon them until the learner has grasped the formal apparatus that goes with them". The significance of Bruner's theory of spiral curriculum in this study is that algebraic skills learnt in previous grades must be revisited to understand functions. In other words, when Grade 7 mathematics learners learn geometry, they should always consider concepts in geometry learnt in Grade 7. The same aspects of learning are to be applied in the process of learning mathematics, which also requires that learners understand and integrate what they already know with new knowledge (Pennbrant, 2017).

There are countless theorists that have theorised about the process of learning in mathematics especially when learners are actively engaged (Freeman et al., 2014; Othman, Shahrill, Mundia, Tan, & Huda, 2016; Siemens, 2014; Fraser, 2015). These theorists propose that learning mathematics requires learners to acquire skills and abilities that can be applied academically and in any area of their everyday lives. This was also emphasised by Aizikovitsh-Udi and Cheng (2015) when they demonstrated that these skills and abilities can be used in analysing, understanding, identifying applicable mathematical concepts and procedures, reasoning, generating solutions and expressing mathematical results properly. The South African Curriculum Assessment Policy and Statement (CAPS) Department of Basic Education (2011) outlined that, it is important that a learner develop these skills in order to be competent and be able to make sound judgement when solving problems. The CAPS document recommends developing these skills if learners are to be able to apply them to physical, social and mathematical problems.

I have realised and concluded that, in most schools in South Africa mathematics has been wrongfully labelled as a difficult subject. In my teaching experience, I have witnessed learners coming to my class fearing and hating mathematics. Larkin and Jorgensen (2016) concluded that it is not an easy thing to get positive feelings and attitudes of learners towards mathematics. If learners have mathematics anxiety it is likely for them to encounter problems and difficulties when learning mathematics (Vitasari, 2010).

Hence Vitasari (2010) concluded that in most cases in a classroom situation, the learners who fear mathematics will always be in the list of learners who do not complete their given tasks.

(Ismajli, 2018) suggested that in one classroom, learners are not at the same level of development. This means that teachers must play a role of motivating learners by unlocking the potential within them to be able to learn independently with meaning and understanding. This is also supported by Huang and Hew (2016, p. 759) who demonstrated that learning behaviour is stimulated and can be sustained by a motivation. It is of paramount importance to discover the ability each learner has including the fears and stigma he or she has to support their learning (Rahman, 2016).

2.3 GEOMETRY WITHIN THE GRADE 8 CURRICULUM

The South African Curriculum and Assessment Policy Statement (CAPS) document Department of Basic Education (2011) emphasised that, during the process of learning there must be critical and active learning. It further states that, there must be an encouragement of an active and critical approach to learning rather than rote and uncritical learning of given truth (Department of Basic Education, 2011b).

The Curriculum and Assessment Policy Statement (CAPS) document emphasises that when the process of teaching and learning is taking place, traditional teaching and learning must not be practised (Department of Basic Education, 2011b). It further encourages learners to be responsible for constructing their own knowledge, meaning and understanding. This can be achieved when there is an implementation of interactive approaches and when learners are actively involved.

Mathematics is moving gradually from a grade to a grade, which is also supported by Miyazaki, Nagata, Fujita, Ichikawa, Shimizu and Iwanaga (2016) when they stated that within the geometry curriculum there must be a corresponding progression from the junior level to the senior level. In South Africa, geometry is learnt from the foundation phase until the senior phase (Department of Basic Education, 2011c). According to the Curriculum and Assessment Policy Statement (CAPS) document of the General Education and Training (GET), there are three concepts that are covered under the topic of Space and Shapes in mathematics namely construction of Geometric Figures, Geometry of 2-D shapes and Geometry of Straight Lines (Department of Basic Education, 2011a). In the construction of geometric figures learners are expected to construct objects using all mathematics construction sets like compass, ruler and protractor in order to construct angles (30^0, 45^0 and 60^0).

In the geometry of 2-D shapes, learners are required to identify and distinguish between 2-D shapes and to work with the similarities and congruency of 2-D shapes (Department of Basic Education, 2011a). In the geometry of straight lines, learners are required to know the relationships within pairs of angles and parallel lines. In this section, Grade 8 geometry will be discussed in relation to angles associated with parallel lines according to the Curriculum and Assessment Policy Statement (CAPS) document.

Table 2.1 exhibits the gradual movement of the geometry content from Grade 7 to Grade 9 in the General Education and Training (GET) phase, as outlined in the Curriculum Assessment Policy and Statement (CAPS) document (Department of Basic Education, 2011a). The gradual movement of the content in geometry is what helps the teacher to obtain the prior knowledge of the learners.

Table 2.1:The gradual movement of geometry content from Grade 7 to 9 adapted from the Mathematics Curriculum Assessment Policy and Statement (CAPS) Department of Basic Education (2011, p. 28)

TOPIC	GRADE 7	GRADE 8	GRADE 9
Geometry of straight lines	**Define:** • Line segment • Ray • Straight lines • Parallel lines • Perpendicular lines 2	**Angle relationships:** • Recognise and describe pairs of angles formed by: - Perpendicular lines - Intersecting lines - Parallel lines cut by a transversal	**Angle relationships:** • Revise and write clear descriptions of the relationship between angles formed by: - Perpendicular lines - Intersecting lines - Parallel lines cut by a

		Solving problems • Solve geometric problems using the relationships between pairs of angles described above.	transversal **Solving problems** • Solve geometric problems using the relationships between pairs of angles described above.

When geometry in relation to angles associated with parallel lines is being introduced to Grade 8 learners, teachers must take into consideration that learners' prior knowledge from Grade 7 does exist. Learners must know and fully understand the significance and methodology of the three main rules (Fujita, 2014). According to Tindall- Ford, Agostinho, Bokosmaty, Paas and Chandler (2015, p. 94-94), learners are expected to be able to identify the positions of the angles and solve problems involving the three main rules which state that:

1. Corresponding angles are always equal.
2. Angles on a straight line and co-interior angles add up to 180^0.
3. Alternate angles are equal.

This is also evident in the Curriculum Assessment Policy and Statement (CAPS) document Department of Basic Education (2011, p. 98) whereby there are clear guidelines on the content coverage.

2.4 EXPLORING LEARNERS' MISCONCEPTIONS WHEN LEARNING GEOMETRY

Learners in all grades have misconceptions when learning various concepts in mathematics. They have tendencies of deriving their own notion of certain mathematical concepts when learning mathematics (Ojose, 2015b). I support Ojose's (2015b) argument when he alluded to the fact that a teacher needs to have the necessary skills and knowledge to detect misconceptions in mathematics. The reason behind my view is that once a teacher has assumptions that the learners are on par with him or her, learners may fail assessments due to their misconceptions.

A gradual process that occurs when learners integrate new knowledge into their own existing knowledge is called a conceptual change (Durkin, 2015). For example, when you ask Grade 8 learners what shape is depicted by Figure 2.1:

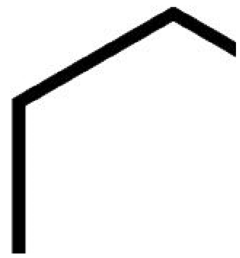


Figure 2.1: Hexagon shape adapted from NCS Classroom Mathematics Grade 10 learner book, p. 63

The normal response from many learners will be that, the shape is a diamond instead of hexagon because according to their existing knowledge that shape is a diamond shape. Durkin and Rittle-Johnson (2015) emphasise that, recognising learners' prior knowledge assists in diagnosing misconceptions.

Geometry is regarded as one of the basic elements of mathematics that learners must understand and master. Geometric concepts go beyond the development of skills required to manipulate geometric shapes and angles (Luneta, 2015) and Poon and Leung (2016) discovered that teachers are unaware of their learners' difficulties in learning geometry. Teachers are unable to identify learners' missing knowledge with respect to angles in parallel lines (Zuya, 2015). Hence it is of importance for teachers to be life- long learners of their subjects and its content in order to identify the types of misconceptions. Learners' misconceptions of geometry may be categorised into 5 categories according to Poon and Leung (2016, p. 3) namely;

1. An inability to understand the real- world applications of geometric concepts.

2. Errors in using basic geometric concepts to solve complex problems.

3. An inability to recognise different forms of the same geometric concepts (symbolic, visual, etc.).

4. A lack of concrete understanding of the geometric concepts underlying particular models.

5. An inability to recall major geometric principles when using nested geometric concepts.

This is also supported by Hock (2015) who encourages the application of the van Hiele levels of geometry thinking, Hock (2015) believes that when using the van Hiele theory when teaching geometry, it will be easy to identify misconceptions by following the levels of geometric thinking.

2.5. THE LEVELS OF GEOMETRIC THINKING

One of the challenges that learners experience when learning geometry is when the instructions are at higher level than the level of the learner (George, 2017). There is a need for understanding the geometric thinking level of learners to understand where and how challenges are occurring. There are 5 levels of Geometric Thinking and each level tells you what kind of instructions learners can understand (Van Hiele, 1999). In a classroom situation there is a diversity of learners with dissimilarity degrees of academic ability and level of geometric thinking (Donohue, 2015).

It is therefore important to study the geometry curriculum in line with each geometric concept within the van Hiele geometric levels of thinking.

Table 2.2: Levels of the van Hiele Geometric Thinking adapted from Ma, Lee and Wu (2015, p. 3)

LEVEL	GEOMETRIC THINKING
1. Visualisation-	Learners must be able to identify any geometric figure by its appearance, the learners can recognise any form of shape. For example the learner can identify a square from a rectangle, horizontal line from the vertical line, etc. based on its appearance.
2. Analysis	At this level the learners must be able to examine things

	in full detail to discover meaning and understanding. They must identify geometric figures using their properties. For example, the learner may know that this kind of shape is a rectangle by looking at the two opposite sides shown that they are equal and the diagonals are equal or the shape has four right angles.
3. Abstraction	At this level learners recognise relationships between geometric figures and are able to reason or perceive the relationships between properties and different geometric figures. This can only be obtained if learners are able to filter concepts from the main content by only deriving aspects.
4. Deduction	At this level learners begin to understand and write proofs by themselves.
5. Rigor	At this level learners can reason formally about mathematical systems without experiencing any difficulties.

These above-mentioned levels of geometric thinking are important in each geometry lesson. According to Alex and Mammen (2016, p. 4), the levels of geometric thinking were created to develop a solid geometric understanding. It is vital for learners to pass through the 5 levels without skipping any level (Hock, 2015). The other critical facet that needs to be considered is making sure that, learners are taught at their level to avoid frustrations (George, 2017).

2.6. LEARNERS' PERCEPTION OF CONCEPTS IN GEOMETRY

Learner's perception of concepts in geometry depends on the learners' ability to construct geometrical conceptual understanding (Sutiarso, 2018). In order for the learner to be able to construct understanding, he or she must discover what is learnt through the existing knowledge. In this way, it will be easy for the learners to remember and know the concepts

(Linn, 1987). Learners may show understanding while the teacher is teaching and respond correctly when asked questions based on the learnt questions but, this does not mean the learners have gained knowledge and understanding.

The findings of Jojo (2016) indicated that learners can respond to questions based on a word or diagram that they associated with a particular concept but still fail given assessment. Learners first need to understand the basic concepts in geometry and when they lack the basic conceptual knowledge they hardly respond to assessment questions (Luneta, 2015).

For example, if the learner does not know that in parallel lines the "F" shape represents corresponding angles, U or "C" shape represents co-interior angles and the "Z" or "N" shape represents the alternate angles, that learner cannot to solve given problems.

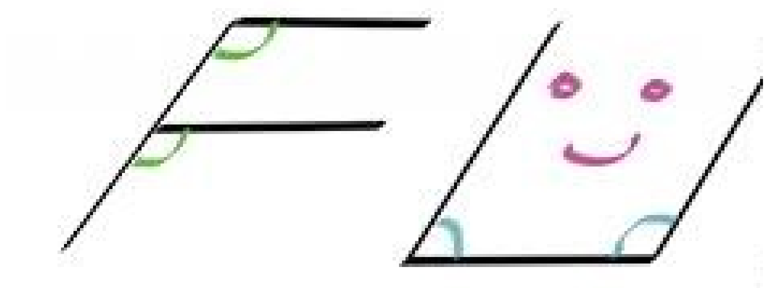


Figure 2.2: Corresponding, Co-interior and Alternate angles adapted from http://www.greatmathsteachingideas.com/2014/03/09/angles-in-parallel-lines-fun/ (Emeny, 2014)

Luneta (2015) also asserted that knowledge of geometric concepts goes beyond the development of skills required to work and solve geometry and what is more important is understanding the concepts and how to apply required geometric skills which will be discussed later in this chapter.

2.7. LANGUAGE AS A LEARNING BARRIER WHEN LEARNING GEOMETRY IN MATHEMATICS

The other challenge that occurs when learning geometry, is the language used to teach and learn mathematics. Mathematics uses symbols and notations to describe numerical, geometric and graphical relationships (Department of Basic Education, 2011b).

Therefore, it is of importance for the learner and the teacher to integrate the spoken language and the mathematics language. According to O'Halloran (2015, p. 63-74), the spoken language is considered as one of the resources that creates meaning when learning mathematics. In mathematics, there are terminologies or certain vocabulary used that requires learners to know them. Smith, Hughes and Fries (2015) have demonstrated that, understanding of the mathematics vocabulary used when learning geometry contributes to the competency of the learner.

In most cases, learners prefer to be taught in their home language and prefer to be instructed and express themselves in their own home language (Wu, 2015). However, it is the responsibility of both the learner and the teacher to communicate any language barrier that occurs during the process of teaching and learning.

Children at an early age may display some understanding of geometrical concepts as they are used to seeing different types of shapes and playing with them (George, 2017) . This tells us that, learners have prior knowledge of what is being taught; it is just that sometimes they cannot relate this knowledge within a scientific context (Siemens, 2014). Learners experience challenges in learning geometry by failing to understand the relationship between the theorem and the definitions of angles focusing on parallel lines. If a learner does not know what a straight line is, the learner is not likely to know the theorem around the straight line (Ding, 2015). For example, a learner must integrate the definition of a straight line with the theorem of the straight-line which states that straight line angles are supplementary.

Learners find it so hard to convert word language to symbolic language which geometry uses. There are learners who can achieve great expertise in speaking any language but cannot read with understanding (Yule, 2016). Unfortunately, this language barrier may contribute to the learners' challenge of understanding what it is that they are required to prove thus , making it difficult for them to attempt solving any given riders because of the geometric terminology that has been used (Clements, 1992). Hence it is important for learners to know and understand the basic knowledge and have the basic skills when learning geometry starting from the terminology and properties of geometry (Ding, 2015).

2.8. EXPLORING THE BASIC KNOWLEDGE AND SKILLS IN GEOMETRY

The process of learning is something that can happen naturally to anyone, anywhere, planned or unplanned. When learning is taking place in a classroom situation, Ding, Jones and Zhang

(2015) emphasised that in order for the learners to learn anything firstly, they must be taught the basics which are the basic knowledge and the basic skills.

There are many reports about the challenges that are experienced by the learners when learning geometry. Geometry is an essential part of mathematics and most learners are afraid of it and hence are failing it (Alex, 2016).The reasons behind the challenges are that learners lack the basic knowledge and basic skills. Jojo (2016) states that the intention of teaching geometry in schools is to equip learners with certain abilities of knowledge or basic skills like critical thinking skills, problem solving skills including the high levels of geometric thinking skills which were discussed earlier on in this chapter. This basic knowledge and skills may be present in the early development of a learner (Bonny, 2015). These skills and knowledge will help learners to understand all geometric concepts and be able to know how each geometric concept can be applied in order to conduct correct proof or sound reasoning.

One of these basic skills is critical thinking skill as reflective thinking, whereby a learner develops the ability to think correctly when working with concepts in assessment (McPeck, 2016). This is done by relating or integrating prior knowledge to new knowledge whereby learners think in an abstract and conceptual way, in order to apply specific correct strategies to construct solutions. Critical thinking skills are essential to a learner because once a learner has critical thinking skills this implies that, he or she has good reasoning and can accurately interpret problems and understand what is required from him or her (Hitchcock, 2017). When learners apply critical thinking skills, they will be able to develop capacity and capability to think, argue and find ways to solve problems apart from classwork given problems (Noddings, 2016).

In geometry, critical thinking skills compel learners to use their critical eye to check all possible solutions to solve riders and assure that each solution is accompanied by a correct reason stating why the learners decided to solve the riders in a certain way. After solving, the learners need to think about and also revise their work before submitting and this requires the application of critical thinking skills (Su, 2016).

Another skill that is important in learning geometry is problem solving skills. According to Schoenfeld (2016, p. 17) learners need to have problem solving skills in order to know which tool and strategy to apply when solving problems (Schoenfeld, 2016).Teaching problem solving skills encourages learners to be active on solving problems on their own. This will empower learners to be able to conduct research, integrate theory, practice and apply knowledge to develop practical solutions to all defined problems (Savery, 2015).

Recent research suggests that having problem solving skills plays a crucial role because problem solving skills involve several cognitive (paying attention, ability to retrieve memory and understanding of the mathematical language) and metacognitive processes (self-questioning, self-monitoring, self- evaluation). Weisz and Kazdin (2017) substantiated that, learners with problem solving skills will not only manage their academics but will also be able to handle their social life.

Problem solving skills do not only mean that a learner must be able to get answers at the end of the problem. In mathematics, learners are able to represent the nature of the problem correctly and have strategic plan to solve problems by using correct mathematical procedures and verify if the attained solution is indeed correct (Jitendra, 2015). In geometry if the lines are not parallel by specifications or indication, rules for corresponding, alternating and co-interior angles should not be applied anyhow. If a learner does not have skills to discover that lines are not parallel, it will be impossible for the learner to solve problems correctly (Jojo, 2016).

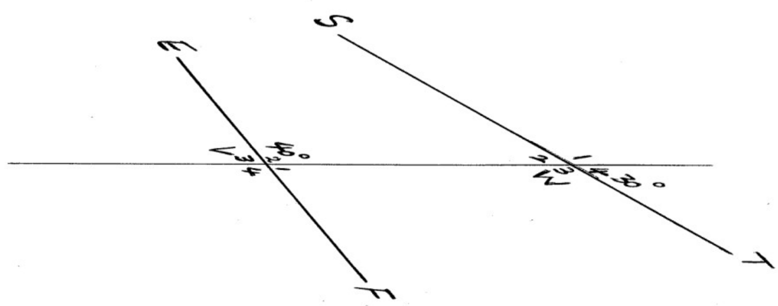


Figure 2.3: Parallel lines adapted from the CAPS Classroom Mathematics Grade 10 learner book, Pg 198 exercise 9.1 no. 3a

In Figure 2.3, the lines are not parallel to each other because when you extend them they will meet and cross each other. This means that the FUN connotation cannot be applied to the angles lying within the lines. A learner who is equipped with geometric skills will be able to identify this without wasting so much time trying to solve the angles by using FUN.

Bokosmaty (2014) argued that learners who are given worked examples of geometry consisting of problems along with their worked-out solutions perform better than learners who are given problems to solve by themselves. This suggests that learners develop problem solving skills when they are giving solutions to solve problems.

I contradict Bokosmaty (2014) because, giving learners worked out problems is the same as spoon feeding them by telling them to memorise the working outs, which will affect learners when they are being assessed with different problems from those they have been given. In a classroom situation there must be interaction between learners and the teacher. Koole (2015) emphases the importance of interaction whereby there will be a process of teaching, asking, explaining, clarifying misconceptions or assessing.

Giving learners worked problems can only accommodate a certain number of learners and will deprive learners of an opportunity to be active and learn from one another. Chen, Kalyuga and Sweller (2015) regards worked examples as guidance to problem solving, which elucidates that a teacher may not give the learners the worked examples but teaches them how to solve problems by demonstrating not giving the learners the solutions. Mudaly and Naidoo (2015) considered that the use of concrete representational abstract makes teaching and learning effective. They further explained that this strategy develops learners to understand mathematical concepts through the use of symbols and visualisations which will be discussed later on. This process can only be effective if the learners have problem solving skills. For these reasons this research study proposes that, learners need to be taught problem solving skills through modeling rather than being given solutions to memorise to make connections, meaning and understanding from what they already know.

Learners will be associated with competence once they are able to correctly apply mathematical skills and understand the mathematical language in order to represent mathematical expressions, processes and results using words, drawings, symbols, numbers and materials (Díaz, 2017).

2.9. THE USE OF VISUALISATION TO UNDERSTAND CONCEPTS IN GEOMETRY

Visualisation encourages communication of knowledge through the use of interactive visual interface (Manovich, 2011). The word visualisation can be broken down for better understanding whereby visualise means making visible and making mental images.

Manovich (2011) further elucidated that one cannot have a visual form until he or she visualises something. In mathematics, using and applying visualisation can be useful for problem solving (Carden, 2015). For example, teachers in the early childhood schools use visuals to assists learners in problems solving. Kashefi (2015) stated that learning is divided into three levels namely; Enactive learning, Iconic learning and Symbolic learning.

These levels of learning were also elaborated by MacBlain (2018) where he quoted the theory by Bruner which explains that the enactive level is when learners are learning by doing or experiencing, at an iconic level, learners learn through diagrams or images and the symbolic is through words and symbols. According to Kashefi (2015) the enactive level is the connection between the practices and formal level of understanding. This enactive level of learning supports the constructivism theory where learners are active and involved in the process of learning through visualisation.

Geometry consists of concepts derived from diagrams and in the classroom situation learners use diagrams to understand the geometric concepts hence visualisation is essential. Cannon (2017) has demonstrated that visualisation in geometry promotes a deeper conceptual understanding. For example, when looking at the angles associated with parallel lines, a learner needs to form images in his or her mind or even on the given problem to apply the FUN principles.

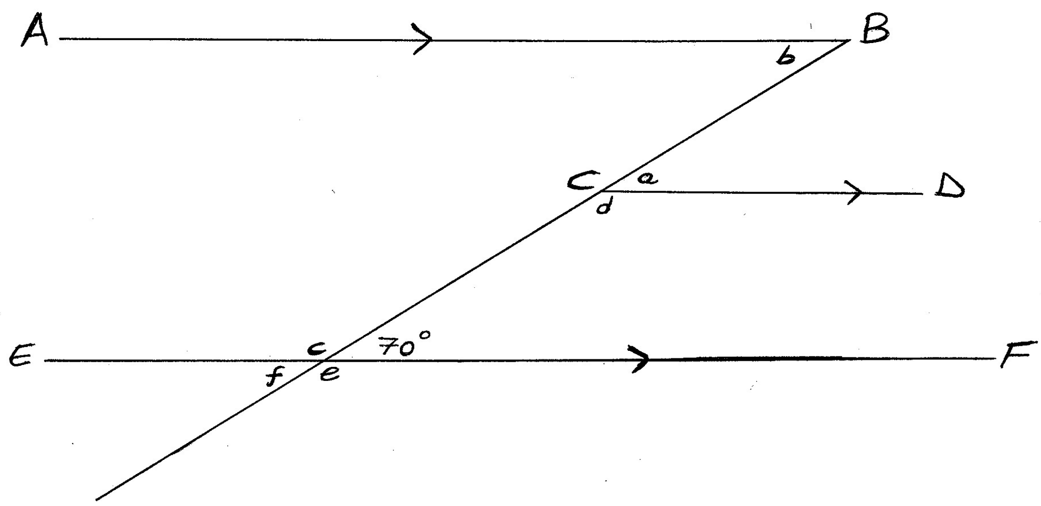


Figure 2.4: Parallel lines adapted from the CAPS Platinum Mathematics Grade 8 learner book, Pg. 142 exercise 12.3 no. 2

In Figure 2.4, a learner needs to first check if the lines are parallel by looking at the qualities of parallel lines. This can be stipulated or demonstrated by the use of arrows in the diagram and if the lines do not meet. A learner then needs to form images of each FUN property for example taken from the above figure;

- Angle $\boldsymbol{a} = 70^0$ reason is, angle $\boldsymbol{a}$ and 70^0 are corresponding. This is concluded by line CD which is parallel to EF and the F-shape is formed by the transversal line cutting through line EF.

- Angle $\boldsymbol{b} = 70^0$ reason is, angle $\boldsymbol{a}$ and 70^0 are alternating angles. This is shown by line AB which is parallel to EF and the transversal line forming the Z-shape.

- Angle $\boldsymbol{c} + \boldsymbol{d} = 180^0$ reason is , co-interior angles add up to 180^0 provided that they lie within two parallel lines which form a C-shape. In this figure line AB and EF are parallel and form a C-shape with the transversal joining the two lines.

There is a national need for the integration of technology during the process of teaching and learning because, technology creates and promotes a constructivists' learning environment (Worthington, 2008). Technology plays a very important role in involving the learners in their learning. Benjamin Franklin as cited by (Sharma, 2014) stated that if you tell me I will forget, if you teach me I may remember but, involve me and I will learn. This tells you that once a learner is involved in his or her learning he or she will learn and understand what is being taught. Regarding the use of visualisation during teaching and learning, the use of technology is relevant to be introduced for the interest of the technologically advanced generation we are currently grooming. Stols, Ferreira, Pelser, Olivier, Van Der Merwe, De Villiers and Venter (2015) were concerned about the South African teachers having internet access but refraining from using online materials to improve teaching and learning to these technology inclined learners. This may be the results of not being trained by the institutions they come from or the department is not providing enough resources or introducing workshops to train teachers to use visualisation in teaching and learning.

Many studies (Skinner, 2016, Venkatesh, Croteau, & Raba, 2014; Henderson, Selwyn, & Aston, 2017; Kirkwood & Price, 2014; Ertmer, Ottenbreit- Leftwich, & Tondeur, 2014) have emphasised the use and the importance of technology during the process of teaching and learning to engage with students and enrich their learning experience in a meaningful and effective way. This suggests that technology must be part of teaching and learning to encourage and support construction of own understanding and knowledge of the world through experiences and reflection (Bull, 2013).

According to Johnston- Wilder, Lee and Pimm (2016) the use of digital technology is an important aspect in visualisation because digital technology scaffolds and motivates learning by observing patterns, seeing connections and working with dynamic images in geometry. The use of technology makes it easier for learners to see what is being taught and will enable them to keep the concepts for a long time (Visser, 2015).

2.10. CONCLUSION

Having reviewed the above literature from different scholars, I have realised that this research study has commonality with them in terms of what is expected from learners when learning angles associated with parallel lines in geometry. For successful learning, learners are expected to integrate their prior knowledge and experiences to new concepts.

Aizikovitsh- Udi and Cheng (2015) mentioned that these acquired skills and abilities are essential for analysing, understanding, identifying applicable mathematical concepts and procedures, reasoning, generating solutions and expressing mathematical results properly to be competent and be able to make sound judgement when solving mathematical problems. I support the CAPS document which emphasises gradual movement of content in geometry so that learners will be able to move from each grade with a solid foundation of mathematical content. However, it has been noted that as much as teaching and learning can take place according to what the department has stipulated there are challenges that learners experience during teaching and learning and one of them is misconceptions. These challenges occur when learners show tendencies of deriving their own notion of certain mathematical concepts when learning mathematics. Learners lack the basic knowledge and basic skills which include critical thinking skills, problem solving skills including the high levels of geometric thinking skills.

The other challenge is the language used to teach, which affects learners' ability to construct geometrical conceptual understanding and the ability to visualise what is being taught. I have concluded that there is a gap regarding Grade 8 learners learning geometry and most of the above-mentioned scholars were focusing on the learners doing FET level at school taken from the literature. Hence this research study will cover the gap by integrating all other scholars' findings and conclusions to explore the challenges Grade 8 learners experience when learning angles associated with parallel lines in geometry.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 INTRODUCTION

This chapter will discuss the theoretical framework within which this research study is framed. Green and Piel (2015) stated that, a theory is an integrated set of statements consisting of internal principles, bridge principles and identifiable body that is used to explain any phenomena.

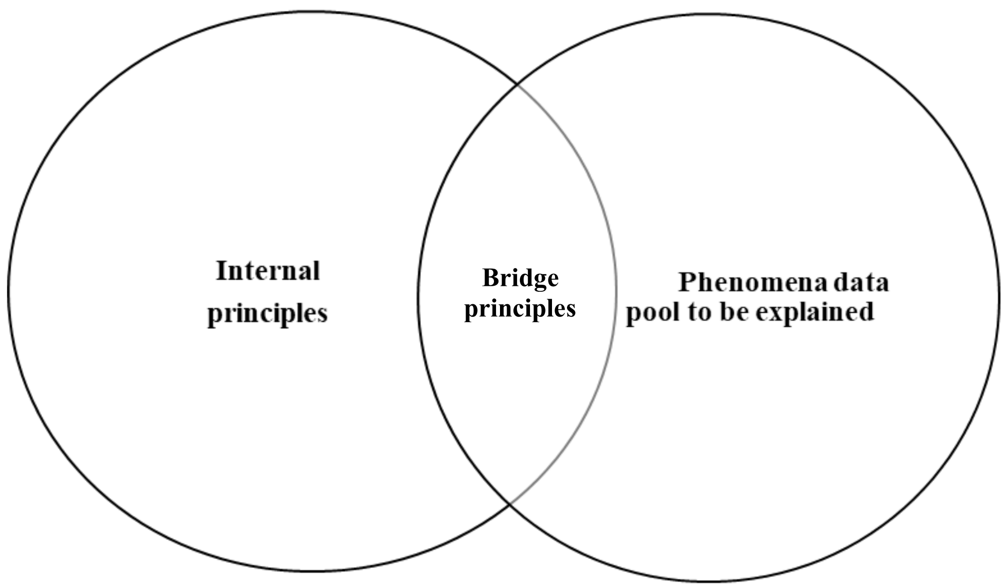


Figure 3.1: Schematic relationship between internal principles, bridge principles and phenomena to be explained adapted from Green and Piel (2015, p. 28-29)

Green and Piel (2015, p. 28-29) explained the schematic relationship between internal principles, bridge principles and phenomena as follows:

- Internal principles refer to the primary concepts and core explanatory principles employed by the theory.
- Phenomena to be explained refers to the essential data the theory attempts to explain.
- Bridge principles are concepts that are used to connect abstract theoretical principles and the real world experiences of human phenomena.

Before I relate my theoretical framework for this research study, there is a need for me to briefly provide the reader with the importance of theoretical framework. According to Grant and Osanloo (2014), the theoretical framework provides a grounding support to the literature review, methods and analysis of the research study. Essentially, the theoretical framework provides an outside and inside view to the entire research study. In addition, it supports, provides important personal beliefs and gives guidance to the whole research study. Linderman (2015) defines the theoretical framework as the tool to justify the importance and significance of the research study. Thus, a researcher cannot continue his or her research study without having the theory that will justify the topic of the research study.

Grant and Osanloo (2014) outlined that, the outside view given by the theoretical framework is the structure on how the research study will be entirely approached using a specific theory. They further explained that the inside view of the research provided by the theoretical framework is when the researcher explains his or her beliefs in relation to the choice of his or her theory and the topic of the research study, identification of the suitable theory, the guiding principles and concepts of the theory, the conflicts and controversies from other scholars regarding the theory and how the identified or chosen theory connects the research study which will be further discussed in this chapter. According to Green and Piel (2015) having a theory to guide your research study is like looking through a window at human nature to observe record and assess their experiences. The aim of any theory is to respond to the research questions focussing on the nature of a selected researched sample and its development.

A theoretical framework guides and examines any systematic explanation of human development by following certain principles outlined by the selected theory. Green and Piel (2015, p. 23-27) further identified the 5 basic principles to look for when identifying suitable theory for research:

1. Explain what facts mean- the theory must explain facts because, facts cannot explain themselves and the theory must organise, shape and interpret facts differently according to its principles.
2. Represent public knowledge- the theory must represent public knowledge in order to explain human nature in a less biased and more defensible way.

3. Principled and testable- the theory must be principled and testable in order to provide an element of self- correction and the extent to which its claims can be objectively verified.
4. Less complex than people- the theory must be understandable and be simple than the phenomena it attempts to explore.
5. Generalisable- the theory must be able to explain characteristics of human nature that are common to all individuals.

In the previous chapter, I discussed the research conducted by other scholars in relation to learner's challenges in learning. Having reviewed other scholar's literature and the significance of a theory in the research study, it was within the researcher's suggestion that social constructivist theory is a suitably identified theory to guide this research study.

3.2. IDENTIFICATION OF THE SUITABLE THEORY- SOCIAL CONSTRUCTIVIST THEORY

In this research study the researcher will focus on the work of Lev Vygotsky and Jean Piaget who emphasised the social constructivist theory of learning (Devi, 2019). When you study the theory of social constructivism which indicates that a learner must be an active person in the process of teaching and learning, you get a full understanding of what a learner is. This theory was demonstrated by the two theorists Jean Piaget (1886- 1980) and Lev Vygotsky (1896-1934) when they emphasised that a learner is someone with an ability to relate what is being taught with others and uses his or her experiences in order to understand and have knowledge and thus makes a learner to be a learner (Qvortrup, 2016).

When a learner enters the classroom, he or she comes with skills, knowledge, abilities, social and emotional experiences. These qualities require a teacher to direct them accordingly so that they influence the learner's life in a more positive and productive way. This emphasises that a learner is not an empty vessel to be filled with knowledge and skills as alluded to by constructivism. A learner is someone with already existing fundamentals of knowledge that needs a more knowledgeable other to integrate existing knowledge with new knowledge and interpret for long life understanding (Imathiu, 2018). When learners construct their own meaning, they participate fully in their learning and ought to be responsible for their own learning. According to (Suhendi, 2018), when learners are involved in their learning, content learnt will last for a long time.

Social constructivist theory encourages and emphasises that a learner must be an active individual during the process of learning because learners learn through their own actions and by interacting with others. The social interaction will allow learners to learn from one another especially from those who have more knowledge about what is being learnt in a classroom situation (Hsieh, 2017). The social constructivist theory encourages learners to make sense through their own experiences and it emphasises that, learners must be able to construct understanding of new knowledge by using the pre-existing knowledge to understand new concepts (Amineh & Asl, 2015).

Smith (2017) mentioned that when learners are active in the process of learning, their capability to understand new knowledge increases and they will seldom have any anxiety of learning new concepts. As much as teaching is a process to equip and develop learners, it does not mean that learners do not have any knowledge of what is being taught to them. According to Hsieh (2017), learners possess knowledge and skills in relation to things from their own world and those things can be organised accordingly over time but, only through experiences they gain when they are active in their learning and social interactions.

Currently social interactions also involves technology and many studies have emphasised the use and the importance of technology during the process of teaching and learning (Skinner, 2016; Venkatesh, Croteau & Rabah, 2014; Henderson, Selwyn & Aston, 2017; Kirkwood & Price, 2014; Ertmer, Ottenbreit-Leftwich & Tondeur, 2014) to engage with learners and enrich their learning experience in a more meaningful and effective way. This suggests that technology is part of the social constructivist theory. Technology encourages and supports that learners must be able to construct their own knowledge, meaning and understanding of the world through their experiences and reflections (Bull, 2013).

Technology has become popular with learners from all levels of education and has played a very critical part in advancing and speeding the process of learning through social engagements and interactions with other people from all over the world (Domingo, 2016).

According to Nurdayansyah, Rais and Aini (2017), learning can still occur without the presence of a teacher as learners can derive knowledge by means of technology. This happens because nowadays, learning is more effective using technology and it is easier to solve problems by engaging with learners.

This was further emphasised by Mattar (2018) when he mentioned that, teachers must understand that the current actual interests of learners lie within or around technology. The use of technology as a teaching strategy helps build communities, creates knowledge, creates engagements, motivates learners and makes learning enjoyable (Dron & Anderson, 2014). The social constructivist theory can be properly used in explaining the importance of using technology in the process of learning. Mattar (2018, p. 201-217) discussed and mentioned subtype approaches of social constructivist theory in relation to learning using technology as follows:

1. Situated cognition, emphasises the importance of context and interaction in the process of knowledge construction. In this process, learners acquire knowledge and understanding through critical thinking and experiencing when using technology to interact with other people.
2. Activity theory emphasises the importance of learner's engagement and action to support the learning process.
3. Experiential learning emphasises the importance of experience whereby learners are practicing what they learn as part of constructing knowledge on their own.
4. Anchored instruction emphasises the importance of placing learning within a meaningful problem solving context.
5. Authentic learning emphasises the importance of allowing learners to meaningfully discover, discuss and construct concepts and relationships involving real world problems and projects that are relevant.
6. Connectivism emphasises the importance of knowing how internet technologies contribute towards learning and integrating them during the learning process in this digital age.

These approaches to the social constructivist theory in relation to learning using technology, encourage learners' actively interactive learning and reduces the gap between learners' knowledge and real life experiences. According to Nurdayansyah, Rais and Aini (2017), integrating technology during the process of learning mathematics increases learners' ability to understand and master any mathematical content of learning. They further alluded to the fact that the software that is being used when learning mathematics contains values of learning mathematics through experiencing and visualising.

In geometry, this software provides demonstration, discussion, experiment, independent learning and a high concentrating level from the start to the end of the lesson (Nurdyansyah, 2017). According to Sinclair, Bussi, De Villiers, Jones, Kortenkamp, Leum and Owens (2017), technology in geometry education has become relatively mainstream because, technology changes geometric representations and lead them to more understandable ways as compared with paper-and-pencil approaches. For example, when you teach geometry of parallel lines learners can be shown examples and be given problems involving real life situations as illustrated in Figure 3.2;

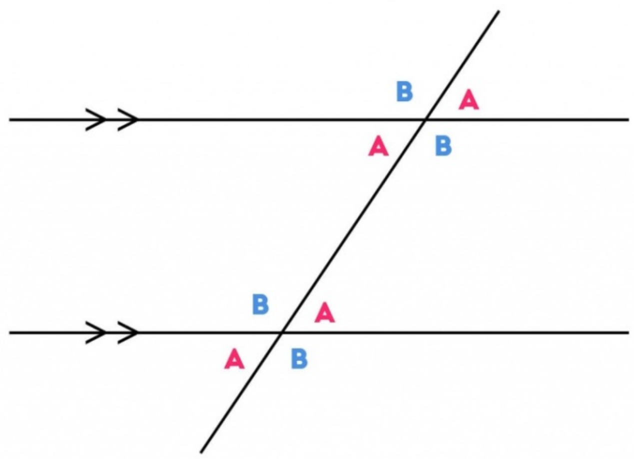


Figure 3.2: Parallel lines adapted from http://www.pythagorasandthat.co.uk/parallel-lines

In Figure 3.2 a teacher can simply draw parallel lines on the board and explain their properties and meaning, but the figure will not capture the full attention and engagement of the learners as much as Figure 3.2.

Figure 3.3: Geometry in real life situation adapted from https://pt.slideshare.net/sudharshansathyamoorthy/geometry-in-daily-life-16924200/6?smtNoRedir=1

In Figure 3.3, learners can relate parallel lines concept with the normal everyday used roads where the lines drawn in the roads are ensuring that cars must stay in their lanes and must not meet or cross each other to avoid collisions which is one of the properties of parallel lines in geometry (Morgan, 2018). When you look at Figure 3.3, the focus will not only be on the road but also the nature around, whereby the trees also display properties of parallel lines as they were planted in a parallel line manner for many reasons like being the barrier for cars not to pass into the farm. This proves that technology in the classroom situation makes learners explore, discuss, experience and construct meaning and understanding as outlined by Mattar (2018).

The social constructivist theory defines the process of learning as a process driven by the ability of learners constructing their own knowledge, meaning and understanding (Kiraly, 2014), unfortunately, this cannot always be the case as Vygotsky (1978) contradicted Piaget's (1952) theory by describing that in a classroom situation, there are different types of learners with different abilities to construct meaning and understanding. Piaget (1952) as cited by Semmar and Al-Thani (2015, p. 2) mentioned that a classroom comprises learners that can construct meaning and understanding on their own through discovery by using their concrete experiences influenced by their environment, and he further did not recognise a teacher's role as of importance in the process of learning.

Vygotsky (1978) then contradicted this by asserting that, learners in a classroom situation can construct meaning and understanding on their own and through social interactions. This proves that in the classroom situation there are at least two types of learners according to Piaget (1952) and Vygotsky (1978), there is one that can construct meaning and understanding on his or her own ability and there is one that cannot construct meaning and understanding on his or her own ability unless he or she can be assisted in the process of teaching and learning (Semmar, 2015).

Hence the zone of proximal development (Vygotsky, 1978) was introduced to cater for certain kinds of learners who can construct meaning and understanding through social interaction and through the process of scaffolding (Amineh, 2015). Piaget (1952) did not see the important role of a teacher during teaching and learning in a classroom situation but Vygotsky (1978) viewed the role of a teacher to be extremely important through modelling and assisting learners when they get confused. Some learners are capable of constructing meaning and understanding individually and excel when influenced by interacting with other people. According to Goods and Lavigne (2017), learners have different needs regarding learning and there are so many different things that bring motivation to them to have successful and effective learning. One of the things that brings motivation to learning is the social interaction, which was asserted by Bruner (1973) as cited by Amineh and Asl (2015 p. 11) when he defines learning as a social process. This research study will look holistically at the learner learning and constructing meaning and understanding individually and when socialising with other learners in order to explore the challenges occurring when learning angles associated with parallel lines in geometry.

It is for these above mentioned reasons I chose social constructivist theory which is supported by both the above mentioned theorists to frame this research study in support of Vygotsky (1978) because, every learner in a classroom situation come from a different background and can respond differently to the process of teaching and learning.

3.3. EXPLORING THE SOCIAL CONSTRUCTIVIST THEORY AND THE LEARNING OF ANGLES ASSOCIATED WITH PARALLEL LINES IN MATHEMATICS

This research study explores the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

Thus, the social constructivist theory is significant to this research study as it encourages actively learning individually or socially in order to construct meaning and understanding (Krahenbuhl, 2016). However, active learning depends on the learner's ability to believe in him or herself. According to Lin-Siegler, Dweck and Cohen (2016) when learners believe that their intellectual abilities can be developed, they are more likely to learn. If a learner experiences low self-esteem, he or she cannot socialise with other learners even in terms of learning which can lead the learner to be inactive during the process of learning. Lin-Siegler, Dweck and Cohen (2016) further asserted that learners must have motivation and self-belief in their capability in order for them to actively learn. This was also supported by (Schunk, 2017) when they defined self-belief or self- regulation as a way that learners systematically activate, sustain self-motivation and competency in their learning and performance.

When a learner believes in him or herself, he or she can easily collaborate with other learners in order to gain or share meaning and understanding. When learning mathematics the social constructivist theory encourages learners to learn how to solve problems with understanding (Simon, 2017) moreover, Retnowati, Ayres and Sweller (2017) stated that problem solving skills can be attained and be more effective through collaborative learning.

Bodrova and Leong (2015, p. 376) outlined that, social learning plays a very important role in learner's self - construction of meaning and understanding through the help of a more knowledgeable other. This statement emanates from an argument by (Vygotsky, 1978) when he declared that learners could construct their own knowledge and understanding through assistance by a teacher or peer. However Bodrova and Leong (2015) believed that Vygotsky (1978)'s theory in that a learner being assisted by a more knowledgeable other is limiting the core definition of the social constructivist theory, which encourages social interaction not only on peer to peer but also in a group of peers. In this way, learners can learn through interacting with another peer and collectively as a group.

This research study explores challenges experienced by leaners during the process of learning angles associated with parallel lines in geometry in mathematics. According to Hank (2016), mathematics requires social interaction which provides learners with social and emotional experiences to improve learning through sharing of knowledge.

This emphasises that in a classroom situation as part of the process of learning, a social interaction learning environment is vital for learners to construct their own meaning and understanding as they share and discuss mathematical concepts.

Concerning the above mentioned beliefs, I anticipate that the process of learning angles associated with parallel lines in geometry will apply to the social constructivist theory whereby learners are actively learning and interacting with one another.

3.4. THE GUIDING PRINCIPLES AND CONCEPTS OF THE SOCIAL CONSTRUCTIVIST THEORY

The social constructivist theory encourages learners to make sense through their own experiences and emphasises that learners must be able to construct understanding of the new knowledge by using the pre-existing knowledge to understand the new concepts (Amineh & Asl, 2015). According to Slavin (2019) social constructivist theory believes that knowledge is attained through the processes that require learners to be active and discover and transform complex knowledge to be their own. Furthermore, learners are also expected to discover basic knowledge and skills to solve problems individually or through scaffolding or cooperative learning. This constructivist theory as outlined by Green and Piel (2015) is also guided by principles and concepts that learners are expected to follow or the teaching and learning process needs to implement. These principles and concepts of the constructivist theory are briefly summarised and discussed as follows:

3.4.1. Learner- centeredness

Learner- centeredness is a learning process which demands that the teaching and learning process uses approaches or strategies that support interaction and engagements of learners in order to develop skills to make independent decisions, solve problems and practice and work with and within a team. According to Aubrey and Riley (2018, p.8), “learner- centeredness encourages learners to experiment based on their own interests rather than adopting a didactic model of learning in which learners have only a passive role”.

This research study explored challenges experienced by learners during learning, which meant that the process of teaching was around and about learners in terms of letting them experience learning for them to derive meaning and understanding.

3.4.2. Active learning

In active learning, learners are encouraged to learn on their own through involvement with concepts and principles and conduct experiments that permit them to discover meaning and understanding on their own. According to Maonde (2015), successful learning is achieved through the process of development that encourages learners to be active participants. In this research study, learners were expected to be more active by engaging and interacting with their peers especially during class activities. This determined the challenges the learners experience when learning individually and learning through interacting with other learners.

3.4.3. Self-regulated learning

In a classroom situation, self- regulated learning encourages learners to be self- motivated, to be effective and life-long learners. Stletten (2017, p. 348) stated that "self- regulated learning involves learner's use of variety of strategies to aid in optimal learning." She further explained that self-regulated learning is the ability to actively influence one's own motivation to learn and behave in order to enhance learning. This research study explored learner's experience when learning angles associated with parallel lines in geometry and self-regulation was one of the guiding principle that encouraged learners to be self- motivated in order to be able to actively experience learning and interact with other learners.

3.4.4. Scaffolding learning

The scaffolding learning process gives learners more structure at the beginning of the lesson and gradually turns the learning responsibility over to them so they can operate on their own. Vygotsky (1896-1934) suggested that during interaction of learners, collaboration with more capable peers is an important way of learning in which learners learn, develop knowledge and understanding.

This research study encouraged learners to work with their peers in solving given problems of angles associated with parallel lines in geometry. This exercise encouraged learners to exchange ideas, receive knowledge and understanding through social interaction with their peers (Maonde, 2015).

3.4.5. Critical thinking learning

Critical thinking learning enhances leaners' capacities to think critically when making correct decisions about what to do when given problems to solve. Chandler (2015) outlined that the teaching and learning process encourages teachers to cultivate more critical thinking and creativity in their classrooms in order to prepare learners for real life problems in today's complex and global world. This research study emphasised that learners become active rather than passive listeners. The activities given to learners were encouraging learners to be critical thinkers and relate all problems with real life situations.

3.4.6. Problem solving learning

Problem solving learning is a process that teaches learners mean-ends analysis and problem presentation steps. According to Bada and Olusegun (2015), constructivist theory triggers learners' curiosity about the world and how things work which requires learners to develop problem solving skills through learning to develop their own meaning and understanding. This research study required learners to apply thinking skills and give feedback on problems they were expected to solve. These problem solving skills involve planning how to solve the problem, classifying or categorising the problem, divergent thinking, identifying any assumptions and misleading information and generating questions in order to solve given problems (Green, 2015).

3.4.7. Cooperative learning

Cooperative learning encourages learners to work together in pairs or in groups by helping one another to discover, discuss and learn in order to improve their meaning and understanding of concepts. In this research study, learners with high and low geometric skills benefit during the process of learning through verbal interactions and working together with their peers (Darnis, 2015). Learners were able to gain knowledge and understanding from other learners when discussing and solving given riders of angles associated with parallel lines in geometry.

3.5. CONFLICTS AND CONTROVERSIES REGARDING SOCIAL CONSTRUCTIVIST THEORY FROM OTHER SCHOLARS

According to Kratochwil (2017), social constructivist theory has known ups and downs. Bada and Olusegun (2015, p.66-67) stated that, "social constructivist theory has been misinterpreted as a learning that forces learners to 'reinvent the wheel'". On the contrary, social constructivists' theory encourages learners' natural curiosity about the world and how things work in order to understand and apply knowledge to solve problems.

According to Aubrey and Riley (2018), social constructivism is the theory that emphasises the importance of understanding culture and environment by learners. They further alluded to the fact that it is the systems and processes employed to build knowledge from own understanding. Numerous scholars Bednar, Cunningham, Duffy and Perry (1992), Bruner (1962) Dewey (1929), Piaget (1980) and Vygotsky (1962) stressed that learning outcomes should focus on the knowledge construction process and its goals should be determined from authentic tasks with specific objectives (Bada, 2015). Having read different findings about the social constructivist theory from other scholars, this research study supported the social constructivist theory because of its main focus on how learners should be learning in order to experience things with understanding and meaning both in the classroom situation and real life situations.

3.6. HOW THE IDENTIFIED OR CHOSEN THEORY CONNECTED THIS RESEARCH STUDY

Having read social constructivist theory from other scholars' research Ambrose et al., 2010; Amineh & Asl, 2015; Dimitriadis, 2006; Green & Piel, 2015; Mattar, 2018) etc., most scholars used social constructivist theory in the process of teaching. A study by (Bada, 2015) emphasised that the main focus during the learning process must be on learners where all attention is paid and directed on learners deriving their own meaning and understanding. In order for a productive teaching and learning process, making learners the centre of teaching and learning is the best option for them to learn meaningfully and with understanding.

Anderson (2016, p. 38) stated that, "social constructivist theory should be noted as a philosophy of learning and not one of teaching".

He further outlined that for effective learning in the classroom situation, learners must actively engage with the teacher and one another. Multiple perspectives and sustained dialogue are important as they lead to effective learning and the role played by the more knowledgeable other is critically important whereby the process of scaffolding takes place.

Therefore, in this research study, social constructivist theory was used for the learning process to explore challenges experienced by Grade 8 learners learning angles associated with parallel lines in geometry. According to Bada and Olusegun (2015), social constructivist theory is about how learners learn using active techniques such as experimenting, real- world problem solving and sharing ideas through social interactions in order to create more knowledge and understanding. In this research study, learners were expected to apply all principles and guidelines of social constructivist theory in order to experience effective learning. This research study focused on the learning process of learners in order to explore challenges learners experience when learning angles associated with parallel lines in geometry and the social constructivist theory was the best suitable theory to connect this research study.

3.7. THE ELEMENT OF SOCIAL CONSTRUCTIVIST THEORY IN RELATION TO LEARNING IN GEOMETRY

Geometry is a source of visualisation that can be used for understanding statistical, algebraic and other arithmetical concepts in mathematics (Sunzuma, 2019). The social constructivist theory encourages learners to construct meaning and understanding on their own through experiencing and geometry requires learners to solve problems by integrating what they have learnt in the classroom situation with the real life situations.

Pavlovicova and Svecova (2015, p. 991) stated that "without geometric experiences, most people do not grow in their spatial sense or spatial reasoning". In order to understand geometry, spatial reasoning is very important especially in visualisation. However, geometry has been regarded as one of the topics that contributes to learners' poor performance in mathematics (Sunzuma, 2019). In many cases, the poor performance is the result of certain teaching and learning approaches that do not encourage learners to be responsible for their learning by being active during the process of learning. Pavlovicova and Svecova (2015) further outlined, that teachers should provide learners with appropriate experience and opportunities to be active in their learning experiences.

Once learners are fully involved in the process of learning, they are able to derive knowledge and understanding by incorporating what they acquired from the classroom situation with real life experiences which are the core fundamentals of learning geometry. The social constructivist theory in this research study supported the van Hiele's levels of geometric thinking whereby learners develop geometric thinking skills by interacting and discussing concepts with peers or even with the teacher during problem solving or discovering of new concepts.

In this research study, learners' prior knowledge of geometry from the previous grade was identified and used in order to orientate them to new knowledge (Aydisheh, 2015). For example, Table 3 exhibits the gradual movement of geometry from Grade 7 to Grade 8 according to the Curriculum and Assessment Policy Statement (CAPS) in mathematics.

Table 3. 1; Gradual movement of geometry from Grade 7 to Grade 8 adapted from the Mathematics Curriculum Assessment Policy and Statement (CAPS) document Department of Basic Education (2011, p. 28)

TOPIC	**GRADE 7**	**GRADE 8**
Geometry of straight lines	**Define:** • Line segment • Ray • Straight lines • Parallel lines • Perpendicular lines	**Angle relationships:** • Recognise and describe pairs of angles formed by: - Perpendicular lines - Intersecting lines - Parallel lines cut by a transversal **Solving problems** • Solve geometric problems using the relationships between pairs of angles described above.

According to the Curriculum and Assessment Policy Statement (CAPS) document in Grade 7, learners are expected to know and define types of straight lines and in this regard parallel lines. Learners are only focusing on knowing how to construct parallel lines and how to identify them amongst other lines using the properties of parallel lines (Department of Basic Education, 2011b). In Grade 8, learners according to the CAPS document Department of Basic Education (2011) are expected to integrate properties of straight lines involving parallel lines from the previous grade to understand the three main rules of angle relationships of parallel lines namely; corresponding angles, co-interior angles and alternate angles, to solve problems and identifying angles associated with parallel lines in geometry.

3.8. CONCLUSION

The social constructivist theory as explained in this chapter emphasises the importance and relevance of encouraging learners to be active learners in order to be able to construct their own meaning and understanding. According to Kandil and Isiksal- Bostan (2019), if learners are actively involved in their learning, they can describe and actively express what they have learnt in their own words. In this research study, social constructivist theory suggested that learners must apply their prior knowledge, self-derived knowledge and understanding in order to investigate open ended tasks and solve problems in the classroom situation and in their real life situations (Bozkurt, 2017).

CHAPTER 4

RESEARCH METHODOLOGY

4.1. INTRODUCTION

This research study aimed to explore the challenges experienced by learners when learning angles associated with parallel lines in geometry in order to explore possible solutions and ways to improve the understanding of learning angles associated with parallel lines in geometry.

In the preceding chapter, I have explored the theory of social constructivism as the framework to guide and support this research study. I then elucidated the importance of the application of the theory of social constructivism theory regarding Grade 8 learners' experiences in the learning of angles associated with parallel lines in geometry. This chapter focuses on the demonstration of the processes used to address the purpose of this research study. Ary, Jacobs, Irvine and Walker (2018), described research as a systematic approach in which conclusions are created from facts derived from general to distinctive knowledge through logical engagements. It is for these reasons this chapter explained the in-depth processes conducted when collecting, organising and analysing data in order to fulfil the purpose and the objectives of the research study (Bertram, 2014).

I have briefly explained and justified the procedures of selecting the paradigm in which this research study falls under, the research approach and the style of research, the geographic location in which the research study took place, research sampling, data collection processes and analysing techniques, ethical consideration, trustworthiness and validity, credibility, dependability, confirmability and limitations of the research study.

4.2. RESEARCH DESIGN

Research design is an overview and a guide of how the research will systematically follow processes to gather data that will answer the research questions and outline the intentions of the research study (Lewis, 2015).

According to Dannels (2018), a research design is regarded as the blueprint of the research study that holds the research study together. Therefore this research study followed all systematical protocols and guidelines of a research design.

4.2.1. Research paradigm

A research paradigm has numerous definitions viewed by various scholars around the world (Thanh, 2015). Bertram and Christiansen (2014) defined the research paradigm as a particular worldview that outlines what is acceptable in conducting a research study and, it acts as a guiding line to interpret the reality. Nicotera (2017) demonstrated that there are 3 major paradigms in the research field namely post-positivist, interpretivist and critical-interpretivist. She then further emphasised the ontology, epistemology, axiology and praxeology of each paradigm.

This research study is situated within the interpretivist paradigm. According to Dean (2018), the interpretivist paradigm derives the subjective, multiple and social reality from subject. Thanh and Thanh (2015) explained that the interpretivist paradigm does not allow predictions or assumptions but focuses on viewing the world through perceptions and experiences. This research study sought to explore challenges Grade 8 learners' experienced when learning angles associated with parallel lines in geometry and this research study was framed well with the above mentioned qualities of the interpretivist paradigm. As stipulated by Nicotera (2017), there are 3 major paradigms the researcher could choose. For example the post-positivist paradigm accepts only one truth and predicts meaning and understanding (Bertram, 2014), differing from the interpretivist paradigm which accepts multiple viewpoints and experiences of different individuals from different backgrounds (Paul Victor, 2016).

In the previous chapter this research study was framed under the social constructivist theory which encourages and supports that learners must be able to construct their own meaning and understanding through their experiences and social interactions (Bull, 2013). Since ontology is about the nature of reality, this research study also focussed on gaining insight about the nature of knowledge and experiences of Grade 8 learners when learning the angles associated with parallel lines in geometry.

It is for these above mentioned reasons that the interpretivist paradigm was used to guide this research study in order to answer all the research questions. In the next section, I present the research approach adopted by this research study.

4.2.2. Research approach

There are three research approaches that are used by researchers, namely qualitative, quantitative and mixed method research approaches. In this research study, I have used the qualitative research approach to understand the challenges Grade 8 learners experienced when learning the angles associated with parallel lines in geometry. The qualitative research approach is described as an approach that is used to understand experiences of the investigated participants Teherani (2015).

According to Stage and Manning (2015), the qualitative research approach assists us to understand and explain the meaning of any social phenomena. In this research study, the phenomenon that was under focus was the challenges experienced by learners. Using the qualitative approach to find these challenges was suitable since the qualitative research approach is applied to understand people's experiences and it is much about all social practices (Silverman, 2016). Since the research paradigm of this study is interpretivist which views the world through perceptions and experiences of participants, this lead the study back to the theory of social constructivism within which the study is framed. Hence, the use of the qualitative research approach was valid and fitted well with the research study (Bertram, 2014).

The social constructivism theory and the interpretivist paradigm encourage social interaction and the qualitative research approach requires the researcher to collect data in a more contact based situation, this involves an interaction between the researcher and the participants. This was also asserted by Thanh and Thanh (2015) when they defined the qualitative research approach as an approach that seeks experiences, understanding and perceptions of individuals to uncover the reality.

This research approach led the research study to adopt a case study method to collect data that was in line with the theoretical framework, the paradigm and the approach of the research study.

4.2.3. Research style

The interpretivist paradigm favours the qualitative research approach and qualitative research style (Thanh, 2015). In this research study I explored the case of Grade 8 learners' challenges experienced when learning the angles associated with parallel lines in geometry therefore the case study research style was used to drive this research study.

There are countless definitions of the case study research style found in literature. Among these definitions, Meyer (2015) defines case study as a style that investigates actions, attitudes and social structures of individuals by observation, interviewing and analysis of documents. Stake, as quoted by Yazan (2015, p. 139) describes case study as an "intensive, holistic, description and analysis of a bounded phenomenon". The theoretical background of the case study is a qualitative approach and interpretivist paradigm is based on the claim that reality is socially constructed through an exploration of experiences (Meyer, 2015). Therefore, the case study research style is about exploring certain phenomenon in- depth. The definitions given by the above mentioned scholars fitted the intentions of using case study research style in this research study.

This research study adopted Yin's (2009) 6 stage case study process to investigate and understand the challenges Grade 8 learners experienced when learning angles associated with parallel lines in geometry.

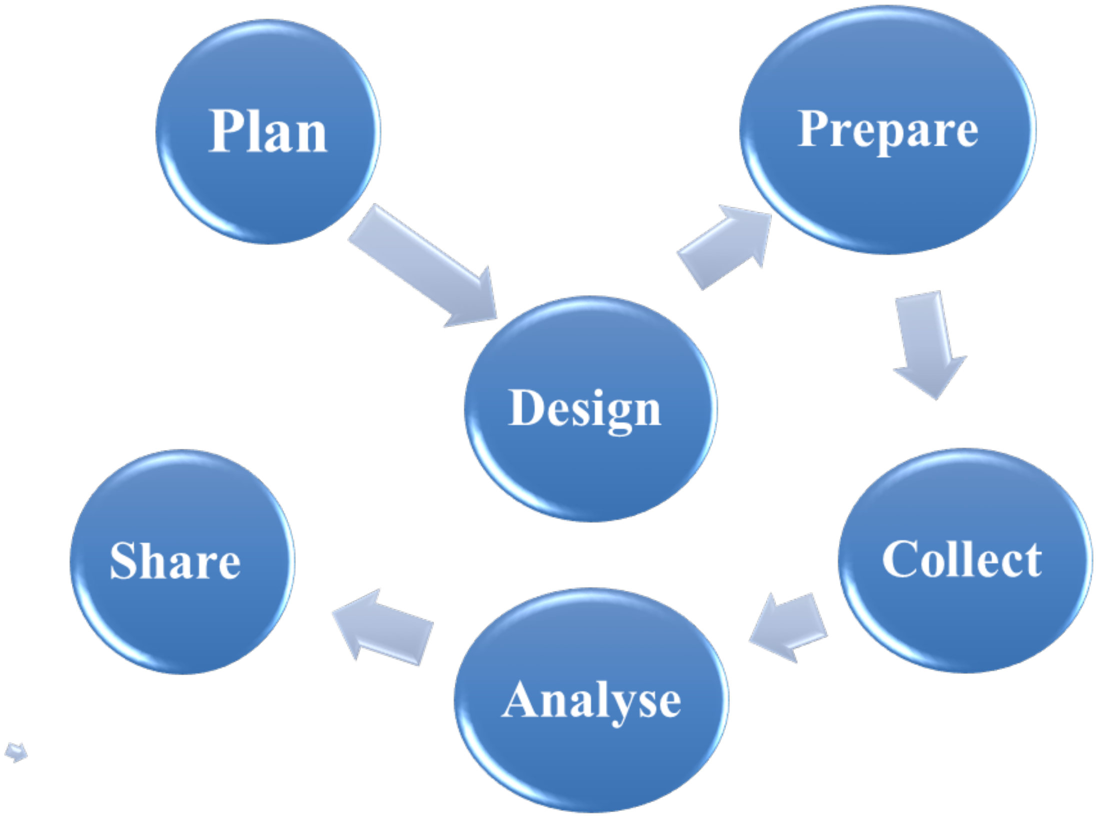


Figure 4.1: The 6 stages case study processes adapted from Baskarada (2014, p. 3)

Figure 4.1 gave this research study guidelines in conducting and evaluating the qualitative case study (Baskarada, 2014). Each stage is elaborated as follows:

- **Plan**
  The planning stage focused on understanding the research questions of this research study to make sure that they fitted and matched the case study research style. Understanding of the research questions and the rationale of this research study led to the confirmation that, the interpretivist paradigm this study followed is aligned with the case study research style.

- **Design**
  This stage focused on designing a plan that will link the research questions, the rationale, the theoretical framework, the paradigm, the approach, data collection and analysis method of the research study to understand the Grade 8 learners'

experiences. The designed plan guided this research study and spoke to the qualities and characteristics of the case study research style.

- **Prepare**

  The preparing stage focused on conducting a pilot study in order to identify any ambiguity to ensure that there was a valid ethical clearance obtained from all stakeholders for the research study.

- **Collect**

  The collect stage ensured that all protocol was observed regarding data collection procedures.

- **Analyse**

  This stage relied on the social constructivist proposition and other methods or approaches used. The analysis stage was about categorising, examining, tabulating or reconnecting evidence to draw findings.

- **Share**

  The share stage focused on reaching the conclusion on the investigated phenomena and the conclusion related back to the literature. The conclusion discussed the findings and shared the findings with the participants in order to obtain an accurate report.

Furthermore, Yin as cited by Yazan (2015, p. 140) allotted 5 components of the case study research style that must be considered when using the case study as a research style, which are:

1. The research study questions.
2. The research study propositions.
3. The research study unit of analysis.
4. The logic linking the collected data to the propositions.
5. The criteria for interpreting the findings.

In addition, Yin as cited by Yazan (2015, p. 140), using a case study as a research style presents a strategy in responding to the “How” or “Why” questions.

I then derived the Table 4.1 that directed and kept this research study in line with the qualities and components of the case study research style to gain an in- depth insight about the challenges experienced by the Grade 8 learners when learning the angles associated with parallel lines in geometry.

Table 4.1; Qualities and components of a case study research style by Yin as cited by Yazan (2015, p. 140)

RESEARCH STUDY QUESTIONS	PROPOSITIONS	UNIT OF ANALYSIS	LOGICAL LINK TO PROPOSITION	CRITERIA FOR INTERPRETING FINDINGS
What challenges do Grade 8 learners experience when learning angles associated with parallel lines in geometry? How and why do Grade 8 learners experience challenges when learning angles	Constructivism theory.	Grade 8 learners learning angles associated with parallel lines in geometry.	Pattern matching. Categorical aggregation. Narrative analysis.	Trustworthiness Validity Credibility Confirmability

associated with parallel lines in geometry?				

Therefore, this research study focused on a single case that resulted in the consideration of an explanatory qualitative case study (Bertram, 2014).

4.3. GEOGRAPHIC LOCATION

This research study was conducted at a school situated in Pietermaritzburg, KwaZulu-Natal, South Africa to fit the purpose of this study. The researcher and the participants met 9 times for the research study to be completed, which did not affect the teaching and learning process. Participants were provided with refreshments during these research meetings.

4.4. RESEARCH SAMPLING

Sampling involves making decisions about participants, background, events or behaviours to include in the research study (Bertram, 2014). The nature of this research study required full descriptive and detailed data. A sample of participants was selected to be part of this research study. In the interpretivist paradigm according to King (2018, p. 20) the qualitative research approach aims to gather accurate information of the participant's real life experiences. Accurate information can be gathered through a chosen population from strategic sampling processes (Etikan, 2016).

Gentle (2015, p. 1775) defines sampling as "the selection of specific data sources from which data are collected to address the research objectives". Gentle (2015, p. 1773) then further reviewed the characteristics of the three research traditions regarding sampling within the qualitative research approach which were:

- The grounded theory- which is the system used to obtain data that will suit the purpose of the research study.
- The phenomenology- which is an approach to understand the lived experiences.
- Case study- which helps to select data sources.

This research study sought to determine the challenges experienced by Grade 8 learners when learning angles associated with parallel lines therefore, the Grade 8 learners were the ones who were providing the useful information about this phenomenon.

In addressing the research questions and the purpose of this research study, Table 4.2 was derived from the reviewed research traditions and used to guide the selection process of the sampling method that was used in this research study.

Table 4.2: Reviewed research traditions by Gentle (2015, p. 1773)

Grounded Theory	Phenomenology	Case Study
The constructivist ground theory was suitable to obtain data which this research study was seeking and framed under. Learners were the centre of this research study where their social interaction and experiences were studied and to get the correct and meaningful data, this research study focused only on the lived experiences of the learners. This ground theory guided this research study to know where to obtain correct data which is where there was social interaction and lived experiences.	In order to understand the lived experiences of the learners, this research study was directed specifically to choose the exact sample that will give the acquired information. This research study explored the challenges experienced by Grade 8 learners and the phenomenology sampling was only focusing on the experiences of Grade 8 learners.	This research study is exploring the phenomenon in-depth by investigating actions and social interactions of learners therefore this research study was a case of Grade 8 learners only who are learning geometry in mathematics.

The application of Table 4.2 led this research study to use purposive sampling since this research study did not aim to generalise the findings to a wider population (Barratt, 2015).

According to King (2018), it is important to use correct method when selecting the exact sample that will give relevant information. This means that the researcher must know where and which method to use when gathering proper data, which can be attained by knowing who is can be willing to provide information through their knowledge or experiences. Etikan (2016, p. 2) stated that “Data is meant to contribute better understanding of a theoretical framework by concentrating on a specific sample with particular characteristics that will contribute to the research study”. This research study focused on Grade 8 learners specifically to answer the research questions.

Silverman (2015, p. 61) asserted that selecting a sample purposively must be based on the group which the research study problem addresses. Etikan (2016) also alluded that a purposive sampling gives unique and rich information of value. He further mentioned different types of sampling and this research study followed the maximum variation type of sampling. The maximum variation sampling looks at the holistic angles of the phenomena from all types of individuals with their different capabilities and backgrounds. The sample size of this research study was 36 Grade 8 learners purposively selected since the researcher is teaching them mathematics at school. However, this did not mean that 36 responses were expected considering that learners have rights to withdraw from participating in the research study.

Thus, the sample was not randomly selected rather, it was purposely selected and the collected data cannot be generalised beyond the selected group sample (Bertram, 2014).

4.5. DATA COLLECTION

The data collected was qualitative in nature which was done in order to understand the purposively selected participants from their own frames of reference (Taylor, 2015). Data was collected through learner’s experiences within their social interactions when learning angles associated with parallel lines in geometry. Data collection process refers to the evidence or information the researcher collected to find answers to the research questions of the research study (Bertram, 2014). In this section, the nature of data and collection methods was described and used to gain full insight of the experiences of Grade 8 learners when learning.

4.6. RESEARCH INSTRUMENTS

There are many ways of collecting data which are influenced by the research questions, the research design and the paradigm. In this research study, I used the Curriculum Assessment Policy Statements (CAPS document), questionnaire, worksheet and interviews to obtain information on the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. The reason for using the four data collection instruments is that according to Bertram and Christiansen (2014) using two or more data collection instrument helps the researcher to obtain an in-depth understanding of the researched situation.

The use of the CAPS document was to determine the concepts that Grade 8 learners needed to know in the learning of angles associated with parallel lines in geometry and looking at the gradual movement of the curriculum from the previous grade in line with the General Education and Training (GET) phase's syllabus. This assisted this research study to gain in-depth knowledge of learners' prior knowledge regarding parallel lines in geometry since effective learning is derived from the prior knowledge of the learner that will influence the learner's new knowledge to be more understandable (Amineh, 2015). This information was also attained through the use of the questionnaire to obtain the profile of the learner. This was achieved through open-ended and closed-ended questions and participants were given a day to complete the questionnaire subsequent to a briefing about the research study and signing of all consent forms.

After obtaining the background of the participants and their prior knowledge regarding the angles associated with parallel lines in geometry, I used different types of teaching strategies to teach the geometric concepts in line with the CAPS document, such as:

- The use of technology instead of using paper based diagrams. Learners were introduced to computer programs such as GeoGebra and Sketchpad. I encouraged learners to also download the software' into their computers at home and cell phones. Using technology in the learning of geometry empowered learners to discover geometric relationships and ways to solve riders that they would not have discovered through the use of traditional teaching and learning (Skultety, 2017).

- The theoretical lens used for this research study was social constructivism which encouraged learning through social interactions and self-regulated learning was taught to learners.

  This helped learners to take control of their learning by doing research at home as part of their homework about the next day's topic. On the next day learners were given a chance to teach others about what they have learnt and their thinking about that certain topic they were presenting. This strategy helped learners to remember all important information since they did the process of learning on their own by discovering new meaning and understanding (Lai & Hwang, 2016; Fadlelmula, Cakiroglu & Sungur, 2015).

- Review and Practice, helped learners to reflect on what they have learnt, asking questions, correcting misconceptions and also practice what they have learnt once a week in order to equip them and improve their understanding of the geometric concepts (Rohrer, 2015).

A worksheet was administered to assess the level of understanding that learners possesses and competence regarding angles associated with parallel lines. This worksheet was a tool that helped to measure how far and deep the geometric concepts that has been transmitted to the learners have been understood, checking if learners were on the right path according to the objectives of the content of angles associated with parallel lines and expected to be achieved (Liljedahl, 2010). The worksheet provided information on learners existing knowledge and challenges they have experienced. This data collection tool assisted to identify regularities occurring from each learner during solving the given riders. After learners completed the worksheet, the researcher communicated the progress of learning to the learners to provide feedback on their performance which helped the researcher to compare the results between the responses from the questionnaire and the worksheet.

Within the qualitative case study, it is easy to view conversation within the interview situation (King, 2018). According to Bertram and Christiansen (2014), and King (2018), an interview is a discussion between the researcher and the willing participant in order to get descriptive and accurate information. This research study adopted semi-structured interviews as one of the data collection instruments.

The semi-structured interviews provide flexible and useful information from a focused yet two way communication between the researcher and the participant furthermore, participants are given a chance to further explain their views and responses in details (Pathak and Intratat 2016).

In this research study, interviews were conducted after the worksheet's feedback. This helped the researcher to assess challenges experienced by learners before the research study, through the teaching and learning process until they had to work on the worksheet.

These interviews were recorded using a voice recording device with the permission of the participant for validity and reliability purposes. The reasons to audio record the semi-structured interviews were to make it easy to transcribe and analyse the responses thoroughly without losing any information from the participants.

4.7. DATA ORGANISATION

According to Beighton (2019) when you organise data, you are systematically arranging or assembling it in an order to discover in-depth understanding of the phenomenon based on interpretation of collected data through data analysis. In this research study, qualitative data was collected from the Curriculum Assessment Policy Statements (CAPS document), questionnaire, worksheet and interviews to obtain information on the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

4.8. DATA ANALYSIS

Data analysis refers to exploring data thoroughly to look for patterns and relationships that will confirm, disprove or discover results for the researched phenomena (Chambers, 2017). Bertram and Christiansen (2014) mentioned that there are two broad approaches used in a qualitative data analysis which are, inductive reasoning and deductive reasoning. They further described inductive reasoning as a process of organising data into categories and identifying patterns or relationships to develop conclusions. In this research study an inductive data analysis process was used to evaluate and sort data into categories or codes by the use of Table 4.3.

Table 4.3; Data evaluation process by Naidoo (2018) derived from Data collection workshop.

RESEARCH QUESTIONS	RESEARCH INSTRUMENTS	ANALYSING DATA
What challenges do Grade 8 learners experience when learning angles associated with parallel lines in geometry?	• CAPS document. • Questionnaire. • Semi- Structured Interview.	• Determine pre-existing geometric concepts from the gradual movement. • Reading of notes taken. • Listening to audio recordings and transcribe the recording, • Finding Patterns or common response & use coding to categorise data.
How and why do Grade 8 learners experience challenges when learning angles associated with parallel lines in	• Semi- structured Interview. • Worksheet.	• Transcribe and reading the transcription to get similarities.

geometry?		• Analysing each question by coding numeric data (correct and incorrect answers) of each question answered, • Finding out the geometric solving skills. • Putting the results into themes and compare the results with the interview schedule transcripts.

This process helped the researcher to find related patterns occurring from the data collected to draw conclusions. After the data was categorised according to their codes, the data was displayed using graphs and tables for further interpretation in order to draw findings and conclusions.

4.9. ETHICAL CONSIDERATIONS

Ethical consideration according to (Swain, 2016) refers to the moral principles or rules of conduct that guide the conduct of a research study. These principles or rules are implemented to protect the rights of participants and making sure that all procedures are followed correctly during the research study (Ketefian, 2015). There are numerous key ethical codes to be considered when conducting a research study Swain (2016). This research study then adopted King's (2018, p. 33- 35) ethical codes that supported this qualitative research study:

- **Gate keeper**

Gate keeper's permission from the Principal of the school was sought and received in order to conduct this research study.

- **Informed consent**

  In this research study, participants were fully informed about the research procedures by giving them the consent form to read and sign voluntarily before data collection took place.

- **Confidentiality**

  In this research study, information gathered about participants was maintained with confidentiality except where the information was leading to significant risk of harm to the participants. However, participants were fully aware of this exception. Furthermore, participants' identities and the description of the school were protected by using pseudonyms and the collected data was used for the research purposes only.

- **Right to withdraw**

  The participants were assured to feel free to withdraw from participating in this research study without fear of being penalised on their academic performance.

- **Assessing risk of harm**

  In this research study, the location where the study was conducted and implemented applied all safety majors to ensure non-maleficence to participants. This research study did not result in any form of abuse or harm physically, emotionally, socially or any other form of harm to the participants.

- **Deception**

  Deception in this research study was avoided except when there was no other way to answer the research questions given to the participants and the potential benefit of the research far exceeded any risk to participants.

- **Debriefing**

  The participants understood the research study and its aims including how data was used. This was done in the beginning of the research study during the consent form session before data collection and throughout the research process as a reminder to the participants to make sure that, we were all on the same page until the end of the research study.

- **Use of incentives**

  This research study was conducted during break time in the school where by participants were supposed to be having their lunch. In that regard, refreshments were provided in each session to participants for the sake of their wellbeing and concentration in the next class. Another reason was to avoid lunch box competition and comparison since all participants were diverse and came from diverse social backgrounds. However, this provision was carefully conducted in a manner that it was not a catalyst to induce participants to say or do things they otherwise would not.

- **Limitations to the researcher's role**

  The participants including the researcher were not allowed to involve their teacher-learner relationship, during the research study. This research study was not going to benefit the participants personally or academically outside the objectives and aims of the study. Participants were constantly reminded of the rules and regulations stipulated in their consent form.

- **Honesty and integrity in this research process**

  As the researcher, I understood that I have an ethical obligation to the participants, the research community, the institution and the wider society to conduct this research study in a fair and honest way.

These ethical codes were considered in this research study in order to protect the participants from any harm, aiming to preserve the well-being and dignity of the participants and the success of the research study. In addition, I requested permission from the school, the school governing body the parents and learners to conduct this research study and, permission was granted (see appendix A, B, C & D). Prior to conducting the research study, I applied and obtained approval from the University of KwaZulu-Natal Ethics Committee and was given protocol reference number: HSS/0411/018M (see appendix E).

4.10. VALIDITY (PILOTING OF INSTRUMENTS)

Dikko (2016) asserted that validity aims to ensure that the research study is adequate. He further stated that one way to ensure that validity is achieved is through conducting a pilot study of research instruments. In this research study piloting of research instruments was done with Grade 9 learners just before they started their geometry topic in Grade 9.

A pilot study was conducted with the people who mirrored the characteristics of the sample to be studied (Castillo-Montoya 2016). In this research study, the former Grade 8 learners fitted the purpose of piloting due to their prior knowledge from Grade 8. The reason the researcher chose to conduct a pilot study with the former Grade 8 learners was that, it assisted the research study to get a realistic sense of how long each research instrument will take, if the response of the participants will be able to answer the research questions, taking notes of the things that need to be improved, making final revisions to all protocol and to prepare the implementation of the research study (Castillo-Montoya, 2016).

4.11. TRUSTWORTHINESS

Trustworthiness is evidence that endorses the research study to be valid and reliable (Kornbluh, 2015) and it gives full details of the characteristics of the rigor process to document and the planned time for conducting trustworthiness of the research study (Amankwaa, 2016). In this research study, the degree of confidence in data, interpretation to ensure quality of the research study included the credibility, dependability and conformability (Connelly, 2016).

4.12. CREDIBILITY

According to Yin (2011) as cited by Stewart (2017), credibility is building a chain of evidence through note taking, memorandums for worksheets, member checks, peer debriefing, prolonged engagements, persistent observation, frameworks and typologies. He further illustrated credibility as majored by transparency where thick description is given, method-ness where an orderly approach is used and adherence to evidence where all steps of data collection are documented. In this research study, I spent the entire month with the participants to gain understanding of their culture, nature of learning, experiences in learning and the use of technology as a learning resource.

Semi-structured interviews created a platform for an open conversation with the learners as they shared their experiences in depth which were done to increase credibility of this research study. Furthermore, my supervisor was provided with all information collected from the learners to check for correlation and securely store it in the department's data storage for a period of 5 years.

4.13. DEPENDABILITY

This research study was under the supervision allocated by the University of KwaZulu-Natal. The supervisor frequently checked and moderated all steps and approaches taken in this research study to ensure that no information was replicated from other scholars (Tong, 2016). This was done through the panel of scholars who critically evaluated the proposal and approved the research study to be conducted. In addition, this research study underwent an examination until it was approved by the external moderator.

4.14. CONFIRMABILITY

In this research study, four data collection instruments were used to obtain in-depth information (Bertram, 2014), other researchers were involved during the process of analysis to verify and confirm legitimacy of this research study and participants were involved in assuring that the findings of this research study were legitimate and according to what the researcher experienced.

4.15. LIMITATIONS

This study explored challenges Grade 8 learners experienced when learning angles associated with parallel lines in geometry in a certain school in KwaZulu-Natal, with a purposively selected sample. Thus the findings of this research study were not generalised beyond the purposively selected sample.

4.16. CONCLUSION

This chapter demonstrated the processes used to address the purpose of this research study by explaining the in-depth systematic processes the research study followed. This chapter outlined the paradigm in which the research study fell under, the research approach and the style of research used, the geographic location in which the research study took place, research sampling, data collection processes and analysing techniques, ethical consideration, trustworthiness and validity, credibility, dependability, conformability and limitations of the research study.

CHAPTER 5

DATA PRESENTATION AND ANALYSIS

5.1 INTRODUCTION

This chapter presents and analyses data generated from Grade 8 learners to explore challenges they experienced when learning angles associated with parallel lines in geometry. Since this research study used a qualitative research approach to understand the experiences of Grade 8 learners, Curriculum Assessment Policy Statement (CAPS document), questionnaire, worksheets and interviews were used to generate data. The data collected was to respond to the following research questions:

1. What challenges do Grade 8 learners experience when learning angles associated with parallel lines in geometry?
2. How and why do Grade 8 learners experience challenges when learning angles associated with parallel lines in geometry?

Anonymity and confidentiality were maintained by using pseudonyms as follows: Learner 1 (L1), Learner 2 (L2), and Learner 3 (L3) up to Learner 36 (L36). The group worksheets were given to five randomly selected learners and randomly the remaining 31 learners were split into five groups namely, Group 1 (G1) up to Group 5 (G5).

5.2 DATA PRESENTATION.

This research study was conducted with 36 Grade 8 learners who participated in an individual and group worksheet. The data collection tools (CAPS document, questionnaire, worksheets and interviews) used in this research study aided the researcher to present findings in table formats. Table 5.1 and Table 5.2 present learners responses to questions that required understanding of angles associated with parallel lines, for instance being able to identify corresponding, alternating and co-interior angles. Table 5.3 and Table 5.4 present learners' responses to questions that required an understanding of angles associated with parallel lines within their designated groups and the results of what learners assumed were correct answers.

Table 5.5 and Table 5.6, presents the comparison of each learner within their randomly selected groups. The analysis drawn from the conducted interviews from 4 randomly selected learners from each group strengthened the links between the learners' individual and group worksheet responses. The interviews' response' were recorded under data analysis and the transcripts are attached as appendix J.

The individual worksheet, group worksheet and the scheduled interviews were conducted and analysed in a manner in which learners displayed their understanding of angles associated with parallel lines. Learners were expected to show their levels of geometric thinking, the use of visualisation to understand concepts in geometry, their perception of concepts in geometry, their basic knowledge and skills in geometry and misconceptions and language as a learning barrier when learning angles associated with parallel lines in geometry.

5.2.1. Curriculum assessment policy statement and questionnaire

The use of the Curriculum Assessment Policy Statement document was to ensure that there was a gradual movement from the previous grade in order to achieve progression that will lay a solid foundation in the Further Education and Training (FET) (Department of Basic Education, 2011b). According to the CAPS document (2011, p. 27-28), progression in geometry is achieved by developing descriptions of geometric figures from informal to formal definitions, solving problems using known properties of geometry and developing inductive reasoning to deductive reasoning.

When you look at the CAPS document Department of Basic Education (2011, p 28), geometry of straight lines involving parallel lines is introduced in Grade 7, where learners are expected to recognise, describe and write clear explanations of the relationship between the pairs of angles formed by parallel lines cut by the transversal line.

In the Grade 8 curriculum according to the CAPS document Department of Basic Education (2011, p. 98), geometry of straight lines is revised and further introduced. This information assisted this research study on getting, how much knowledge of angles associated with parallel lines learners' have from the previous grade through the use of questionnaires. According to the questionnaires given to the learners, they did not know or understand the concepts within geometry except constructing and recognising different types of lines and their properties. At least 50% or more of learners were able to give their prior knowledge regarding the concepts within geometry.

5.2.2. Individual worksheet data presentation

Learners were given an individual worksheet, Table 5.1 and Table 5.2 display learners' responses to the individual worksheet.

Table 5.1: Summary of learners' responses to the individual worksheet question 1.1 & 1.2a

QUESTION	No. of learners who identified types of angles Question 1.1	Percentage	No. of learners who determined the value of angle E_4 Question 1.2a	Percentage
All identified	24	66,67%	1	2,78%
All not identified	5	13,89%	28	77,78%
Know Alternating Angles	24	66,67%	1	2,78%
Only corresponding Angles	7	19,44%	Not applicable	Not applicable
Know Corresponding Angles	31	86,11 %	1	2,78%
Know Co-int.	24	66.67%	1	2,78%

angles				
Wrong naming of angles	4	11,11%	3	8,33%
Misconceptions	N/A	N/A	11	30,56%
Spelling errors	13	36%	0	0%
Did not answer	1	2,78%	7	19,44%

Table 5.2: Summary of learners' responses to the individual worksheet question 1.2b

Question 1.2 b	**No. of learners who were able determine correct answers :**	**Percentage**
Angle $a = 40^0$ with correct reason	18	50%
Angle $a = 40^0$ without/ wrong reason	7	19,44%
Angle $b + 40^0 = 180^0$ with correct reason	3	8,33%
Transposing correctly	3	8,33%
Angel c= Angle b with correct reason	18	50%
Wrong naming of angles	9	25%

All correct	3	8,33%
All wrong	5	13,89%
Did not answer	3	8,33%

5.2.3. Group worksheet data presentation

Learners were randomly grouped into 5 groups and were given a group worksheet in order to explore challenges that they experienced when learning angles associated with parallel lines, Table 5.3 to Table 5.4 display learners' responses from their respective groups.

Table 5.3: Summary of each groups' response to each group worksheet questions

Question &answer	Group 1 achievement	Group 2 Achievement	Group 3 Achievement	Group 4 achievement	Group 5 achievement
1= A	0%	0%	0%	100%	0%
2 = G	0%	0%	0%	0%	0%
3 = F	100%	0%	100%	100%	0%
4 = C	100%	0%	100%	100%	0%
5 = A	0%	0%	0%	0%	0%
6 = E	0%	100%	0%	100%	0%

7 = N/A	0%	0%	0%	0%	0%

Table 5.4: The percentage of question 2 group worksheet matching column 1 & 2 results

	No.1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
All correct	20%	0%	60%	60%	0%	40%	0%
Corresponding angles	20%	0%	0%	0%	0%	0%	60%
Co-interior angles	20%	0%	0%	0%	0%	0%	0%
Alternating angles	N/A	40%	0%	0%	0%	0%	0%
Other angles	40%	60%	40%	40%	100%	60%	40%

5.2.4. Summary of each learner within each group

Table 5.5 and Table 5.6, display the results found when learners' individual results were compared within his or her group. Since the learners were grouped into five randomly selected groups, each question from the individual worksheet was checked and compared amongst other groups in order to find if, learners are performing better or experiencing challenges also when they learn through the interaction with one another.

Table 5.5: Summary of learners' response within each group

	Question 1.1					Question 1.2 a				
	G1	G2	G3	G4	G5	G1	G2	G3	G4	G5
All correct	100%	37, 5%	50%	85,71%	62,5%	14,29%	0%	0%	0%	0%
All wrong	0%	12, 5%	0%	0%	25%	85,71%	100%	100%	100%	100 %
Spelling error	85,71%	37,5%	66,67%	42,86%	25%	42,86%	12,5%	16,67%	14,29%	0%
Knows alternating angles	100%	37,5%	50%	85,71%	62,5%	14,29%	0%	0%	0%	0%
Knows corresponding angles	100%	75%	100%	85,71%	75%	14,29%	0%	0%	0%	0%
Knows co-interior angles	100%	50%	50%	85,71%	62,5%	14,29%	0%	0%	0%	0%
Mixing up contents	0%	12,5%	0%	14,29	37,5%	0%	0%	0%	0%	0%
Wrong naming of angles	0%	0%	0%	0%	0%	57,14%	12,5%	16,67%	0%	25%

Table 5.6: Summary of each learner's response within each group

	Question 1.1 b				
	G1	G2	G3	G4	G5
All correct	14,29%	0%	16,67%	14,29%	0%
All wrong	N/A	12,5%	33,33%	14,29%	50%
Spelling error	28,57%	25%	N/A	28,57%	25%
Knows alternating angles	85,71%	37,5%	33,33%	71,43%	37,5%
Knows corresponding angles	N/A	N/A	N/A	N/A	N/A
Knows co-interior angles	28,57%	0%	16,67%	14,29%	0%
Mixing up contents	0%	0%	0%	0%	0%
Wrong naming of angles	14,29%	0%	0%	0%	25%

5.2.5. Data from interviews

Interviews were scheduled to be conducted to five learners, one learner per group however, only four learners pitched for the scheduled interviews due to unforeseen circumstances experienced by the fifth learner. Responses from the interviews are recorded under data analysis.

5.3. ANALYSIS OF DATA

5.3.1. Learning geometry in mathematics

Learning involves transformation of knowledge in order to look at things differently than before (Geijsel, 2005). Learning requires learners to be actively involved in order to produce their own meaning and understanding when solving problems.

According to Boaler (2015), mathematics is a living act where learners need to practice and live it daily in order to derive ways to interpret the world. This means that every learner must develop love and interest to practice mathematics to learn with understanding. During the conversation between the researcher and the four randomly selected learners, 75% of learners indicated that they do not love mathematics. The following excerpt is of learners' responses to the interview question:

R (Researcher): *Do you love maths? Explain.*

L2: *No. Maths is not the subject that I love because; it has lot of hard things to learn.*

L12: *I love it but I like it depending on the teacher who is teaching it.*

L26: *No because, maths consists of geometry which is difficult.*

The question for Table 5.6 sought to enquire about learners' love for mathematics and their response indicated that there is no passion for it. According to Altintas (2018) when learners show interest and passion of mathematics, positive attitudes develop and anxieties of mathematics decrease. This shows that once a learner loses interest in mathematics, it is impossible to pay attention and understand what is being taught regarding mathematics. Brady and Winn (2014) as cited by (Altintas, 2018), suggest that mathematics requires effort, interest and hard work in order to derive meaning and understanding.

This research study explored learning of angles associated with parallel lines in geometry and from the conversation held with the learners, all the participating learners stated that geometry is a difficult topic in mathematics and they further outlined that it makes them hate mathematics as a subject.

The analysis drawn from the conversation strengthened the link between learning mathematics through traditional learning and the social constructivist theory point of view in which this research study is framed. According to Krahenbuhl (2016) learners must be actively learning individuals or be able to learn through social interactions in order to construct meaning and understanding.

This research study made use of individual worksheets and a group worksheet to explore the importance of social learning within learners. According to the responses from the conversation with the learners, 75% of the learners revealed that they were more comfortable to work on given problems and able to understand the procedures to be followed when they were working within the group.

R: *Did you benefit in answering the group worksheet with your peers? And how can you compare your understanding of angles associated with parallel lines on your group worksheet and individual worksheet?*

L21: *I did benefit, I could solve problems in the group because we understood each other. The knowledge from the group helped to gain more knowledge and understanding more than when I was working alone.*

Table 5.5 and Table 5.6 in question 1.1, learners were supposed to identify types of angles found in each diagram. 100% of group one (G1) learners were able to identify all angles in each diagram, 85,71% of group four (G4) learners were able to identify all angles, 62,5% of group five (G5) were able to identify, 50% of group three (G3) learners were able to identify all angles and 37,5% of group two (G2) learners were able to identify all angles.

When you look at the results of each learner within their group on the types of angles associated with parallel lines, relating to identifying alternating angles, group one (G1) learners got 100%, group four (G4) learners got 85,71%, group five (G5) learners got 62,5%, group three (G3) learners got 50% and group two (G2) learners got 37,5%. This provides evidence that, learners were performing better when they were engaging and interacting with other learners as compared to when they were doing the worksheets independently.

Social interaction during the learning of mathematics is regarded as the best way of learning for learners' understanding. According to Boaler (2015), learners understand an explanation much more from one another than from a teacher when they explain and justify their work to each other. This does not imply that the teacher does not teach the content well but sometimes the attitude and manner the teacher uses when teaching does affect the process of learning.

Good and Lavigne (2017) proposed that a teacher must be fully aware that every learner in a classroom context is unique and possesses his or her own level of capacity in terms of learning abilities. This means that, some learners may not fully understand the teacher hence it is important to create opportunities for learners to interact with one another during the process of learning.

5.3.2. Basic knowledge and skills when learning geometry

As discussed in Chapter 3, learners must be taught basic knowledge and skills. Jojo (2016) outlined that in order for leaners to understand geometry, they must be equipped with certain abilities of knowledge and basic skills.

In Table 5.2 question 1.2b, learners were expected to determine the values of angle *a, b* and *c*. The results displayed that 50% of learners were able to find the value of angle *a* and *c* with a correct reason and 19,44% were able to determine the value of angle *a*, but given an incorrect reason, 8,33% of learners were able to correctly write down the algebraic equation and correctly transposed in order to determine the value of angle *b*. 25% of learners were wrongly naming angles, 13,89% of learners were not able to correctly determine the values of angles and 8, 33% of learners did not attempt to answer the given rider. This tells us that, learners are lacking the basic knowledge of correctly determining the values of angles using critical thinking skills and problem solving skills. Jojo (2016) outlined that for learners to understand geometry, they must be equipped with certain abilities of knowledge and basic skills. Learners were expected to integrate their basic knowledge from solving algebraic equations into deriving solutions for the missing values of angles.

5.3.3. Learners' misconceptions when learning geometry

Ojose (2015b) outlined that learners in all grades have misconceptions when learning various concepts in mathematics.

This means that learners have tendencies of deriving their own notion of certain mathematical concepts when learning mathematics which is confirmed by the results shown on Table 5.1 question 1.1**.** When you study the results from this research study, 13,89% of learners were not able to identify any angles, 11, 11% showed that they experienced misconceptions as they were naming angles associated with parallel lines using acute, right angles etc.

These responses gave the researcher an insight that when the learners looked at the drawn figures, they only visualise other angles for example, the "Z" shape figure looks like an acute angle when you turn a blind eye to the top part of the shape and the "F" shape figure gives you right angles when the two parallel lines touch the vertical line perpendicular. Learners' mixing up of concepts led to misconceptions and hence were unable to attain correct results to the question.

In question 2 of the group worksheet, learners were expected to match column 1 and 2 by referring to a given diagram. This question consisted of different angles associated with parallel lines and straight lines, Table 5.3 and 5.4 display groups' responses to the group question 2 worksheet.

Table 5.3, showed that 25, 71% of question 2 was correctly answered and 11, 43% was correctly answered by group four (G4), 5, 71% was correctly answered by group three and group one (G3 & G1). Group two (G2) only correctly answered 2, 86% of the questions and group five (G5) did not get any correct answers (0%). These results indicate that learners are experiencing many challenges regarding angles associated with parallel lines. When you study the results of each group, you find that the reasons that made learners fail matching correctly the two (2) columns is that learners are mixing up properties of all angles especially angles found in triangles with angles associated with parallel lines.

Table 5.5 and Table 5.6, relating to identifying corresponding angles, group one and three (G1& G3) leaners got 100%, group four (G4) learners got 85,71% and group two and five (G2 & G5) got 75% . Relating to identifying co-interior angles group one (G1) learners got 100%, group four (G4) learners got 85,71%, group five (G5) learners got 62,5% and group two and three (G2 & G3) got 60 %, 12,5% of group two learners, 14,29% of group four (G4) learners and 37,5% of group five learners were mixing up contents. These three learners on these groups assumed that properties of angles associated with parallel lines are the same as those of acute, right angle, obtuse etc. angles.

This is also evident from the conversation with Learner two (L2) who displayed high results of misconceptions when asked a question as follows;

R: *How many types of angles associated with parallel lines do you know? Name them.*

L2: *Acute, isosceles, triangles…. Parallel lines are opposite to each other…*

Learner two (L2) was provided with an additional figure from the individual worksheet to identify angles associated with parallel lines and he identified a ninety degrees angle (90^0) and called it an acute angle. The learners were given another figure showing "FUN" to identify angles associated with parallel lines, and the learner identified the co-interior angles as obtuse and acute angles.

According to Poon and Leung (2016), learners' misconceptions of geometry may be categorised into five categories which are; not being able to derive meaning of the applications of geometric concepts, making errors in using basic geometric concepts when solving complex problems, inability to acknowledge different forms of the same geometric concepts (symbolic, visual, etc.), lacking concrete understanding of geometric concepts and inability to recall geometric principles. If these misconceptions are not dealt with, learners will carry on experiencing challenges in learning angles associated with parallel lines in geometry.

5.3.4. The levels of geometric thinking

There are five levels of Geometric Thinking (Van Hiele, 1999) and each learner must gradually improve from one level to another at his or her own pace (Donohue, 2015).

In Table 5.1 question 1.2a of the individual worksheet, learners were to determine the value of one angle by integrating their prior knowledge of interior angles and triangle properties or the use of the properties of co-interior angles.

The results showed that 2,78% were able to find the value of angle E_4 using co-interior and corresponding angles strategy, 19,44% did not attempt to write, 77,78% did attempt but all methods used were incorrect. Apart from the 2,78% who were able to determine the value of angle E_4, the 77,78% of learners experienced challenges in recalling and applying all properties of angles formed by parallel lines intersected by a transversal line.

Figure 5.1 depicts the responses of L20.

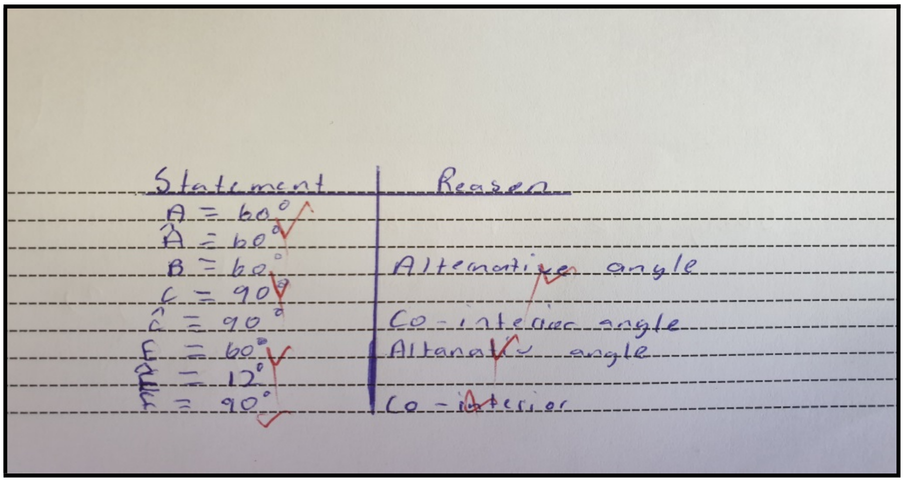


Figure 5.1: The response of L20 to question 1.2a

In the above excerpt, L20 understood that the given figure was a triangle but treated the triangle as an isosceles triangle. This is evident when the learner states that angle A = 60^0 which was given and the learner continued to state that angle B= 60^0, meaning that angles A and B are equal. The reasoning of angle B= 60^0 showed that the learner was mixing up the content of triangles and angles associated with parallel lines, the learner's reasoning was angle B is alternating with angle A hence both are 60^0.

When you analyse this response further, it was apparent that L20 knew that co-interior angles are associated with parallel lines as the learner recognised that angle C= 90^0 but gave a wrong reason and angle F= 90^0 with a correct reason but not correctly naming the angle as F_2. The learner forgot that the sum of two angles equals to 180^0 which forms co-interior angles, rather, the learner assumed that angles C and F are equal and the reason is co-interior angles.

This is evident that, learners are still struggling with level one (visualisation) and level two (analysis) of the geometric thinking where they are expected to be able to identify any geometric figure by its appearance, the learners can recognise any form of shape and examine things in full detail in order to discover meaning and understanding (Van Hiele, 1999).

The Figure below displays the correct geometric methods correctly used by L4.

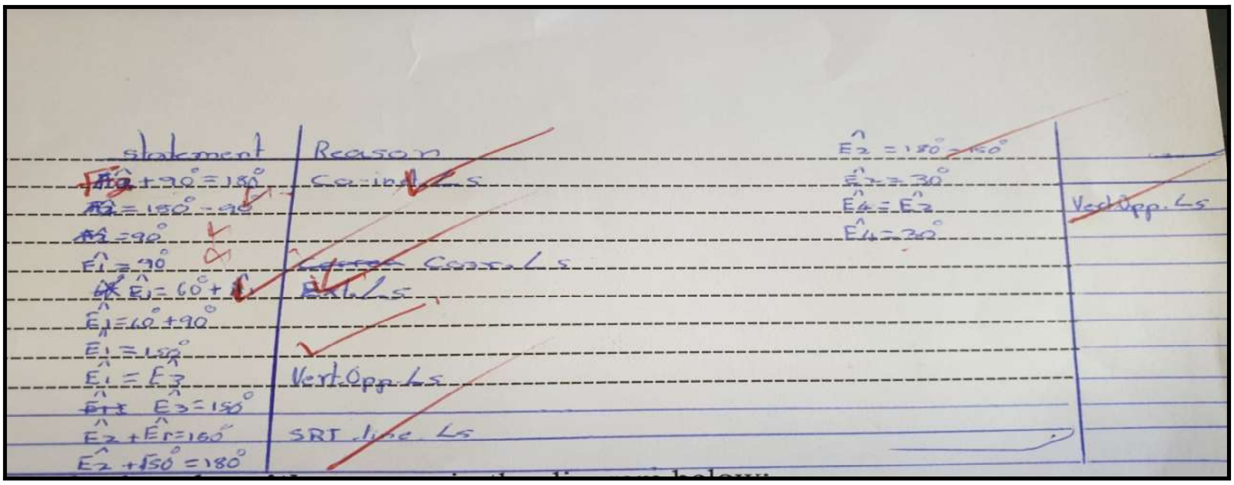


Figure 5.2: The response of L4 to question 1.2a

From Figure 5.2, L4 was correctly able to determine the value of angle E_4 using all properties of angles associated with parallel lines. However, the learner incorrectly named angle F_2 as angle A_2, angle F_1 as angle A_1. This means that L4 has progressed to level three (abstraction) of geometric thinking where the learner recognises relationships between geometric figures and is able to reason or perceive the relationships between properties and different geometric figures. This can only be obtained if learners are able to filter concepts from the main content by only deriving aspects (Van Hiele, 1999).

In question 1 as illustrated in Table 5.4, the correct answer was adjacent supplementary angles and 20% of the learners got the question correct, 20% of the learners assumed that the answer was corresponding angles, and 20% of learners assumed that the answer was co-interior angles. The other 40% assumed that the answer was amongst other angles outlined in column 2 which are not associated with parallel lines.

In question 2**,** the answer was adjacent angles. 40% of the learners assumed that the answer was the alternating angles and 60% of the learners assumed that the answer was amongst other angles outlined in column 2 which are not associated with parallel lines.

In question 3, the answer was co-interior angles. 60% of the learners got the correct answer and 40% of the learners assumed that the answer was amongst other angles outlined in column two (2) which are not associated with parallel lines. In question 4, the answer was alternating angles. 60% of the learners got the correct answer and 40% of the learners assumed that the answer was amongst other angles outlined in column 2 which are not associated with parallel lines.

In question 5, the answer was adjacent supplementary angles. 100% of the learners incorrectly assumed that that the answer was amongst other angles outlined in column 2 which are not associated with parallel lines. In question 6, the answer was adjacent complementary angles. 40% of the learners got the correct answer and 60% of the learners assumed that the answer was amongst other angles outlined in column 2 which are not associated with parallel lines. In question 7, this question did not have an answer because there are no properties of a pair of angles like the ones which were in question. However, learners did not notice that and 60% of the learners assumed that the answer was corresponding angles and 40% of the learners assumed that that the answer was amongst other angles outlined in column 2 which are not associated with parallel lines.

This is an indication of the challenge experienced by learners due to the lack of geometric thinking skills and according to Alex and Mammen (2016) learners need these geometric thinking skills in order to develop a solid geometric understanding.

5.3.5. Importance of visualisation to understand concepts in geometry.

Visualisation means the use of interactive visual interface for better understanding (Manovich, 2011). Visualisation is on the first level of geometric thinking outlined by van Hiele (1999) which is treated as an important part of learning geometry and can be useful for problem solving in mathematics (Carden, 2015). According to Manovich (2011), one cannot have a visual form until he or she visualises something.

Table 5.1 in question 1.1 of the individual worksheet, 66,67% of learners' responses indicated that learners were able to identify angles found in the "FUN" drawn shape and this proved that they knew alternating, corresponding and co-interior angles found in parallel lines.

However, 13,89% were not able to identify any angles in the given shapes and 19,44% were only able to identify corresponding angles.

The results showed that 66,67% of learners' were able to identify co-interior and alternating angles and 86, 11% were able to identify corresponding angles.The only time learners are able to better apply visualisation skills, is through the influence of interaction with other learners but along the way you can pick up that they can also wrongly influence one another.

From the group worksheet;

- In question 1.1, learners were instructed to construct a diagram consisting of parallel lines and a transversal line. In the diagram, learners were expected to correctly draw and label the diagram with specific label points. All five groups were able to indicate that drawn lines were parallel using arrows, labelling all lines according to the given instructions, draw and label the transversal line, put intersection points on specific lines and label them accordingly.
- In question 1.2 a, learners were requested to show or mention all corresponding, alternating and co-interior angles from their drawn diagram. Group one and five (G1 & G5) were able to find all corresponding angles, group three and four (G3 & G4) were not able to find all corresponding angles, group two (G2) was able to find only one (1) pair of corresponding angles. Group two (G2) and three (G3) were incorrectly naming angles by treating lines as angles and mixing up properties of angles for example, confusing co-interior angles with corresponding angles.
- In question 1.2 b, group four and five (G4 & G5) were able to find all alternating angles. Group one, two and three (G1, G2 & G3) were not able to find alternating angles. Group one and two (G1 & G2) assumed that co-interior angles were alternating angles and group three (G3) assumed corresponding angles are alternating angles.
- In question 1.2 c, group four and five (G4 & G5) were able to get all co-interior angles and group one and two (G1 & G2) were not able to get co-interior angles. Group three (G3) was mistaking alternating angles with co-interior angles and managed to only get one pair of correct co-interior angles. Group two (G2) was experiencing a challenge in naming angles and attempted to get one pair of co-interior angles.

There are four cognitive levels of questioning (level 1 to level 4) which correspond directly with all Curriculum and Assessment Policy Statement (CAPS) assessment guidelines namely knowledge (25%), routine procedures (45%), problem solving (10%) and complex procedures (20%) respectively.

The results indicated that, learners possessed levels of geometric thinking whereby they are able to identify figures by their appearance using correct properties but only with questions involving cognitive level one questioning.

When compared with other questions with level three of questioning, the learners are struggling to identify angles within a complex figure and are struggling to recognise relationships between geometric figures for them to solve given problems.

5.3.6. Language as a learning barrier in geometry

O'Halloran (2015) outlined that, the spoken language is one of the resources that creates meaning when learning mathematics. Some learners easily derive meaning and understanding when they learn using their own home language. During the conversation with learner twenty six (L26), the researcher was struggling to get responses from the learner until the researcher allowed the learner to speak in IsiZulu. Furthermore, 36% of the learners were failing to write correct spelling when answering questions. The results from the group worksheet, 85,71% of group one (G1) learners, 66,67% of group three learners (G3), 42,86% of group four (G4) learners, 37,5% of group two (G2) learners and 25% of group five learners were experiencing challenges regarding to writing the correct spelling of angles. This resulted in learners experiencing misconceptions as they were learning angles associated with parallel lines and led to incorrect solving problems regarding angles associated with parallel lines.

5.4. CONCLUSION

The analysis of the findings from this research study indicated that, the most learners experienced many challenges when learning angles associated with parallel lines. This was evident from the high percentage of learners indicating the importance of social interaction of learning, the lack of basic skills and knowledge, misconceptions, the lack of geometric thinking skills, the lack of visualisation application and language as the learning barrier when learning angles associated with parallel lines in geometry.

The aim of this research study was to explore the challenges experienced by Grade 8 learners when learning angles associated with parallel lines and the next chapter presents a summary of the findings, discussions, limitations and concludes by making recommendations for future research from this research study.

CHAPTER 6

FINDINGS, DISCUSSIONS, CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

6.1. INTRODUCTION

The purpose of this research study was to explore challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. In addition, this research study sought to understand the reasons resulting in learners experiencing challenges when learning angles associating with parallel lines in geometry. This research study sought to respond to the following research questions:

1. What challenges do Grade 8 learners experience when learning angles associated with parallel lines in geometry?
2. How and why do Grade 8 learners experience challenges when learning angles associated with parallel lines in geometry?

The social constructivist theory which encourages and supports learners to actively construct meaning and understanding on their own through experiences and social interactions (Bull, 2013) was used to guide this research study and provided a framework for the literature review, research methods and data analysis (Grant, 2014). This motivated the conceptualisation of this research study to gain an in-depth insight of challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. This research study was situated within the interpretivist paradigm because according to Dean (2018, p. 3), the interpretivist paradigm focuses on reality being subjective, multiple and socially constructed and it was for these reasons that this research study was situated under the interpretivist paradigm in order to focus on the reality and experiences of learners when learning angles associated with parallel lines in geometry. A qualitative case study research method was used in this research study to collect data that secured and in- depth understanding of challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

In this concluding chapter, there is presentation of the main findings in relation to the research questions, discussion of significant research findings of this research study, limitations and finally, the chapter concludes by making recommendations for future research studies.

6.2. SUMMARY OF MAIN FINDINGS OF RESEARCH QUESTIONS

6.2.1. What challenges do Grade 8 learners experience when learning angles associated with parallel lines in geometry?

The focus of this research study was centered on the challenges Grade 8 learners experienced when learning angles associated with parallel lines in geometry. In this research study the research question "What challenges do Grade 8 learners experience when learning angles associated with parallel lines in geometry?" in response to this research question, this research study found that the challenges learners experienced included:

1. The pedagogy of learning angles associated with parallel lines in geometry,
2. The negative social interactions and associations of learners within the society regarding learning angles associated with parallel lines in geometry,
3. The misunderstanding of the level of pre-existing knowledge of the angles associated with parallel lines in geometry and
4. The language barrier was a challenge experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

The pedagogy of learning angles associated with parallel lines in geometry

This research study revealed that the pedagogy of learning angles associated with parallel lines in geometry was a challenge experienced by grade 8 learners. This was focused on how the knowledge and skills of angles associated with parallel lines in geometry were imparted to learners. According to (Geduld, 2014), numerous interpretations and theories have been generated to ensure that meaningful learning is achieved through effective and excellent facilitation of these interpretations and theories.

According to Geduld (2014, p.11), the interpretations and theories that ensure meaningful learning is achieved are behaviourism, constructivism, social constructivism and liberationism. This research study supported social constructivism theory as its framework and which led to the exploration of social constructivism pedagogy where the teacher guides and the learners are placed at the centre of teaching and learning (Geduld, 2014).

The pedagogy used for learning in a classroom situation is a critical aspect in any learning culture of any education system. Bailey (2019) outlined that, the main purpose of the process of teaching and learning is to empower or equip learners with knowledge and understanding through their pre-existing knowledge to meaningful and understanding of new imparted knowledge. Therefore, it is important to observe the objectives of the implementation of the country's preferred education system to apply correct majors required to teach any topic and in this research study, angles associated with parallel lines in geometry are the main focus. According to Khuzwayo (2019, p. 1), teachers are unable to adjust and adopt the learner-centered instructions brought about by our Department of Education, which are outlined in the Curriculum Assessment Policy Statement document. The South African Curriculum Assessment Policy Statement document indicated the gradual movement of the curriculum from the previous grade to the current grade and in this research study, Grade 8 gradual movement and curriculum were explored.

According to Amineh and Asl (2015), effective learning depends on the existing knowledge that influences the new knowledge, which was for these reasons the Curriculum Assessment Policy Statement document encourages that learning must be a gradual movement for learners to understand and interpret the acquired knowledge through pre-existing knowledge. During the process of learning in a classroom situation, a correct pedagogy for learning mathematics especially geometry in relation to angles associated with parallel lines is not correctly implemented. This pedagogy for learning mathematics involves strategies where by, a teacher discovers the passion and attitude of learners towards mathematics as the subject and geometry as the content, a teacher is checking if a learner can individually construct meaning and understanding or a learner can construct meaning and understanding through the process of social interaction and with the help from a more knowledgeable other amongst his or her peers. Vygotsky (1978), states the level of prior knowledge existing from a learner and a smooth gradual movement of geometry as the content must be correctly implemented according to the stipulation of the Curriculum Assessment Policy Statement document.

Negative social interactions and associations of learners

Bozkurt (2011, p.211) argues that, knowledge and understanding of mathematics is built or constructed actively through interactions and social interactions. This emphasises that an environment where a learner grew up plays a crucial part in the learning of mathematics and can lead to higher or lower levels of reasoning and learning of mathematics.

This research study found that it has become a norm that learners within their social upbringing environment, are mostly told how difficult mathematics is and how they must work hard to achieve good results only. Instead of leading learners to fear mathematics and causing mathematics anxieties, teachers and the society where learners are socially interacting must explore challenges that learners are experiencing when learning mathematics and create solutions in order to assist learners. According to the findings of this research study, this process can be done by both the society where learners are growing up and teachers who are teaching mathematics. According to this research study's findings, this way of teaching whereby a learner is threatened or made to fear mathematics creates negative anxieties. This research study supported and implemented a social constructivist pedagogy during the process of teaching and learning of angles associated with parallel lines in geometry. This pedagogy of learning involves learners constructing their own meaning and understanding through the process of interactions with one another in the classroom situation and through their social living and learning environment (Bozkurt, 2017). This research study found that 75% of learners were unable to derive meaning and understanding on their own and required assistance from the more knowledgeable other who is amongst their peers. According to the results of this research study, 75% of learners when placed within groups to solve geometric problems, performed well and showed understanding of all the geometric applications.

The analysis of the data collected by this research study supported Krahenbuhl (2016) and Boaler's (2015) claims that learners learn and understand much more through social interaction with one another. This is because in the classroom situation, learners are not the same. Some learners can independently construct meaning and understanding on their own while other learners need assistance from other peers rather than only from the teacher (Good & Lavigne, 2017). This research study further found that it is important that the society and mathematics teachers direct learners on looking forward to engage and explore mathematics as a subject and be able to relate geometry to their everyday lives.

This research study further found that the implementation of counselling and motivation of learners to not fear or hate geometry as a content as well as mathematics as a subject play a crucial role in learners and can eliminate challenges experienced by learners when learning angles associated with parallel lines.

Misunderstanding of the level of pre-existing knowledge

Another aspect of a correct pedagogy for learning is to explore the level of prior knowledge of angles associated with parallel lines in geometry from learners in order to explore the existing gradual movement of the content according to the Curriculum Assessment Policy Statement document.

According to the findings of this research study, learners were experiencing misconceptions due to the lack of proper analysis of existing knowledge from the previous grade to the current grade where the content of angles associated with parallel lines in geometry was introduced. This study found that once a teacher does not know the exact prior knowledge possessed by learners, the new imparted knowledge may develop learners to experience challenges such as misconceptions. This research study found that 51.79% of learners experienced misconceptions during the process of learning angles associated with parallel lines in geometry. This resulted from a perception that learners already knew about angles associated with parallel lines in geometry as they did learn about parallel lines from the previous grade according to the Curriculum Assessment Policy Statement document. The results found by this research study indicated that, as much as learners were learning about parallel lines from the previous grade, they were not focusing on angles associated with parallel lines but were constructing parallel lines. Learners experience challenges when a teacher is teaching the content of angles associated with parallel lines bearing in mind that learners are familiar with the content as their prior knowledge whereas, learners start to know and explore angles associated with parallel lines in Grade 8.

It is important for learners to have a smooth transition of existing knowledge to new knowledge in order for the gradual movement of the content to occur correctly and in line with the stipulations of the Curriculum Assessment Policy Statement document.

The results of this research study indicated that, it is important to check the level of prior knowledge that learners possess if they are in line with the content including the level of understanding of terminologies and definitions of angles associated with parallel lines in geometry from the previous grade to the new imparted knowledge. In this research study the researcher found that, learners did learn about parallel lines from the previous grade in line with the stipulation of the Curriculum Assessment Policy Statement document.

From the previous grade, learners were defining the types of straight lines including parallel lines and they were expected to know how to construct and identify parallel lines using their properties. However, in Grade 8, learners are expected to know and understand the three main rules of angle relationships of parallel lines which are corresponding, co-interior and alternating angles to solve problems which is stipulated by the Curriculum Assessment Policy Document (2011, p. 98). This indicated that, the prior knowledge of parallel lines existed from learners but, the knowledge did not include the knowledge of angles associated with parallel lines in geometry. This was evident from the responses of learners during the interviews.

This means that learners started to learn about angles associated with parallel lines in geometry when they arrived in Grade 8. This indicated to the researcher that, during the process of learning, the teacher must not confuse the prior knowledge on parallel lines possessed by learners with the knowledge of angles associated with parallel lines in geometry because, learners encounter the knowledge of angles associated with parallel lines only in Grade 8. According to Poon and Leung (2016) teachers often make a mistake by not checking their learners' difficulties in learning geometry from the first lesson. This is the result of confusing the existing knowledge of learners in terms of the actual existing known content and the new knowledge of the content. In this case, the teacher will assume that learners did learn about parallel lines from the previous grade but forgetting to check the actual content that was taught under parallel lines in line with the Curriculum Assessment Policy Statement document.

Zuya and Kwalat (2015) outlined that teachers are unable to identify learners' missing knowledge with respect to angles associated with parallel lines in geometry and this mistake creates fear and confusion to learners when encountering problems of angles associated with parallel lines in geometry.

In order to have productive lessons of angles associated with parallel lines in geometry, there must be a smooth transition of integrating the prior knowledge and new experiences including concepts and ideas to learners (Pisano, 1994).

This attests to the importance of using a correct pedagogy approach according to Acharya (2017, p. 8) where there is integration of new geometric concepts and the existing geometric concepts. In a classroom situation, the teaching and learning approach must involve learner centeredness where the focus is around learners from where the learners are coming from through the guidance of the more knowledgeable other to the new knowledge with meaning and understanding.

The challenges associated with language barriers

This research study found that 51, 75% of learners were experiencing a challenge due to language barrier. This was evident when learners could not read or follow instructions properly when they were given worksheets and during interviews whereby they could not comfortably answer interview questions. The analysis of the results indicated that the language barrier contributed to the rate of 51, 95% of learners experiencing so many misconceptions. The results indicated that learners were not answering what was asked by the questions rather they were giving totally different answers of things not yet taught in class.

When learners were showing signs of experiencing a language barrier as a challenge using this research study, the researcher switched back to the home language of the learners and started asking interview questions by using their mother tongue to explore if learners are experiencing a language barrier. The results showed that, learners were more comfortable to answer all questions and with understanding in both data location tools. This led the researcher to go back to the worksheets and asked all questions using learners' home language and the results indicated that learners were able to understand what the questions were looking for from the worksheets and from the interview questions. Throughout the process of using learners' home language, learners were correctly answering all questions and were more comfortable. These results indicated that, learners were experiencing a challenge of language as a barrier.

6.2.2. How and why do Grade 8 learners experience challenges when learning angles associated with parallel lines in geometry?

This research study also sought to investigate how Grade 8 learners experienced challenges when learning angles associated with parallel lines in geometry. According to this research study, learners lacked passion for mathematics as a subject and for geometry as the content within the subject and as a result, learners were experiencing challenges when learning angles associated with parallel lines in geometry.

This research study further investigated why Grade 8 learners experienced challenges when learning angles associated with parallel lines in geometry. According to this research study, learners were unable to relate geometry to their everyday lives thus experiencing challenges during the process of teaching and learning. This research study found the following results on how and why learners experienced challenges when learning angles associated with parallel lines in geometry:

1. Learners lacked passion and
2. Learners' inability to relate geometry to real life.

Learners lacked passion

This research study found that 75% of learners that participated in this research study were found to have a negative attitude towards mathematics and they were having mathematics anxiety which was caused by unknown content of geometry from their family members and peers from school.

According to the findings of this research study, learners are indirectly taught to fear mathematics and regard it as a subject of difficulties and in this research study, this is considered as an incorrect perception of mathematics. Naidoo and Kapofu (2020) also attested that most learners do not have passion and interest of mathematics as a subject rather, consider mathematics to be a difficult, confusing and stressful subject. This negative attitude towards mathematics led learners not to invest more effort and time in mathematics as a subject and led learners to develop mathematics anxiety.

If these negative expressions and attitudes are not dealt with immediately by the society where learners are exposed to and by teachers teaching mathematics, challenges start to occur from the early grades till the final grade of learning.

Learners' inability to relate geometry to real life

Learners refer to mathematics as the most difficult subject which makes it hard for them to see mathematics as a subject that they can relate to in real life situations.

According to Acharya (2017), society, consisting of parents, siblings or peers and teachers also have played a negative role with negative views and opinions by creating mathematics anxiety and making learners see mathematics as a difficult subject that does not have real life meanings. Acharya (2017) further emphasised that, mathematics is regarded as a main part of *the* human lifestyle and when learners fail to relate mathematics in real life situations, they tend to lose interest and confidence. This makes it difficult for learners to understand and well achieve mathematics knowledge and meaning of every concept in each mathematical content. In this research study, learners indicated that they cannot relate geometry to real life situations which was one of the major answers to why learners experience challenges when learning angles associated with parallel lines in geometry.

Geometry is considered as a basic skill that is essential to effectively function in this four-dimensional world (Adelabu, 2019). In our real life situations, we use geometry to give directions or location for example, stating that a certain street is parallel to a certain main street or, identifying shapes of objects or, when we are planting in our gardens and we want our plants to be in certain parallel lines or, when we are doing construction of our buildings or bridges. According to Altay, Yalvar and Yeltekin (2017), learners struggle to relate geometry in real life situations unless it is about shapes and numbers. If learners can develop the skill of connecting what they learn in geometry with what they experience in their everyday lives, the knowledge and understanding of geometric concepts will be permanent.

Alex and Mammen (2016) outlined that when technology is imparted to the process of teaching and learning of geometry, the geometric level of thinking skills of each learner will be triggered through visualisation. Teachers need to develop technologically integrated knowledge of mathematics concepts to support their mathematical pedagogic skills. Altay, Yalvar and Yeltekin (2017) further emphasised that using technology during the process of teaching and learning is a practical example of making learners relate to geometry in a real life context. For example, learners can be shown real life situation visuals and be asked to relate the visuals to geometric concepts (see Figure 6.1).

REAL LIFE SITUATION	**GEOMETRIC CONCEPT**	**CONNECTION**

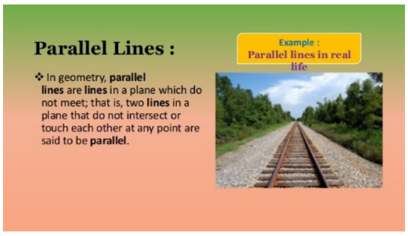
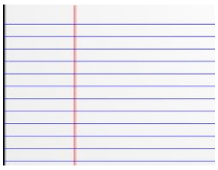
  	Parallel lines	Parallel lines never meet (Morgan, 2018), in a real life situation the same concept is used when designing roads or railways and when planting crops. This helps to direct cars or trains and plants not to collide with each other but stay in their respective lanes accordingly.
  	Parallel lines	In schools, offices even at home we use shelves to pack things in order and the shelves are parallel to each other. The electric lines must be parallel to each in order for them to work properly and to be safe for use. The parallel lines in papers help learners to write neatly, the writing will stay separate.
 	Parallel lines and Transversal line forming angles	Planks must be parallel to each other in order to support the roof made out of tiles, metal sheets etc. Some roof trusses are designed to have spaces in between them for certain purposes and those angles are formed by the parallel intersected by a transversal(s).

Figure 6.1; Relating real life situations to geometric concepts adapted from Altay, Yalvar and Yeltekin (2017, p.161). Nature of parallel lines in real life adapted from; https://www.google.com/search?q=Nature+of+parallel+lines+in+real+life&sxsrf=ALeKk03yYcdVqdYYN_4Z_UKIV5hZXB8A4Q:1593520355630&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiLh_X1xanqAhUJAcAKHXYRC10Q_AUoAXoECA0QAw&biw=1366&bih=657

The evidence from the responses during interviews indicated that during the process of teaching and learning of angles associated with parallel lines in geometry, learners lack geometric skills to connect geometric concepts with real life situations.

According to Jelatu (2018), learners should be supported with learning visuals so that they can easily relate geometric concepts in real life situations. This can be achieved through observations, exploring and discovering in order to construct their own knowledge, meaning and understanding of angles associated with parallel lines in geometry through the use of technology. According to Mifetu (2019, p. 28), there are not enough instructional materials in schools to make teaching and learning of mathematics to be real. This leads to learners finding mathematics to be a challenging subject that they cannot relate to in real life situations.

This research study found that the use of technology as instructional material for learning geometry can easily support learners' ability to construct meaning and understanding. One of the important aspects of learning geometry is having a high level of geometric thinking. For learners to have a high level of geometric thinking, the use of technology is vital as learners would be able to find correlations between any geometric concepts and be able to relate them to real life situations by recalling what he or she saw when each concept was explained. The data generated by this research study indicated that learners were unable to relate geometry to real life situations because of the lack of the use of technology during the process of teaching and learning from the previous grade. When learners were given a chance to experience geometry through technology, it became easier for them to be active, explore, and discover their own meaning and understanding through asking new questions and relating geometric concepts in real life situations. According to (Villella, 2018), technology should be considered as an effective tool for learning in learners in order to expand their mathematical knowledge.

The findings of this research study are consistent with the studies of (Kanbur, 2019) and (Jelatu, 2018) which indicated that the use of technology during the process of teaching and learning develops thinking skills in learners as they can easily relate what they see with what they know.

61, 11% of learners in this research study could not recall geometric principles in order to solve problems concerning angles associated with parallel lines in geometry within complex figures but they have shown an indication of having reached level 2 of geometric thinking. This was a result of the use of technology where by learners were able to identify and recall all geometric principles and apply all geometric applications through visualisation. 50% of the learners experienced lack of basic knowledge and skills to solve given problems of the angles associated with parallel lines. About 77.78% of the learners were lacking not only the basic knowledge and skills but also their geometric levels of thinking were very low. In order to eliminate these challenges, according to Mifetu (2019, p. 29), a correct pedagogy for learning must be implemented during the process of teaching and learning. Learners must be taught in a manner that, what they learn in the classroom situation must connected to their real life situations.

This research study found that, developing strategies that can lead learners to connect or relate geometric concept with real life situations results in permanent meaning and understanding. This can be achieved through the use of technology where learners' self-construct meaning and understanding in order for them to gradually progress to new knowledge and understanding of new geometric concepts (Mifetu, 2019).

6.3. DISCUSSION OF SIGNIFICANCE OF THE RESEARCH FINDINGS

In the introductory and literature chapters, it was noted that learners in South Africa are not competent in both Mathematics and Science according to the results from the Annual National Assessments (ANA) and the Trends in International Mathematics and Sciences Study (TIMSS) (Alex, 2017; Moodley 2013; Spaul, 2013), this has led South Africa to be labelled as one of the countries with the worst education system than other developing countries particularly in Africa (Cloete, 2016). This research study has tried to articulate the underlying reasons for these adversities from the scholars and the main focus was on the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

The reason for this research study to explore geometry was because, geometry is considered as a challenging (Naidoo, 2020) and difficult concept in mathematics (Yudianto, 2018). When you study the Further Education and Training Annual Teaching Plans, the results show that geometry contributes an average of 66.6% of any Grade 10 to Grade 12 Mathematics paper 2.

In Grade 10, geometry has an average of 67% of marks within the mathematics exam paper 2 (November 2018), in Grade 11, geometry has an average of 68% of marks within the mathematics exam paper 2 (November 2018) and in Grade 12, geometry has an average 65% of marks within the mathematics exam paper 2 (November 2019).

This indicates how important Grade 8 geometry is, as it is the first basic introductory contents that are needed as the gradual movement of geometry occurs. If learners experience challenges from an early grade and those challenges are not dealt with, chances are learners will not do well in mathematics from Grade 10 until Grade 12. The Further Education and Training Mathematics Grade 12 Annual Teaching Plans including the revised one, indicated that geometry contributes more marks towards the mathematics tests or examination paper than other topics. Figure 6.1 indicates that in Term one, geometry contributes at least 40%, in Term two, geometry contributes at least 27% and in Term three and Term four, geometry contributes 30% towards the mathematics test or examination paper. According to the mark allocation per topic, a learner can pass mathematics easily if he or she attempts and finishes the mathematics paper consisting of geometry.

In some cases, learners do not try to attempt writing geometry which affects their final marks no matter how good other marks attained are from other mathematics topics within the mathematics test or examination paper. For example, if a learner attains good marks from a test or examination paper 1 consisting of algebra, equations and inequalities, patterns, sequences, finance, growth and decay, functions and graphs, differential calculus and probability and not attempt to do or fail geometry, his or her marks will drastically decrease and may lead to failing or bad final marks. According to Figure 6.1 and Figure 6.2, geometry contributes 30% or more for mathematics tests or examination papers and 30% is a minimum passing rate. If a learner passes the geometry section only, it is guaranteed that a learner will pass the mathematics test or examination. It is for these reasons that this research study went back to the eighth Grade where learners attain the first basics of knowledge and understanding of geometry to explore the challenges that learners experience when learning angles associated with parallel lines in geometry.

TRIAL EXAMINATION		
PAPER 1:		
DURATION:	**3 hours**	
TOTAL MARKS:	**150**	
This paper will consist of the following sections:		
Algebra, Equations and Inequalities		25±3 marks
Patterns and Sequences		25±3 marks
Finance, Growth and Decay		15±3 marks
Functions and Graphs		35±3 marks
Differential Calculus		35±3 marks
Probability		15±3 marks
PAPER 2:		
DURATION:	**3 hours**	
TOTAL MARKS:	**150**	
This paper will consist of the following sections:		
Statistics		20±3 marks
Analytical Geometry		40±3 marks
Trigonometry		40±3 marks
Euclidean Geometry		50±3 marks
Completion date of the last topic for the Trial Examination: 13/08/2020		

Figure 6.2: Grade 12 Mathematics 2020 Test and Examination Scope/Guidelines adapted from; FET Mathematics Grade 12 SBA Administration Documents (2020 p. 7).

EXAM

3 hours

PAPER 1

Paper 1 **3 hours**	
Algebraic expressions and equations (and inequalities)	25
Number patterns	25
Functions and graphs	35
Finance, growth, and decay	15
Differential Calculus	35
Counting and probability	15
TOTAL MARK	**150**

PAPER 2

Paper 2 **3 hours**	
Euclidean Geometry and measurement	50
Analytical Geometry	40
Trigonometry	40
Statistics	20
TOTAL MARK	**150**

Figure 6.3: Grade 12 Mathematics 2020 Test and Examination Scope/Guidelines adapted from; National Revised Teaching Plans Grade 12 (2020, p. 110).

The significance of this research study through the in-depth exploration, has contributed to the dearth of understanding challenges experienced by Grade 8 learners when learning angles associated with parallel lines and contributed an understanding of how and why learners experienced challenges. This research study aimed to eliminate all possible challenges experienced by learners to prepare them to attain excellent results in their Grade 12 final examination results and for future endeavours.

6.4. LIMITATIONS

The focus of this research study was to explore challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry, in addition, this research study further explored the reasons resulting in learners experiencing challenges when learning angles associated with parallel lines in geometry in one of the schools in the Umgungundlovu district. This means that the researcher did not consider other schools within the district of Umgungundlovu or the province of KwaZulu-Natal nor did the researcher engage with other Grade 8 learners within the school or other schools. Thus, the nature of the purposive sample of this research study prevented drawing generalisations in conclusion about the challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. This means that, the other schools within the city and province to the country at large were not considered hence findings of this research study are limited.

The second limitation was time constraint occurring during the process of conducting this research study within the school. The researcher only had time during break periods where by learners are expected to refresh and have breaks or lunch. This was because, learners were using specific transportation to attend and leave school, which required them to always reach school around 07h30 which was the time the researcher was meant to be in the staff meeting and learners were to leave school at 14h40 where by their transportation was already waiting and ready to leave with the learners. Hence the researcher opted to meet with the learners during their break times and in some cases, the researcher could not find learners due to other break time commitments of the learners. The researcher then decided to provide learners with refreshments in order to cover time spent going to the tuck shop by learners and still some learners were committed with other teachers or other school activities such as break detention, media centre duties or activities, extra lessons etc.

The third limitation was that, some learners were not comfortable during the process of interviews sessions. Learners could not fully express themselves as they were being interviewed by the researcher who was also their mathematics subject teacher and some were not comfortable to speak or express themselves in English. This result influenced observations and conclusions as in some cases the researcher had to deviate from the main issue that was studied. Also, during the process of the interviews, the researcher found that learners could not answer questions correctly due to the lack of understanding of the questions written in English. This was discovered by the researcher when noticing that learners were unable to express themselves in English and the researcher further went back to ask worksheet questions in the learners' vernacular language. Subsequently, the learners expressed correct answers, thus, indicating that learners were limited to one language which somehow disadvantaged them and compromised this research study.

6.5. RECOMMENDATIONS

This research study identified a range of areas for attention in relation to the learning of angles associated with parallel lines in geometry by Grade 8 learners. The following recommendations for future research studies are based on the findings provided by this research study in order to eliminate challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry:

1. This research study recommends that teachers must remain lifelong learners by attending workshops, seminars and training in order to equip themselves with all possible teaching strategies, the use of technology and support needed towards learners during the process of teaching and learning of all mathematics content. This recommendation will help teachers to develop a correct pedagogy of learning angles associated with parallel lines in geometry from the introduction of the content to the conclusion.

2. A successful educational background of learners also depends on the role played by the society through social interactions with learners. This research study recommends that the society must be taught about the importance of engaging positively with learners regarding learning angles associated with parallel lines in geometry.

This will assist in eliminating anxieties and negative attitudes towards learning of angles associated with parallel lines in geometry and mathematics as a subject.
This research study further recommends that teachers take advantage of social interactions within the classroom situation where by learners are interacting with each other to derive their own meaning and understanding and, the same must be encouraged by teachers to occur within learners' society by giving learners extra work or projects to be done by the learners and the society in which they live and learn. This will also help learners to see and relate geometry or mathematics in real life situations.

3. This research study recommends that teachers must be able to detect the exact level of prior knowledge of learners from the Curriculum Assessment Policy Statement gradual movement of geometry. This will assist in eliminating misunderstanding of the level of pre-existing knowledge of angles associated with parallel lines in geometry and what is meant to be taught to learners.

4. This research study further recommends that within the school context, teachers must consider using all possible South African official languages especially the mother tongue of learners towards their learning to check if learners were able to understand and can easily express their own meaning and understanding. This will help in preventing the language barrier as a challenge experienced by Grade 8 learners when learning angles associated with parallel lines in geometry.

This research study limited participants of the research study and used a purposely selected sample and it would be of great interest for future studies to explore challenges experienced by all learners in secondary schools when learning geometry as the content in mathematics not specifically angles associated with parallel lines in geometry. This is recommended as a result found by this research study that angles associated with parallel lines in geometry has a limited percentage as learners gradually move to other grades.

Furthermore, geometry is considered as a challenging and difficult concept in mathematics, it has an average 65% of marks within the mathematics exam paper two and contributes 30% or more for mathematics test or examination paper.

6.6. CONCLUSION

This research study came to the conclusion that, there are number of challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry. These challenges are the result of improper implementation of pedagogy of learning where by learners are placed at the centre of the process of teaching and learning. This research study has revealed that learners experience challenges when learning angles associated with parallel lines in geometry if the impartation of knowledge and skills of learning is not supporting learners to derive their own meaning and understanding and through the social interactions with one another or more knowledgeable other. For these reasons, the use of technology during the process of teaching and learning is important for learners to easily learn, interact, engage and be empowered in discovering their own meaning and understanding.

From the results of this research study, it can be concluded that there is a strong need of an application of social constructivist theory which encourages learners to learn through social interactions from where learners are coming and during the process of teaching and learning. During the process of learning, this research study demonstrated that the significance of proper analysis of pre-existing knowledge of angles associated with parallel lines in geometry is important. This will assist in knowing exactly what knowledge learners possess before introducing new knowledge of angles associated with parallel lines in geometry. Furthermore, this research study concluded that the language barrier is one of the challenges learners experience when learning angles associated with parallel lines in geometry as it limits learners from participating and practicing social interaction during the process of learning to their full potential. This challenge does not only negatively affect learners during the learning process but also during the assessment processes whereby learners do not respond correctly on instructions.

This research study contributed to the literature by discovering the role played by the society in the learning of learners. If the society is negatively interacting with learners without support, proper counselling and motivation, learners develop a negative attitude and anxiety towards learning angles associated with parallel lines in geometry. This research study finds that negative social interactions and comments can outweigh a positive attitude and may cause frustrations towards learning of angles associated with parallel lines in geometry.

According to Italy (2017, p.165), mathematics is not just a set of rules to be applied. This means that every concept in mathematics and in this research study geometry, must be taught in a manner that learners are able to relate to their real life situations. Findings of this research study revealed that, learners are experiencing a challenge of not being able to relate geometry in real life situations which makes it difficult for learners to develop passion and a positive attitude towards geometry. This research study concluded that all these factors of challenges experienced by Grade 8 learners when learning angles associated with parallel lines in geometry found by this research study are the major catalyst of lower and poor results in the teaching and learning of learners.

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APPENDICES

APPENDIX A: Permission to conduct research study to the Principal.

Xoliswa Dlamini
School of Education
College of Humanities
University of KwaZulu-Natal
Edgewood Campus
Pinetown
16 February 2018

The Principal

Linpark High School

P.O. Box 21477

Mayors Walk

3208

RE: Permission & Inform Consent Form To Conduct Research At Linpark High School

My name is Xoliswa Dlamini; I am a Master's Degree candidate studying at the University of KwaZulu-Natal, Edgewood Campus, South Africa. I am interested in Mathematics Education and wish to conduct and gather information at your school.

I am kindly requesting your approval to conduct my research and promise that it will not affect the teaching and learning process in the school; please can you kindly provide me with a signed letter on a school letter head allowing me permission to conduct the research study at your school.

Please kindly note that:

- The confidentiality of the school and the learners is guaranteed as the input will not be attributed in person rather, pseudonyms will be used.
- Any information given by the participants cannot be used against you or the school and the collected data will be used for purposes of this study only.
- Data will be stored in a secure storage and be destroyed after five (5) years.
- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- The interview may last for about 45 minutes to 1 hour.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment	**Willing**	**Not willing**
Audio equipment		
Photographic equipment		
Video equipment		

I can be contacted at:
Email: asinothemthimkhulu@gmail.com
Cell: 0727724141

My supervisor is Dr. Jayaluxmi Naidoo who is located at the School of Education, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127.

You may also contact the Research Office through:
Ms P Ximba (HSSREC Research Office)

Tel: 031 260 3587

Email: ximbap@ukzn.ac.za)

Thank you for your contribution to this research.

DECLARATION

I……………………………………………………………………… (full names of principal) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF THE PRINCIPAL DATE

……………………………………… …………………

SCHOOL STAMP

…………………………………………..

Yours Faithfully

Miss X. Dlamini

………………………………

APPENDIX B: Permission to conduct research study to the Parent.

Xoliswa Dlamini
School of Education
College of Humanities
University of KwaZulu-Natal
Edgewood Campus
Pinetown
16 February 2018

The Parent

Linpark High School

P.O. Box 21477

Mayors Walk

3208

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- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
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- If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment	**Willing**	**Not willing**
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Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127.

You may also contact the Research Office through:
Ms P Ximba (HSSREC Research Office)
Tel: 031 260 3587
Email: ximbap@ukzn.ac.za)

Thank you for your contribution to this research.

DECLARATION

I………………………………………………………………………… (full names of parent) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF THE PARENT **DATE**

……………………………………… **…………………**

Yours Faithfully

Miss X. Dlamini

………………………

APPENDIX C: Permission to conduct research study to the Learner.

Xoliswa Dlamini
School of Education
College of Humanities
University of KwaZulu-Natal
Edgewood Campus
Pinetown

16 February 2018

The Learner

Linpark High School

P.O. Box 21477

Mayors Walk

3208

RE: Permission & Inform Consent Form To Conduct Research At Linpark High School

My name is Xoliswa Dlamini; I am a Master's Degree candidate studying at the University of KwaZulu-Natal, Edgewood Campus, South Africa. I am interested in Mathematics Education and wish to conduct and gather information at your school.

I am kindly requesting your approval to conduct my research and promise that it will not affect the teaching and learning process in the school; please can you kindly provide me with a signed letter on a school letter head allowing me permission to conduct the research study at your school.

Please kindly note that:

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- Any information given by the participants cannot be used against you or the school and the collected data will be used for purposes of this study only.
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- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment	**Willing**	**Not willing**
Audio equipment		
Photographic equipment		
Video equipment		

I can be contacted at:
Email: asinothemthimkhulu@gmail.com
Cell: 0727724141

My supervisor is Dr. Jayaluxmi Naidoo who is located at the School of Education, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: naidooj2@ukzn.ac.za   Phone number: +27312601127.

You may also contact the Research Office through:
Ms P Ximba (HSSREC Research Office)
Tel: 031 260 3587
Email: ximbap@ukzn.ac.za)

Thank you for your contribution to this research.

DECLARATION

I……………………………………………………………………… (Full names of principal) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF THE LEARNER DATE

……………………………………… …………………

SIGNATURE OF THE PARENT DATE

…………………………… ……………………

Yours Faithfully

Miss X. Dlamini

………………………………

APPENDIX D: Approval to conduct research.

Linpark High School

Tel (033) 3441544/3441545
Fax (033) 3442219
info@linparkadmin.co.za

P O Box 21477
Mayors Walk
3208

16 February 2018

Dear Miss X Dlamini

PERMISSION TO CONDUCT RESEARCH AT LINPARK HIGH SCHOOL

We hereby grant you permission to do your research in Mathematics at Linpark High School provided it is not done during lesson times, and there are no costs that will be carried by the school or learners.

Yours faithfully

[redacted]

MR H BUYS [redacted]
Deputy Principal

THE PRINCIPAL
Linpark High School
Pietermaritzburg
Tel.: 033 3441544/3441545
Fax.: 033 3442219
Email: info@linparkadmin.co.za

APPENDIX E: Ethical Clearance letter

APPENDIX F: Questionnaire.

LEARNER'S PROFILE

Please cross here to indicate your informed consent to participate in this research study ☐

GENERAL INFORMATION

Surname: ___________________________ Name:_________________________

Nickname: ________________________

Grade: ____ Gender: _________________

Race: ________________ Age: ________

Home Language: _____________________

Who is helping you with your maths homework everyday?:

____

____

***NB: Kindly please cross where it is relevant to you*.**

Do you Love going to school? : YES ☐ NO ☐

Do you think it is important to study Mathematics in schools? :

YES ☐ NO ☐

Do you know what Geometry is in mathematics? YES ☐ NO ☐

Can you kindly please draw the following lines below?

- Horizontal Line:

- Vertical Line:

- Straight Line:

- Parallel Lines:

Do you experience any language barrier when you are learning Geometry?

YES ☐ NO ☐

Explain what language barrier are you experiencing, if not explain how do you understand the language of geometry when learning.

____

____

____


Thank you

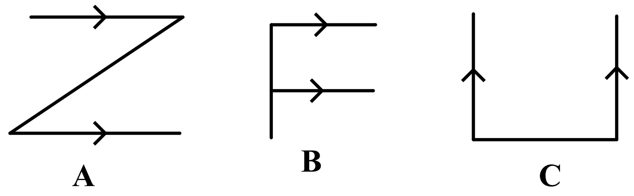
APPENDIX G: Individual Worksheet

GRADE 8 INDIVIDUAL: WORKSHEET

LEARNER'S NAME: ____

QUESTION 1

1.1 Consider the diagram below:



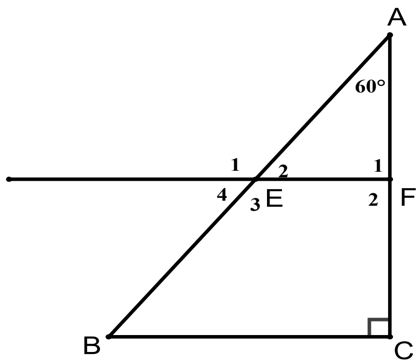
Looking at the above diagrams, identify the types of angles found in:

1.1.1 **A**

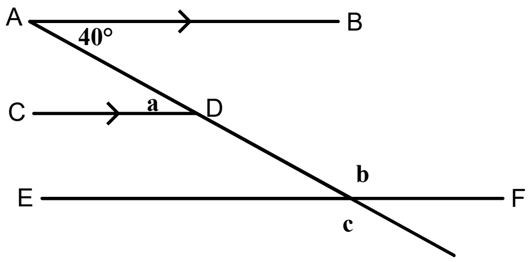
1.1.2 **B**

1.1.3 **C**

1.2 In Δ ABC, $\hat{C} = 90^\circ, \hat{A} = 60^\circ$, $EF \parallel BC$. $\hat{F}_3 = 12^\circ$, Determine with reasons the value of $\hat{E}_4$.



1.2 Determine the values of a, b and c **with reasons** in the diagram below:



APPENDIX H: Group Worksheet

<u>GRADE 8 GROUP WORK: WORKSHEET</u>

GROUP NAME:____

QUESTION 1

1. Construct a diagram consisting of $AB \parallel DC$ with the transversal line EF, H is the point of intersection between AB and EF with angles ($\hat{H}_1;\hat{H}_2;\hat{H}_3;\hat{H}_4$). There is another point of intersection between CD and EF with angles ($\hat{G}_1;\hat{G}_2;\hat{G}_3;\hat{G}_4$).

1.1 Use the above information to draw the mentioned diagram.

1.2. From your drawn diagram, show the following angles:

1. All corresponding angles

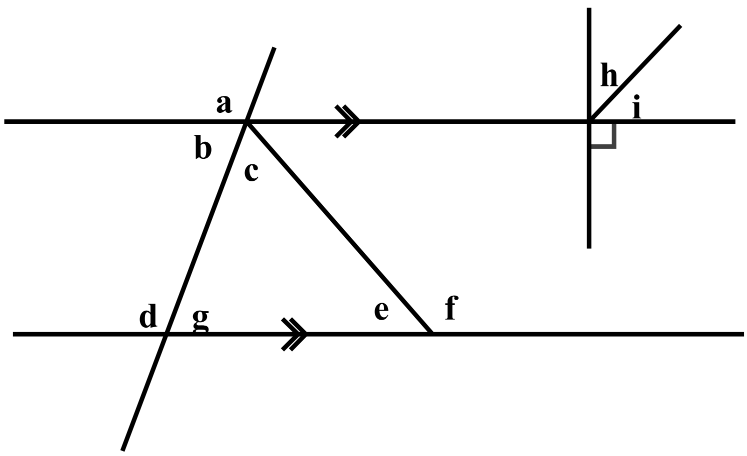
----

2. All alternate angles

----

3. All co-interior angles

2.



Refer to the diagram above and match COLUMN 1 and COLUMN 2. Write down the number and next to the number write the correct letter.

Example: 8. H

COLUMN 1	**COLUMN 2**
1. *a* and *b*	A. adjacent supplementary angles
2. *b* and *c*	B. vertically opposite angles
3. *b* and *d*	C. alternate angles
4. *b* and *g*	D. corresponding angles
5. *e* and *f*	E. adjacent complementary angles
6. *h* and *i*	F. co- interior angles
7. *a* and *g*	G. adjacent angles

APPENDIX I: Interview Schedule

TITLE:

Exploring the challenges experienced by grade eight (8) learners when learning angles associated with parallel lines in geometry

Introduction to the research study

The researcher is conducting a research study which is exploring challenges grade eight (8) learners experiencing when learning angles associated with parallel lines in geometry. As part of this research study, the researcher will carry out face to face interviews with grade eight (8) learners who are doing mathematics and will be randomly purposefully selected. The information that will be collected will be used by the researcher to identify challenges Grade eight (8) learners experience when learning angles associated with parallel lines in geometry, to examine how Grade eight (8) learners cope with the challenges they experience when learning angels associated with parallel lines in geometry and to gain an insight on why Grade eight (8) learners experience challenges when learning angles associated parallel lines in geometry.

Kindly please be assured that no authority or individual will be named in the researcher's report and nothing will be linked back to you as an interviewee. Everything you will tell the researcher will be treated confidential but if you happen to mention something that can lead the researcher to see or believe that you or someone else is in a serious physical or emotional harm, the researcher will have to pass the information to the Supervisor (Dr J. Naidoo). The interview will take roughly 30 minutes of your time, kindly please answer the following questions before the interview can begin.

1. Are you happy and agreeing to take part in the interview today? Kindly please be aware that you can withdraw from the interview at any point if you wish to.

2. Do you have any questions before the interview can start?
3. Just to help with accurate notes, can the researcher record the interview?
   (Once the interviewee agrees to be recorded, the researcher will test if the recorder is working properly and begin to record when all is in correct order).

INTERVIEW QUESTIONS

1. Do you love Math?
2. What topic do you find challenging when learning mathematics? Why you find it challenging?
3. Can you relate geometry in real life situation?
4. In which Grade did you first learn about angles associated with parallel lines in geometry?
5. How many types of angles associated with parallel lines do you know?
6. Did you find learning about angles associated with parallel lines easy or difficult?
7. Did you learn anything from working with your group members? How or What did you learn?
8. How did you acquire knowledge or skills to answer question 1.1?
9. How did you work out the solutions in question 1.2?
10. Did working with group members assisted you in learning angles associated with parallel lines in geometry?
11. What strategies you think you would have used to teach angles associated with parallel lines in geometry if you were a teacher?

Closure

- Our Interview has come to an end; do you have any questions or anything you wish to add to your responses?
- Can I kindly check if I have your correct details and that our interview has been saved?

Thank you so much for participating in this research study.

APPENDIX J: Interview Transcript

Learner 12 (L12)

RESEARCHER	LEARNER
Do you love Math? What do you mean teaching you properly? So your definition of a proper teaching is not shouting?	I don't love it but like it and it depends on a teacher who is teaching me. That, how does he or she teaches. If he or she teaches properly, I love it but if not…. (learner nodded). Like when you explain the things and you making it easy to understand and when you…. It's just that Mem, I'm trying to compare teachers like the one from last year, he was not good at all and was always shouting at children. No Mem like, when you explain the thing and making sure that the children understand what you are teaching.
What topic do you find challenging when learning mathematics? Why you find it challenging?	Geometry. Because I do not like angles, things with angles I do not like, it is difficult.
Can you relate geometry in real life situation?	A little, maybe if I can learn to take it serious…. Mhmm I don't know.
In which Grade did you first learn about angles associated with parallel lines in geometry?	In Grade 8
How many types of angles associated with parallel lines do you know?	I find the FUN thing nice, like alternate, corresponding and co-interior. That is nice and fun to do.
Did you find learning about angles associated with parallel lines easy or	It wasn't easy but also it wasn't difficult because, it is not something hard to learn. If

difficult? Why?	you look at it and you can get to explain how it's done.
Did you learn anything from working with your group members? How or What did you learn?	Yes. Some people in my group could understand things that I couldn't understand.
How did you acquire knowledge or skills to answer question 1.1?	I know the names and meaning of the shape FUN, F is for corresponding angles, U is for co-interior angles and N is alternate.
How did you work out the solutions in question 1.2?	I know angle B and angle C are opposite, angle a = 40^0…. No No No… I don't know.
Did working with group members assisted you in learning angles associated with parallel lines in geometry?	Question 1.2 was easier to solve alone but no. 2 wasn't easy. The right angle was challenging but I do understand the straight line.
What strategies you think you would have used to teach angles associated with parallel lines in geometry if you were a teacher?	Providing extra lessons and tutoring.
Our Interview has come to an end; do you have any questions or anything you wish to add to your responses?	NO.
Can I kindly check if I have your correct details and that our interview has been saved?	Yes.

Learner 21 (L21)

RESEARCHER	LEARNER
Do you love Math?	Yes. I love counting.
What topic do you find challenging when learning mathematics? Why you find it challenging?	Geometry. I do not know equations and solving for x. (Learner was not comfortable to speak or express himself in English).
Can you relate geometry in real life situation?	No.
In which Grade did you first learn about angles associated with parallel lines in geometry?	In Grade 8
How many types of angles associated with parallel lines do you know?	Alternate, corresponding, co-interior,… that's all.
Did you find learning about angles associated with parallel lines easy or difficult? Why?	Easy. I was able to understand.
Did you learn anything from working with your group members? How or What did you learn?	I was understanding more when working with the group, we were able to solve problems together.
How did you acquire knowledge or skills to answer question 1.1?	I couldn't.
How did you work out the solutions in question 1.2?	It was better when I was working with other learners but alone….. very difficult.
Did working with group members assisted you in learning angles associated with parallel lines in geometry?	Yes. I was understanding better and learning.
What strategies you think you would have used to teach angles associated with parallel lines in geometry if you were a teacher?	Extra classes.

Our Interview has come to an end; do you have any questions or anything you wish to add to your responses?	No.
Can I kindly check if I have your correct details and that our interview has been saved?	Yes.

APPENDIX K: Editor's language and editing certificate

Angela Bryan & Associates

6 Martin Crescent
Westville

Date: 01 July 2021

To whom it may concern

This is to certify that the Master's Dissertation: Exploring Challenges Experienced by Grade 8 Learners When Learning Angles Associated with Parallel lines in Geometry written by Xoliswa Dlamini has been re-edited by me for language.

Please contact me should you require any further information.

Kind Regards

Angela Bryan

angelakirbybryan@gmail.com

0832983312

APPENDIX L: Turnitin Certificate

Exploring challenges experienced by grade 8 learners when learning angles associated with parallel lines in geometry.

ORIGINALITY REPORT

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