BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN MATHEMATICS

AN INVESTIGATION ON LEARNERS' PERFORMANCE IN GEOMETRIC CONSTRUCTIONS AT ORDINARY LEVEL, BASED ON GENDER.

BY KAFUME PHILIP

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE HONORS DEGREE IN MATHEMATICS EDUCATION

JUNE 2024

RELEASE FORM

Title of the dissertation: An investigation on learners' performance in geometric constructions at ordinary level, based on gender.

1. **To be completed by the student**

   I certify that this dissertation is in conformity with the preparation guidelines as presented in the Faculty Guide and Instructions for Typing dissertations.

   

   16/08/24

   (Signature of student) (Date)

2. **To be completed by the supervisor**

   This dissertation is suitable for submission to the Faculty. This dissertation should be checked for conformity with Faculty guidelines.

   (Signature of Supervisor) (Date)

3. **To be completed by the chairperson of the department**

   I certify to the best of my knowledge that the required procedures have been followed and the preparation criteria have been met for this dissertation

   (Signature of the chairman) (Date)

APPROVAL FORM

Name of the student: KAFUME PHILIP

Registration Number: B1026984

Dissertation Title: An investigation on learners' performance in geometric constructions at ordinary level, based on gender.

Degree Title: Bachelor of Science Education Honours Degree in Mathematics

Year of completion: 2024

Signed…… Date ……/……./……

Permanent Address
Chimoio secondary school
P.O. Box 671
Muzarabani

AKNOWLEDGEMENTS

My heartfelt gratitude goes to the Almighty Father who by his loving grace has been my light and my hope. Many thanks goes to my supervisor Mr Gwizangwe I. for his unwavering and continuous support that he gave me in carrying out this research. His suggestions, knowledge and comments shaped this project and made what it is. All the credit goes to him for his suggestions and valuable comments on this research; this would not be possible without his support and guidance. I also thank the administrators of Chimoio Secondary school for allowing me to carry out the research at their institution. Special thanks to my parents, my wife, my children and my friends, for their moral and financial support during the course of this research. I would also like to acknowledge the mathematics teachers and students who agreed to be part of this research project.

DEDICATION

This research is dedicated to my lovely wife, Christina Nashoni, my beloved sons and daughters, Nostalgia Ruvimbo., Novice Varaidzo., Providence Danaishe, Nourish Kudzaishe and Prominence Anashe, my mother and my late father. All relatives who supported me financially and spiritually and encouraged me to work towards the achievement of this study. Dear friends and colleagues I am thankful for all the encouragement you have given me.

ABREVIATIONS/ACCRONYMS

STEM : Science, Technology, Engineering and Mathematics

SDC : School Development Committee

HBSCED: Honours Bachelors of Science Education

ZIMSEC: Zimbabwe Schools Examination Council

HEXCO : Higher Education Examination Council

NCTM : National Council for Teachers of Mathematics

ABSTRACT

This study investigates the performance of ordinary level learners in geometric constructions, specifically focusing on gender differences. The study further examined other factors that could contribute to low performance of learners at Chimoio secondary school in Muzarabani District. A mixed-methods approach was employed, combining both quantitative and qualitative data from a sample of 20 learners, 10 boys and 10 girls from form 4 class and 5 mathematics teachers from two different schools Chadereka and Kairezi secondary schools. Stratified random sampling has been employed to select learners who participated in attempting the given geometric constructions questions in the observational schedule, the questionnaires and the face-to-face interviews. Stratified random sampling was used as a way of making sure that learners from ordinary level class were represented in the study. Purposive sampling was used to choose 5 mathematics teachers from 2 different schools in order to extract a variety of information from the teachers on their teaching experience specifically in the teaching of geometric constructions at ordinary level. The results show that male learners outperformed their female counterparts in geometric constructions, with significant differences in accuracy, completion time and the required skills in the handling of construction tools. This shows that when we talk about gender and geometric constructions, boys perform better as compared to girls. Girls are very slow when presenting their work. The work they presented was not so neat as compared to that of boys and the logic of the work was not presentable. However, qualitative analysis revealed that female learners exhibited higher levels of spatial reasoning and problem-solving skills, despite lower overall scores. The study's findings have implications for mathematics education, suggesting that gender-sensitive teaching approaches and interventions may be necessary to address disparities in geometric constructions performance. The researcher recommended that the mathematics educators should always be equipped with current information through attending workshops and staff development meetings. These workshops and staff development meetings should provide teachers with gender sensitivity training to address biases and promote inclusive teaching practices. It was also important for the parents to support learners financially so that they can purchase materials such as pairs of compasses, protractors, scale rulers and dividers. If learners make frequent use of these tools, they

familiarise with them and it will be easy to use them. The research contributes to the ongoing discussion on gender and mathematics achievement, highlighting the need for a more comprehensive understanding of learners' strengths and challenges in the area of geometric constructions.

Table of Contents

RELEASE FORM i
APPROVAL FORM ii
AKNOWLEDGEMENTS iii
DEDICATION iv
ABREVIATIONS/ACCRONYMS v
ABSTRACT vi
List of figures xi
List of Appendixes ..... **Error! Bookmark not defined.**
CHAPTER 1 1
1:1 Introduction 1
1:2 Background of the study 1
1:3 Significance of the study 3
1:4 Statement of the problem 3
1:5 Research aim 4
1:6 Research objectives 4
1:7 Research questions 4
1:8 Assumption 4
1:9 Limitations of the study 5
1:10 Delimitations of the study 5
1:11 Definition of terms 6
Chapter 2 8
2.0 Review of related literature 8
2.1 Introduction 8
2.2 Gender and education 8
2.2.1 Gender Differences on Large Scale Mathematical Assessment 9
2.2.2 Why Gender Matters 10
2.3 Geometric Constructions in Education 11
2.4 Critical milestone in school geometric constructions 12
2.5.0 Factors affecting performance in secondary schools 13
2.5.1 Learning Environment 14
2.5.2 Family Background 14

2.5.3 School Infrastructure 14
2.5.4 Challenges in Understanding Geometric Constructions 15
2.5.5 Teacher-Learner Ratio 15
2.5.6 Unhealthy Lifestyle 16
2.5.7 Loss of Interest 16
2.6 Teacher's gender on learners performance 16
2.7 Summary 17
Chapter 3 18
3.0 Research design and methodology 18
3.2 Research design 18
3.3.0 Research instruments 19
3.3.1. Questionnaires 19
3.3.2. Interview 20
3.3.3 Observational schedule 20
3.4 Target population 21
3.5. Sampling techniques 21
3.6 Data collection procedure 22
3.7 Data presentation and analysis 23
3.8 Summary 23
CHAPTER 4 24
4.0 Data presentation, analysis and discussion 24
4.1 Introduction 24
4.2.0 Link between the literature review and new findings 24
4.2.1 Gender information of mathematics teachers who participated in this research 25
4.2.2 Educational workshops and staff development meetings attended 26
4.2.3 Mathematics teachers' workload 27
4.3 Availability of mathematics resources at the school 29
4.4 Availability of mathematics textbooks at the school 29
4.5 Performance of learners in geometric constructions based on gender 31
4.6,0 Learner related challenges on construction 32
4.6.1 Lack of resources 32
4.6.2 Learners' attitude toward the subject 32

4.7 Mathematics pass rate at the school 33
4.8 Summary 34
CHAPTER 5 35
5.0 Summary, Conclusion and Recommendations 35
5.1 Introduction 35
5.2 Summary 35
5.3 Conclusion 35
5.4 Recommendations 36
References 38
Appendix I 46
Teacher's Questionnaire 46
Appendix II 49
Learner's Questionnaire 49
Introduction 49
Appendix III 51
Interview questions for learners 51
Appendix IV 52
Observational Schedule 52
Geometric Construction for Ordinary Level Learners 52

List of tables

Table 4. 1 Gender ratio and qualification of mathematics teachers..... 25
Table 4. 2 : Scores obtained in the task by gender..... 31

List of figures

Figure 4. 1: The link between past and new findings on gender differences..... 24
Figure 4. 2: Educational workshops and staff development meetings attended..... 27
Figure 4. 3: Responses on weather mathematics teachers have other subjects they teach other than mathematics 28
Figure 4. 4: Mathematics teachers teaching experience 29
Figure 4. 5: Mathematics textbooks versus enrolment 30
Figure 4. 6: School pass rate for the previous four years..... 34

List of Appendixes

Appendix I 46
Teacher's Questionnaire 46
Appendix II 49
Learner's Questionnaire 49
Introduction 49
Appendix III 51
Interview questions for learners 51
Appendix IV 52
Observational Schedule. 52
Geometric Construction for Ordinary Level Learners 52

CHAPTER 1: Introduction

1:1 Introduction

In the Zimbabwean education system, mathematics is considered to be the most important learning area as it creates many opportunities for everyone in the country and the world at large. This chapter gives an articulate account of the problem under investigation by stating the background of the study where the researcher openly highlights what propelled him to carry out this study. The researcher also gives the rationale for embarking on this research by a way of having the main aim of the research study and giving well explained statement of the problem. Research questions, as well as research objectives of the study are stated. The significance of the study enlightens and gives a clear picture of the importance of carrying out this study. In this chapter, limitations and delimitations of the study are also explained in detail. Key terms used in the research are defined.

1:2 Background of the study

The study of mathematics is as important as understanding life itself. This is the core reason that prompted the researcher to find out why the performance of boys and girls seemed to differ when learning geometric constructions at ordinary level. Globally, female learners lack participation in mathematics and this has become a major concern to researchers (Mandina et al, 2013).

Geometric constructions help students realize the relations between different geometric models and develop their problem solving abilities (Napitupulu, 2001). Geometric constructions is one of the topics which leads to the study of Technical Drawing in secondary schools, polytechnics, universities and other colleges. Technical drawing is the most popular, skill-oriented technical subject in any technical education programme (Oviawe and Adeola, 2017). Technical drawing is the universal and graphic language of technology used by architects, technicians, engineers, designers, craftsmen, operators, manufacturers and industrialists to communicate ideas by means of pictures, drawings, graphics and symbols.

Mathematics teaching and problem solving should be considered together in modern education. It is important to determine students' problem solving abilities as well as developing them. The

researcher has been teaching mathematics for more than twelve years and discovered that geometric constructions is one of the challenging topics in Mathematics to many rural secondary school learners. Hanna & De Villiers (2012) pointed out that geometry in mathematics has also been considered challenging for many learners. Geometric construction is a common topic that Zimbabwe Examinations Council uses to assess the construction skills of the learners specifically at ordinary level. However, from my experience, l discovered that the performance of boys and girls seemed to differ on the topic of geometric constructions. Osakwe (2023) affirms that students taught geometric constructions utilizing interaction patterns remember more material than those taught using expository approach. This has driven the researcher to carry out the research on whether the topic of geometric constructions has anything to do with the teaching approach that could be a contributing factor to gender differences in individual learner's performance. Since the examination board does not consider the gender differences when making final decisions on the grading system, there should be enough clarity on the performance of boys and girls on the topic of geometric constructions. Once anything of concern is noted, if there is any chance of having different performance led by the difference in gender, teachers will have enough assistance on how best they can help learners to cooperate despite gender differences between them. This will in turn help the examination boards to come up with a fair grading system of results considering these differences within individuals based on gender.

Above all, there is need to have equal education for all and we cannot have equal education if we have an element of gender disparity. This research will also add value to the curriculum development so that if the concept of geometric constructions is truly said to be gender based, then the content needs to be reviewed. The curriculum development stakeholders will use it also to determine whether the mathematics content can be changed to suit all the individuals or not. Mejia-Rodriguez et al (2021) supports that gender differences in mathematics may be different depending on the particular area of mathematics. Therefore, gender differences in geometric construction performance and efficacy deserve attention. Geometric constructions has an important place in everyday life in mathematics and other branches of science.

1:3 Significance of the study

The research focuses much on the investigation into learners' performance in geometric construction at ordinary level, based on gender differences. This will be of much essence to all educational stakeholders. Learners also need to know that there are differences in performance among them in as far as geometric construction topic is concerned. This will let them know if gender differences have an influence on their performance. Teachers are always at the forefront of the system, as such they need to be well informed about the system. If they are fully equipped with knowledge of who performs best or worst on the topic of geometric construction, they will be able to treat learners accordingly. This study also enriches educational planners to appropriately consider content that needs to be included in the educational system at a specific level. It is not a good idea to let learners continue to learn the content which they perform differently as a result of gender differences. Instead, all concepts that suit both boys and girls should be promoted since learners will be able to enjoy equal opportunities despite being a boy or a girl. In addition, examination boards do not offer assessment tests that are gender based on the topic, instead they award marks by a way of looking at an individual learner's performance. Their intention is to examine individuals to be graded according to individual performance. Therefore, this research is of much significance to the educators, learners and other educational stakeholders such as the examination boards, curriculum developers and curriculum planners to ensure that the system becomes fair to everyone regardless of gender.

1:4 Statement of the problem

Students' mathematics proficiency in Zimbabwe is often used for decision making regarding schooling and job opportunities (Channon et al., 2011) while the pass rate in the poverty stricken schools in rural areas is continuously declining (Mupa, 2015). Many girls in rural secondary schools leave school before or after they attain ordinary level. It has been noted with great concern that most of secondary school level girls poorly performed in mathematics concepts that are related to geometric constructions. As a result, they score low grades in their final examination in mathematics as compared to boys at the same level. To some extent, they opt for early marriages as a result of myths and misconceptions they encounter in the learning of geometric constructions. This study would want to establish whether there exist such gender differences to combat the welfare of children and have the balanced treatment for both boys and girls in as far as performance at school is concerned.

1:5 Research aim

The research aims to investigate whether gender has anything to do with the learners' performance on the geometric construction concepts at ordinary level.

1:6 Research objectives

The researcher intends to:

1) investigate the performance of ordinary level learners on the concept of geometric constructions based on gender
2) find out whether geometric construction skills are within individuals or are something that can be acquired.
3) identify a group, if any, between the two sexes that performs better than the other.

1:7 Research questions

The study will be guided by the following questions;

1) Does gender contribute to the performance of learners focusing on the concept of geometric constructions?
2) Is there a significant interaction between gender and teaching methods on learners' performance in geometric constructions?
3) Does the relationship between learners' gender and their motivation or anxiety in learning geometric constructions exists?

1:8 Assumption

The researcher assumes that; anything done practically is easily understood, therefore, learners would perform better in geometric constructions than in other topics that are done theoretically.

Provided learners are at the same level of learning, they can perform equally regardless of being a boy or a girl. The target group has already covered some concepts on geometric constructions before participating in this survey. Both teachers and learners will positively participate and provide reliable information the researcher is looking for.

1:9 Limitations of the study

Research results that can be obtained from the survey can be affected by false responses. The respondents may take the research for granted and give false responses. Also, poor co-operation and dishonest response can reduce the reliability of the results that are gotten from this research. Poor financial backup would confine the researcher to carrying out the research at Chimoio secondary school, probably with a small number of respondents from the neighbouring secondary schools. It would have been of great benefit if the research was to be carried out in different schools that would render the research findings to be of great value. Despite all these factors, the research will try to create a good rapport with respondents to get unbiased responses. The respondents will be assured of privacy and confidentiality.

1:10 Delimitations of the study

Delimitations are what the researcher includes and excludes to make a project manageable and focused on the research question. Theofanidis (2019), defined delimitations as limitations consciously set by authors as boundaries or limits of their work so that the study's aims and objectives do not become impossible to achieve. The delimitation of the research problem is the precise limit of the issue the researcher is to cover, that is, where it is going to start and end. The researcher is a permanent resident of Chimoio area where he is going to carry out the research. Chimoio secondary school is a rural secondary school where educational resources are scarce and in most cases, learners make use of the available modelled materials. The researcher has chosen to carry out the research study at Chimoio secondary school because it is accessible as it is the place where the researcher works. The school is approximately 87 km east of Muzarabani growth point. The researcher will hand post the questionnaires so as to maximize returns. The research is limited

to schools in lower Muzarabani district and the schools which are in the neighbourhood of Chimoio secondary school.

1:11 Definition of terms

1:11:1 Geometry

Geometry could mean the mathematics of space. Geometry is a branch of mathematics that deals with shapes and structures, and defines terms such as lines, surfaces, curves, circles, and points (AL-salahat, 2022; Creager, 2022; Greenberg, 2008). From a theoretical perspective, the educators of mathematics consider spatial ability as the element of geometry. In this research the term geometric constructions means mathematical concepts that are in mind and can be presented on the paper through practical means.

1:11:2 Ordinary level

This refers to the level of education, particularly in Zimbabwe, a learner attains after thirteen (13) years of schooling. (Zimbabwe Curriculum Framework for Primary and Secondary Education 2015-2022)

1:11:3 Gender

The term gender can be understood as the way individuals express and understand themselves in relation to their sex. Lindqvist et al (2021) pointed out that gender is represented by a dichotomous variable with possible responses of woman or man, female or male. In this research the term gender simply differentiate the boy and the girl.

1.11.4 Learner

A learner is an individual who is acquiring new knowledge and skills through experience, practice and instructions.

1:11:5 Performance

Students' academic score attained in a given task

1:12 Summary

This chapter clearly provides the main framework of this research. It looks at the background of the study, stating what exactly propelled the researcher to carry out the survey. It also provides the main thrust of the research by stating the aim and objectives of the study. As the study will benefit many people in the education fraternity, the significance of the study was indicated as well, together with the limitations and delimitations of the study. The chapter highlighted some of the facts that drove the researcher to embark on this study. Therefore, it is the goal of the researcher to unearth any underlying factors to the above mentioned problems. In doing this, the researcher discovered the works and findings of other researchers that delved deeper into related studies before him in an attempt to unveil some of the key reasons they obtained. These would be the foundation for his study from which he builds the research. The next chapter will address these findings and how they assisted the researcher in the current research.

Chapter 2: Review of related literature

2.1 Introduction

As the researcher was about to embark on the research study, he took enough time to look at other researchers' findings pertaining to a similar subject or related topics. This topic displays researches carried out by researchers and brings in together the interconnectedness of the researcher's proposed study and other researchers' findings in relation to the performance of ordinary level learners on geometric constructions based on gender. This chapter provides a research gap between the proposed study and what other researchers have found in relation to learners' performance on geometric constructions.

2.2 Gender and education

It has become a general norm that mathematics is a man's domain. A study through a meta-analysis reveals that males tend to perform better in mathematics tests than in problem-solving (Hyde, Fennema and Eamon, 1990). Females tended to do better in computations and there were no significant gender differences in understanding mathematics concepts. Another study indicates that females tend to earn better grades than males in mathematics (Kimball, 1989). Fennema and Sherman (1978) identified as critical belief about the usefulness and confidence in learning mathematics, with males providing evidence that they were more confident about learning mathematics and believed that was and would be more useful to them than females would do. Females were found not to be strongly believing in stereotype that mathematics was not their subject, while their male counterparts did not strongly stereotype mathematics as a male domain. The importance of these variables such as confidence, usefulness and stereotyping, their long-term influence and their differential impact on males and females has been confirmed by many other studies (Tartre and Fennema, 1991). Another study which was conducted to analyse factors that affect mathematics achievement under geometric constructions also showed that males scored high American grades than females in 11th grade on the mathematics achievement test, but difference decreased from 10th grade (Campbell and Beaudry, 1998). It has been revealed by some recent studies that gender differences in mathematics education in many countries seem to be narrowing. However, studies show that as learners move to higher grades, males tend to show elevated levels of mathematics achievement. Hall et al (1999), examined gender differences of 5th and 8th grade

learners in mathematics. They found out that there were no substantial differences found in gender. However, in the final year of secondary school, evidence was found for gender differences in mathematics achievement.

2.2.1 Gender Differences on Large Scale Mathematical Assessment

Mathematical achievements can be demonstrated through formative and summative assessments (Schoenfeld, 2015). Formative and summative assessments have, "complementary objectives of determining mathematics learning outcomes" (Adabor, 2013). Formative assessments are given to learners before or during instructions in order to determine learner strengths and areas of improvement. The primary purpose of formative assessment is to provide both learners and teachers with feedback as to areas that need improvement before instruction is complete and a summative assessment is given (Schoenfeld, 2015). Teachers may use data from formative assessments to "build up learner understanding through focusing on learner thinking while engaging in rich mathematical tasks such as geometric constructions" (Schoenfeld, 2015). In contrast, learners complete summative assessments at the end of instruction. The primary purpose of summative assessments is to assess learner knowledge after instruction by assigning scores to individual learners that are compared to other learner scores. Summative assessments may be external, taking the form of national, state, or district-level assessments, or may be internal, such as school end-of-course examinations. Adabor (2013) suggested that teachers and learners view formative assessments as "micro-summative" assessments because they assess learner knowledge after smaller amounts of instructional time than a full course. In relation to summative assessments, standardized testing, whether from nationally formed boards or internationally formed boards such as the ZIMSEC, HEXCO and CAMBRIDGE respectively, measures learner performance which is measured by formative assessments. Large-scale assessments provide national and international data on mathematics that may be different from classroom performance, which is often overall data about mathematical performance and gender gaps. Researchers use data from these large-scale assessments to examine both short-term and long-term trends in gender equity and inequity in order to inform educational policymakers as to the effectiveness of the current policy. Researchers also review large-scale assessments for patterns of gender equity in mathematics.

Even when test scores reflect significantly different results for male learners and female learners, causative factors other than gender alone may be accountable.

2.2.2 Why Gender Matters

In exploration of why gender matters in the secondary school education and what parents and teachers need to know about the emerging science of sex differences. Sax (2005) noted that researchers have found evidence that pre- programmed differences exist in male and female brains. According to Achiron and Lipitz (2001), male and female learners use different portions of their brains, contributing to differences in vision, language processing, numeracy, problem solving and performance. These differences influence their learning styles, which are coupled with different maturation rates. Maturation rates may contribute to disruptive classroom and learning environment behaviours for the respective genders. Based on this research, Sax argued that female learners use both sides of their brain to process different skills, male learners use only the left side of the brain to process skills. Sax also contended that male learners activate a different portion of their brain than female learners to solve geometric and arithmetic computations. Sax also noted that female and male children exhibit differences in the rods and cones of their eyes, which may account for why female children pay more attention to texture, colour and details, male children are more attentive to actions. Brain differences may also influence differences in behavior. Sax (2005), cited researchers who have found that male children play more aggressively than female children, even across primate species boundaries, generally preferring play involving actions like running and throwing, while female children are likely to engage in passive play such as pretending babysitting (Berenbaum and Snyder, 1995). Differences in learning styles surface early, Sax noted, often by school age. Young female learners are more likely to attend to homework even when it is of little interest to them, only to please their teachers. Male learners, on the other hand, need to find some interest in the homework topic in order to actively engage with it. Sax (2011) presented several key recommendations for improving instructions based on his findings that biological differences influence behavioural differences, which in turn could influence educational success or failure because these behavioural and learning styles develop at staggered times in early childhood. Sax (2005) recommended that parents delay enrolling their children in school until they

are 7 years old, especially boys. Since gender differences are significant in early childhood, Sax believed that single-sex education should be an option in elementary school classrooms.

2.3 Geometric Constructions in Education

Geometric constructions are useful scientific reasoning tasks because they are discovery tasks in which the results of learnt mathematical problems can be applied to physical objects in the real world. It serves as a means of showing the physical world and assists in the development of various fields, such as art, architecture, chemistry, physics, and so on, which require adaptation and the use of design and prediction skills, alongside mathematical, creative and logical thinking (Janicic, 2009). Similar to geometry proofs, constructions should be supported by deductions. However, research has shown that learners in secondary schools and universities, including pre-service teachersn are regarding deductive proofs as irrelevant in geometric constructions (Miyakawa, 2002). The failure to use the deductive mathematical knowledge that learners already possess attributed to passive instruction. Pre-service teachers can be actively engaged with the learning task through involving them in peer-feedback provision. But since they rely on empirical approaches when performing geometric construction tasks, they are more likely to use the same approaches during peer-feedback provision unless they are being trained and supported to use specific types of feedback. Several studies in geometric constructions education have shown that teaching learners using worked examples works better than the convectional teaching, especially for learners with low domain knowledge (Carroll, 1994). Using a worked example as a domain knowledge scaffold can be expected to reduce the demand introduced by the complexity of the task and consequently, help learners to focus on the peer-feedback provision process. The work that learners do with geometric tools (such pairs of compasses and straightedges) helps them develop an understanding of significant geometric constructions. Such connections, in turn, support learners' capacities to prove and problem solve. When learners learn a geometric concept that is not coherent, that is, connected to nothing but a theorem in a book, sentences in their notes or statements made by their teacher, they are not able to provide meaning to that theorem. Sequences of activities that integrate geometric constructions, digital technology, and elements of art and principles of design to enhance learners' geometric reasoning need to be focused on. Several authors have developed and utilised such tools or rubrics and these existing rubrics are

served as a starting point in our discussions for determining how best to capture and measure these notions. Burger (2013) developed a series of rubrics for use as part of a project in college-level geometry that focuses on five criteria: accuracy, neatness, and creativity, effort and meeting deadlines or following directions. Finally, Rajdl (2014) developed a five-point art rubric that incorporates the elements of art and principles of design. However, lack of instrument to measure learners' understandings, skills and lack of video recordings or transcriptions of classroom discussions can highly affect the educators to determine whether the learner is gifted or not in certain aspects of the study. The National Council for Teachers of Mathematics has long encouraged mathematics teachers to "develop multiple representations and connections and construct meanings from new situations" (NCTM, 1989). The sequences of activities described in this article, implemented through a STEAM approach that focuses on the benefits of integrated learning (Liao, 2019), provide learners with opportunities to develop such meanings and connections in the context of creating artistic geometric constructions.

2.4 Critical milestone in school geometric constructions

In the mathematics education research literature, one can find many studies that focus on the construction of geometric concepts, and specifically on the mutual interaction between their concept definition and learners concept images. One of the main findings of the research literature is the prototype phenomenon. Vinner and Hershkowitz (1980) found out that, for each geometric concept, there is at least one prototypical example. These prototypical examples are usually obtained first and are prominent in the concept image of most learners. Often, non-critical attributes have dominant visual properties, which have an effect on the concept's identification, classification and construction. Parzysz (1988) pointed out that the drawing is unique, wherever it represents a set of objects, which has usually infinite and common critical attributes. Laborde (2005) showed that learners often regarded the unique and particular drawing on paper as the object itself, rather the abstract object represented by the drawing. Thus, drawing may cause difficulties for learners in their proving processes while using a particular attribute of the single drawing instead of using the critical attribute of the geometric concept. As learners progress through school, their failure to meet certain milestones is highly predictive on loosing concentration on certain aspects. Parents and teachers should be particularly vigilant regarding each learner's academic

performance. Recognising the warning signs promptly is crucial to early and effective intervention. It is very important for learners to master how to acquire construction skills at earlier age since it underpins future learning in the upper elementary grades where more complex construction skills in geometry are required. They should be transitioned from "learning to construct to construct to learn". Poor academic performance in the mathematics, low reading scores, absenteeism and disengagement from school become very reliable predictors of whether they will later perform well in high schools (Kannelly and Monrad, 2007). On the individual level, it is also important to consider pupils' beliefs in their own competencies and motivation to succeed academically. Some researchers pointed out that pupils' beliefs in their abilities tend to become increasingly negative as they grow, at least through early adolescence. When pupils believe that they are less competent in certain academic activities, they tend to value them less, which can make them perform poorly academically.

2.5.0 Factors affecting performance in secondary schools

Gender is not only the factor that contributes to the difference in performance, but only gender is the main factor that contributes to the difference in performance of secondary learners in mathematics education, especially in the sections of geometric constructions. Quite a number of studies have been carried out to identify factors that caused poor academic performance in a number of institutions worldwide. Diaz (2003) reported that most studies focus on the three elements that intervene, that is, parents (family factor), teachers (academic factor), and learners (personal factor). Though the influence on academic performance varies from one academic environment to another, from one set of learners to the next, and indeed from one cultural setting to another. James (2009) pointed out that a learner who is successful in his desired career has good study habits. On the other hand, the studies which were carried out by Kornell and Bjork's (2008) suggested that only about two-thirds of secondary school learners routinely quiz themselves, and a majority of learners study only once for the upcoming examinations. Some of the common factors that have been brought out by other researchers are mentioned below.

2.5.1 Learning Environment

The type of the environment and the people a child interacts with during the higher secondary school phase is partially responsible for the overall performance, including the academic score. When a child is bullied by his/her peers, does not have a particular liking towards his/her peers, or has difficulty in making friends, it may affect the focus he must have during classes. Additionally, if the learner is not enthusiastic about going to school, it might cause a poor school attendance, which makes the child miss important lessons with topics that he/she would probably have difficulty in preparing for the public examinations. Interacting in class, talking to fellow learners, and taking small steps towards getting involved in the school activities can help the learner have a liking for his surroundings, and eventually perform better.

2.5.2 Family Background

Internal family conflicts often affect the academic performance of a learner in higher secondary school. Returning home to a negative atmosphere affects the will to study, and to work towards school work. Learners coming from conflicting families mostly have little concentration in classroom discussions and lessons and are unable to catch up while studying at home. In such situations, parents are encouraged to maintain a healthy and happy family, and not involve children in quarrelsome environments, especially during important examinations. In such situations where learners are unable to perform well academically, due to family matters, educators are being advised to offer parental counselling sessions for families to help their children to fully engage in the forthcoming examinations.

2.5.3 School Infrastructure

In line with the school infrastructure, the recent pandemic posed a challenge to the learning system of the rural secondary school learners due to limited infrastructure. The COVID-19 pandemic affected the set teaching and learning pattern of most schools. Most learners were not equipped to study online, due to the lack of resources, and appropriate infrastructure. While some learners faced challenges in concentrating and participating in online classes due to lack of subdued learning environment, unnecessary disturbances, and noise were witnessed. Quite a number of rural secondary school learners do not possess mobile phones or laptops to facilitate their online education. When taking geometric constructions as a major consideration, for a learner to perform

well in this area he/she should have a good learning environment with recommended infrastructure so as to display the construction skills when performing the task. The use of physical facilities such as models will also help grasp the idea of geometry, which seems to be abstract (Sarfo et al., 2014). It is the facilities in terms of infrastructure, equipment and materials that afford the students the opportunity to acquire the necessary knowledge (Sarfo et al., 2014). Schools with few teaching equipment, seating areas, cramped classrooms, and outdated technology also adversely affect the child's will to learn basic understanding of the subject and thus the academic performance will also be affected.

2.5.4 Challenges in Understanding Geometric Constructions

Many concepts and topics of the higher secondary school curriculum can be difficult to understand and among these concepts and topics, geometric constructions cannot be an exception. Although geometry is a study subject that is important to teach in school, it is identified as a difficult subject for both students and teachers. Students and teachers believe that this is a subject in which the level of requirements is high (Leal, 2007). Being absent from classes when such topics are taught may be unfortunate for the child, thus affecting the overall academic score. Educators are encouraged to identify classes with marginal students or remedial classes and provide extra lessons for learners who have difficulty in understanding the concepts.

2.5.5 Teacher-Learner Ratio

A teacher's undivided attention, appreciation, and understanding play a huge role in developing the learner's interest in the subject. If teachers are burdened with immense side responsibilities, and an abnormal number of learners to teach, it may affect the teaching style and the quality of education imparted to the learners. Learner-teacher ratio refers to the number of learners in a classroom, per teacher. It is equally important to adhere to the regulations of the MoPSE. An imbalance in the ratio has proven to affect the academic performance of the learners. Maintaining a healthy learner-teacher ratio, to ensure quality education for their young learners is highly encouraged and recommended.

2.5.6 Unhealthy Lifestyle

An unhealthy lifestyle has a drawback to learners' educational welfare. Learners believe that studying for a long time and having short time for sleeping usually yields good academic results. This is not true at all, according to most researchers. Surviving on caffeine, or getting insufficient hours of sleep affects the ability to learn and think. A healthy lifestyle is important to performing well in academics or any other field. Having a balanced diet, along with adequate hours of sleep, and study breaks is very important to sustain and improve an academic record.

2.5.7 Loss of Interest

Every learner has his /her favourite learning area. It is not always the case that every child would like all topics, and perform exceptionally well in every subject all the time. There are situations when children lose interest in a few topics in the curriculum and do not have the will to study and prepare them for the examinations. It is understandable but detrimental to the academic score of the learner. During these situations, it is highly recommended for learners to share such problems with their teachers so that they can help them in overcoming such obstacles.

2.6 Teacher's gender on learners performance

Several previous studies have investigated the role of teacher gender on learner performance, thus addressing the issue of whether or not female teachers play a significant role in enhancing learners' grades, more specifically on female learners. The topic is still widely debated due to the varying results obtained from the different studies. In the context of the United States, Dee (2007) shows that girls outperform boys in measures of reading achievement while generally underperform in Science and Mathematics, and that one major class of explanations for these gaps involves gender-based interactions between learners and teachers. The study also examines whether assignment to a same gender teacher influences learner achievement, teacher perceptions of learner performance, and learner engagement. The results suggested that a year with a female teacher would close the gender gap in Mathematics achievement among learners by half and eliminate entirely the smaller achievement gap in Mathematics. However, how these interactions contribute to the gender gaps in educational outcomes also depends on the gender distribution of teachers by subject. The main

policy implication of these results is simply to underscore that the gender interactions between learners and teachers do appear to constitute an important 'environmental' influence on educational outcomes for both girls and boys. Alternatively, a policy might be rooted in the conjectured existence of stereotype threat among learners or of biases in teachers' behaviour and expectations. Discriminating among these explanations and designing appropriately targeted policies is a prospective avenue for shaping the gender patterns of educational outcomes. The results show no empirical evidence to support the claim that there is a tendency for male teachers to enhance the educational performance of boys and, conversely, for female teachers to enhance the educational performance of girls. One reason for the insignificant impact of teacher gender on learner performance could be that the study included no information about the length of time spent with those teachers for the sample of pupils analysed. In addition to this, there was no random assignment of teachers to classes, such could have been employed to investigate the issue more rigorously. However, when we consider attitudes, children taught by women, both boys and girls alike were more inclined to show positive attitudes towards school than those taught by men.

2.7 Summary

The chapter looked at selected literature sources which provide information on the relationship between gender and academic performance of secondary school learners, based on the aspect of geometric constructions. Different viewpoints from different sources were highlighted in this chapter. To mention a few, the chapter looked at gender and its impact on the academic performance, factors that contribute to poor performance of learners in secondary schools in general, and the development of geometric construction skills. On the other hand, links of comparative literature between previous studies and this study were highlighted in this chapter.

Chapter 3: Research design and methodology

3.1 Introduction

This chapter is going to give a description of how the research is going to be conducted. It clearly outlines all the activities that will take place while the research is being carried out to gather relevant information for the research study. This chapter gives clarity on the research design, instruments used to gather the wanted data, population samples, sampling techniques, data collection and analysis procedures.

3.2 Research design

A research design is a detailed framework that guides the researcher in collecting, analyzing and interpreting data to answer research questions or test hypotheses. It is a strategy used to acquire the information needed to solve the problem in the research question. This research will use both quantitative and qualitative research methods. The researcher will employ both quantitative and qualitative research methods in order to have reliable, logical and valid conclusions to the research findings. Yousefi et-al (2020) described quantitative research method as a deductive approach which mainly uses numbers and qualitative research method as an inductive approach using words. The quantitative approach helps the researcher to collect data from a large number of participants, thereby increasing the possibility to generalize the findings to a wider population. The qualitative approach provides a deeper understanding of the issue being investigated, respecting the voices of the participants. Dawadi (2021), pointed out that quantitative data brings breadth to the study and qualitative data provides depth to it. The researcher also found it to be ideal to use these two methods because of different backgrounds of the individual participants. Some participants might find it difficult to answer questionnaires due to restricted time they might have, while others may easily respond through the questionnaires. The researcher also employed a case study design. Schoch (2020) defined case study as an in-depth investigation of a contemporary phenomenon within its real-life context. In a case study, nearly every aspect of the subject's life and history is analyzed to seek patterns and causes of behaviours. The case study design allows the researcher to use any method of data collection which suits the purpose (Priya, 2021). A case study gives enough room for the researcher to use instruments such as questionnaires, observations and interviews when gathering information from the respondents. The design involves the participants from

ordinary level learners together with the teachers who are teaching form fours. Instruments like questionnaires, interviews, observations will be used to gather data.

3.3.0 Research instruments

Questionnaires, interviews and observations are used for data collection. The use of these three instruments minimizes the shortcomings of each instrument while increasing the validity and reliability of the data generated, thus the researcher accommodated triangulation. The researchers pay particular attention to the use of triangulation of research methods. Triangulation is the use of multiple methods or data sources to develop a comprehensive understanding of a research problem through the convergence of information from different sources (Carter et al, 2014). The application of several research methods is very beneficial to the final results (Dzwigol, 2022).

3.3.1. Questionnaires

A questionnaire is a research instrument that consists of a set of questions for the purpose of gathering information from respondents through survey or statistical study. (https//:en m.wikipedia.org/wiki/Questionnaire). Mcleod (2023) suggested that questionnaires provide quick, cheap and efficient means of obtaining large amounts of information from a large sample of people. However they lack detail because the responses are fixed, there is less scope for respondents to supply answers that reflect their true feelings on a topic. These questionnaires are designed to extract relevant information about the study from the respondents. Two different questionnaires are designed to collect relevant information for this research study. The questionnaires will be labelled appendix 1 and appendix 2. The questionnaire which is labelled appendix 1 is meant to guide mathematics secondary school teachers when giving their responses. Section A of the questionnaire provides the general background of the mathematics teacher. In Section B the questionnaire is designed in such a way that the respondents provide useful information concerning the impact of gender on the academic performance of learners, especially when dealing with geometric constructions at ordinary level. Section C is specifically looking at how the teacher assesses the learners. Appendix 2 is designed to guide mathematics learners at ordinary level. In this appendix, Section A allows the learners to provide information about their background and in

Section B there are questions seeking to establish the attitude of learners towards geometric constructions at ordinary level and the challenges they face on this topic.

3.3.2. Interview

Interviews between the researcher and respondents were made available to cover up a gap created to some respondents who do not have much time to attempt to complete questionnaires. Interview interactions are much reliable as respondents tend to positively respond to what they are being requested to provide. In most circumstances, it is very easy to note that the information provided through interviews is true or not true since this will be done on face-to-face conversation where the researcher is able to read it from the facial expressions of the respondent, the way the respondent speaks and respondent's action. Phellas (2019) supports that interviewer can control the context and the environment in which the interview takes place, that is, the interviewer can make sure that the questions are asked and therefore answered in the correct order and that the interview takes place in an appropriate setting which is conducive to accurate responses. Thus, the researcher designed the appendix 3 that assisted him to gather information through interviewing ordinary level learners.

3.3.3 Observational schedule

An observation is a way of noting and recording information about people and their behaviour without asking specific questions. Observations will be employed in this study because they do not require provision of instant answers and they do not require people to report. The researcher used participant observations where the researcher is involved in the event being researched. Many advantages have been identified in using observations in research. The biggest advantage is that the researcher is part of the group. In this case, the researcher is a participant observer who is a teacher at the same school the research is going to be carried out. Above all, the results obtained from these observations are fairly trusted since the researcher is involved and has an opportunity to control the participants. Appendix 4 was designed to guide the researcher as he was observing different geometric construction skills among respondents. Some of the skills being observed are

techniques of handling construction instruments, constructional styles, neatness of work presented, fastness in construction and critical thinking.

3.4 Target population

Population is the totality of cases or figures in an investigation. According to Shukla (2020) population refers to a set of all units which possess variable characteristics under study and for which findings of research can be generalized. Casteel (2021) emphasized that the target population must be a complete subset of the population of interest, that is, members of the target population must also be described by the boundaries of the population of interest. The school has a total population of 115 learners and 5 teachers, 3 male teachers and 2 female teachers. Out of 115 learners, only 20 learners who are at ordinary level will participate in this research. Since the school has only one teacher who teaches mathematics, the researcher invited 3 mathematics teachers from Chadereka secondary school and the other 2 mathematics teachers from Kairezi secondary school to make a total of 5 mathematics teachers who are involved in the research study as participants. The researcher will choose purposively 5 mathematics teachers from 2 different schools in order to extract a variety of information from the teachers on their teaching experience, specifically in the teaching of geometric constructions at ordinary level.

3.5. Sampling techniques

Sampling is described as an act, process or technique of selecting a representative sample of population to observe and analyze the characteristics of the entire population (Rahman, 2022). According to Deshpande (2019), sampling technique aids and guides the researcher to identify the elements or units from whom the data is to be collected. When selecting mathematics teachers who are going to participate as respondents to questionnaires, the researcher will use purposive sampling. Bakkalbasioglu (2020) pointed out that using purposive sampling to access potential interviewees is easier than other methods. The researcher believes that the mathematics teachers who are chosen have enough experience of how to teach geometric constructions since they have worked in their respective stations for 1 or more years. They are able to explain on the performance pattern of the mathematics learners in geometric constructions. Due to their experience, the

teachers can tell whether gender has a contribution to the learners' performance and the common challenges learners face in this topic. Stratified random sampling will be used to select learners who will participate in attempting the given geometric constructions questions in the observational schedule, the questionnaires and the face-to-face interviews. Rahman (2022) stated that this stratified random sampling technique ensures representation of all parts of the population, each member in the targeted population has an equal chance of being selected. Ordinary level mathematics learners will be randomly grouped according to their gender. In these groups, each member of the group will have an equal chance of being selected. A set of 10 cards to be inscribed YES for the males and the other set of 10 cards written YES for the females will be put in two separate boxes so that the learners will pick the cards from the box individually. The rest of the cards will be inscribed NO. The researcher will provide 2 boxes, one for the male learners and the other for the female learners. Ordinary level mathematics learners are going to be randomly grouped according to their gender. In these two groups, each member of the group has an equal chance of being selected because two sets of those cards of 10 written YES are made available to both boys and girls. Twenty participants will be selected to participate in this research.

3.6 Data collection procedure

Questionnaires prepared by the researcher are specifically meant to collect data from the respondents. The researcher will also gather relevant information through interviews he will be conducting with the participants. Permission to collect data will be obtained from the school authorities where the participants are going to be drawn. The questionnaires for teachers are to be distributed by the researcher to the selected participants of the research study. On the learners' side, the researcher will first address his intention to the learners and later distribute the questionnaires to the learners. After the completion of the tasks on the questionnaires, the respondents will submit the questionnaires to the researcher as instructed.

3.7 Data presentation and analysis

Quantitative data will be analyzed using descriptive statistics and represented in the form of tables, percentages, graphs and pie charts. The descriptive statistics summarize and organize characteristics of a data set (Bhandari, 2023). The percentages will make it easier to identify the variable with the highest frequency, while tables will make it easy to compare the percentages of the variables. Tabulated statistical data methodically is important since properly tabulated results enable a great deal of information to be clearly presented. The preparation of tables and graphs is a crucial tool in the analysis and production of results, given that it organizes the collected information in a clear, summarized manner (Duquia, 2014). Tables allow researchers to present information efficiently and with significant visual appeal, making the results more easily understandable and thus more attractive to the users of the produced information. After the representation of data on tables, graphs and charts, the researcher will comment on the values presented below the diagrams.

3.8 Summary

This chapter gave an outline of the methodology which is going to be used in carrying out this study. The researcher pointed out that the research will be done at Chimoio secondary school in Muzarabani District. He described how he is going to conduct the research. The research methods and instruments to be used in carrying out the research and their possible advantages and disadvantages are highlighted distinctively in this chapter. Furthermore, target population, procedures to be used in gathering data, how the data will be presented and analyzed have been also elucidated.

CHAPTER 4: Data presentation, analysis and discussion

4.1 Introduction

This chapter intends to address the link between performance of learners and gender in secondary schools, considering the topic of geometric constructions. Results obtained from this research are presented, mostly in graphical methods. Also, this chapter gave a brief analysis of the obtained results and discussions were made as well.

4.2.0 Link between the literature review and new findings

As pointed out in the previous chapter, some researchers had an argument that supported the idea that gender has a great contribution to the performance of learners on the topic of geometric constructions. Some gave a different view point, asserting that gender has nothing to do with the learner's performance in geometric concepts, especially when considering ordinary level students in different classes. The figure below shows the distribution of previous researchers who support and oppose the idea that gender and performance are closely related or not.

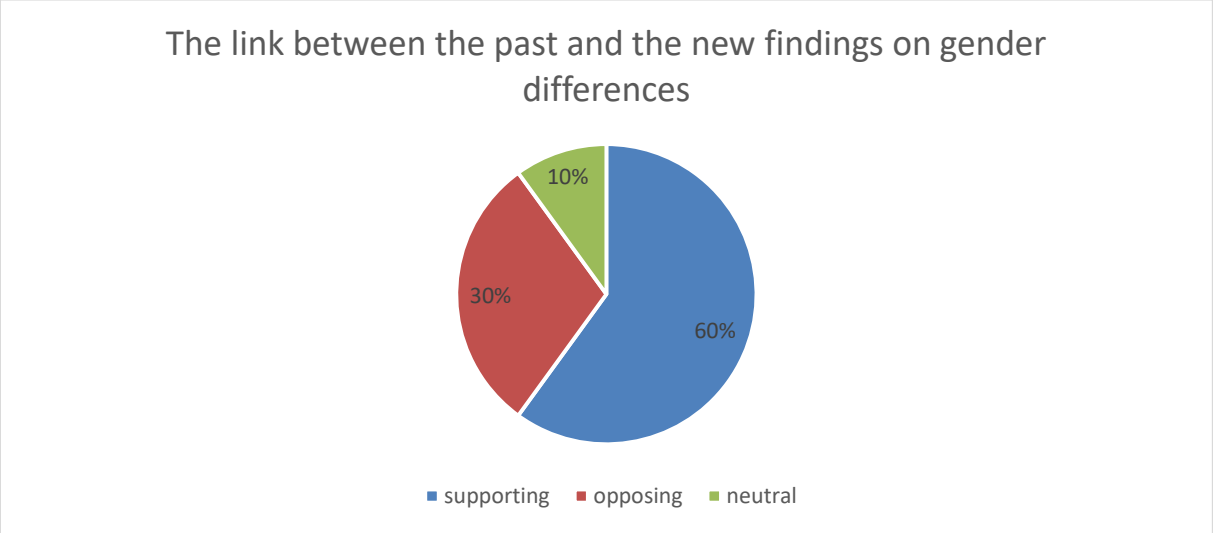

Figure 4. 1: The link between past and new findings on gender differences

As shown on the chart above, previously carried out researches indicate that nearly 60% of the researchers had the view that supports the idea that in geometric constructions, learners perform

in accordance to gender. The findings of this research study were consistent with the findings of (Battista, 1990; Fennema, 1974; Fennema & Sherman, 1978; Guay & McDaniel, 1977; Maccoby & Jacklin, 1974 and Matteucci & Mignani, 2011), who reported that male students outperformed female students in mathematics performance. These researchers clearly articulated that male learners perform better as compared to girls. However, 30% of the previous studies made by (Calvin, Fernandes, Smith, Visscher & Deary, 2010; Felson & Trudeau 1991 and Lawton 1997), found that female students' performance was significantly higher than male students' performance. Lindberg, Hyde & Linn (2010) constitute 10% of the researchers who supported the idea that boys and girls have equal chances of performing well or poorly in mathematics, especially on geometric constructions. The researcher has noted something similar to the researches carried out previously. He noted that ordinary level learners performed differently in geometric constructions considering gender. Boys appeared to be more gifted at constructional skills.

4.2.1 Gender information of mathematics teachers who participated in this research

It is so important to indicate the percentage of mathematics educators who greatly participated in this research. This will give a clue as well about the impact of gender. The table below shows the professional qualifications and gender among mathematics teachers at both Chadereka and Kairezi Secondary schools.

Table 4. 1 Gender ratio and qualification of mathematics teachers

Qualification	**Gender**		**Total**	**Percentage**
	Male	**Female**		
Certificate/Diploma in Education	2	1	3	60
Degree in Education	1	0	1	20
Advanced Level	1	0	1	20
Total	**4**	**1**	**5**	**100**

From the above table, it clearly shows that 60% of the mathematics teachers are made up of teachers who are holders of certificates and diplomas in education. There are 2 male teachers and 1 female teacher who make up the 60% of the certificate and diploma holders. One male teacher has a degree in mathematics education, thus constituting 20% of the teaching participants and another 20% are student teachers. Out of 5 teachers who participated in this research, 4 are males and only 1 is a female. This statistical data has a certain meaning to the relationship between gender and education, especially regarding the mathematical concepts. The general inference to the data presented is; males have a greater chance of performing better than women in mathematics. Lynch et al (2018) noted that in high schools and colleges, male students are still more likely to enroll in courses like advanced mathematics, science and engineering than female students.

4.2.2 Educational workshops and staff development meetings attended

Staff development is the process of improving the knowledge, skills and employees or staff performance within the organization or company. If executed correctly, the effects of training teachers improves the performance and often encourages growth within the worker and the organisation itself (Catcher and Snyder, 2003). Educational workshops and staff development provide opportunities for professional growth. Staff development has a number of benefits. Among them, including improving job performance and productivity, enhancing leadership and management skills, increasing teacher engagement and motivation and boosting employee morale and job satisfaction. Below is a figure that shows how often mathematics teachers have been staff developed for the past two years.

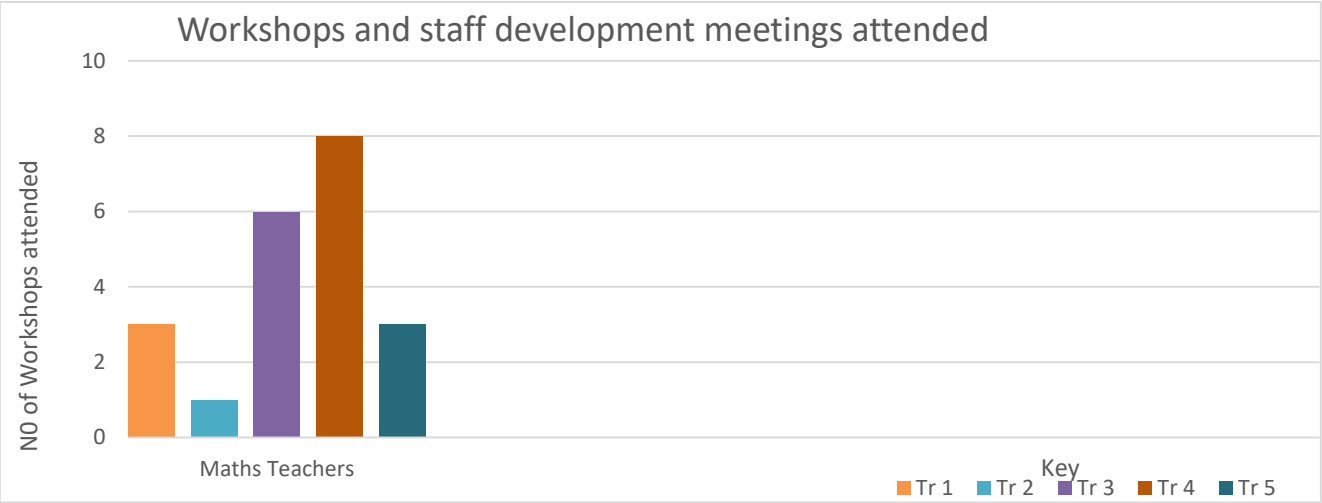

Figure 4. 2: Educational workshops and staff development meetings attended

Out of all ten educational workshops and staff development meetings held in the district in the past 2 years, the teacher who attended the workshops most attended 8 workshops out of 10. One teacher attended 6 times, followed by 2 teachers who attended 3 workshops. The least number of attendance was 1 as indicated by the above figure. The difference in the number of people who attended these workshops and staff development meetings depended on the financial support of the schools. It is highly recommended for all teachers, if possible, to attend all workshops and staff development activities held in the district since there will be sharing of ideas and advice on how to assist learners so that they can perform better in difficult areas of the subject like geometric constructions.

4.2.3 Mathematics teachers' workload

Most rural secondary schools are understaffed. This has been reveled in the questionnaires completed by the teachers which showed that some teachers are teaching more than one subject (mathematics). Those who teach mathematics only indicated by writing 'NO' and those ones teaching more than one subject wrote 'YES'.

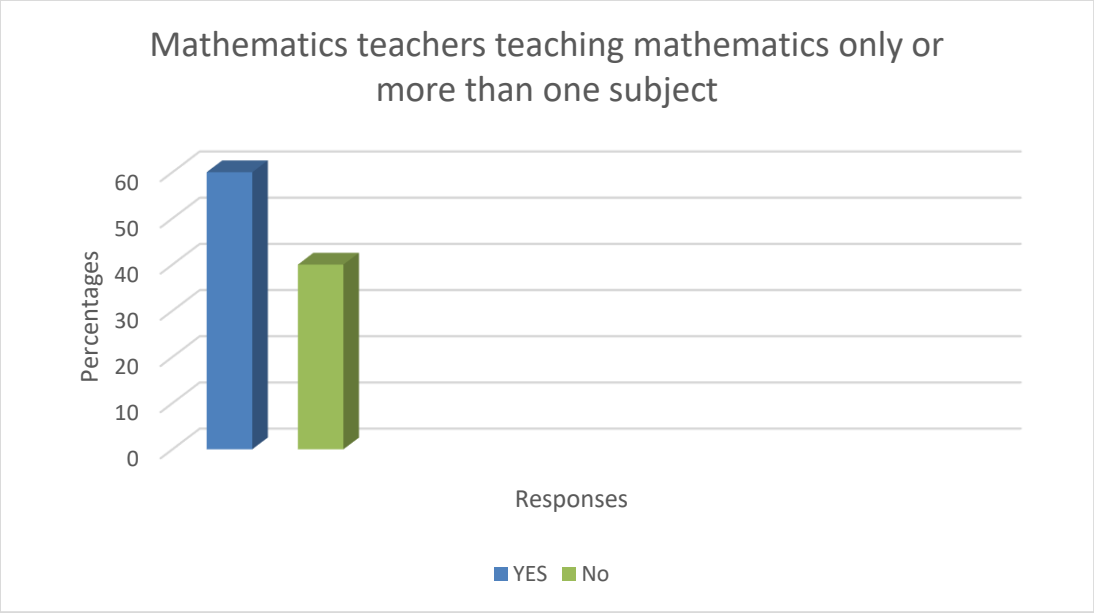

Figure 4. 3: Responses on weather mathematics teachers have other subjects they teach other than mathematics

Information from the teacher questionnaire revealed that 60% of the mathematics teachers have other subjects they teach other than mathematics only. Only 40% of them have no other subjects they teach other than mathematics. Therefore, it may mean that extra load is a challenge to rural schools which may cause learners to have no interest towards the subject due to ineffectiveness and inefficiency in lesson delivery by the teachers who are overwhelmed by the work load such as scheming, planning and other responsibilities which include co-curricular activities.

As reported by Widener (2010), rural schools offer a wide range of subjects, ending up allocating mathematics teachers other different subjects. This calls for more work for mathematics teachers as they have to prepare for these lessons and the end result is incompetence on the part of the teacher.

4.2.4 Teacher experience in the teaching of Mathematics

This information is important because experience of teaching mathematics equips the teachers with many approaches in the teaching of geometric constructions since the teachers will be familiar with the challenges faced by both the teacher and the learner in the teaching and learning of such

mathematical concepts. On the other hand, if the teachers have experience of teaching mathematics, leaners will have trust in their teacher thereby developing interest in the topic.

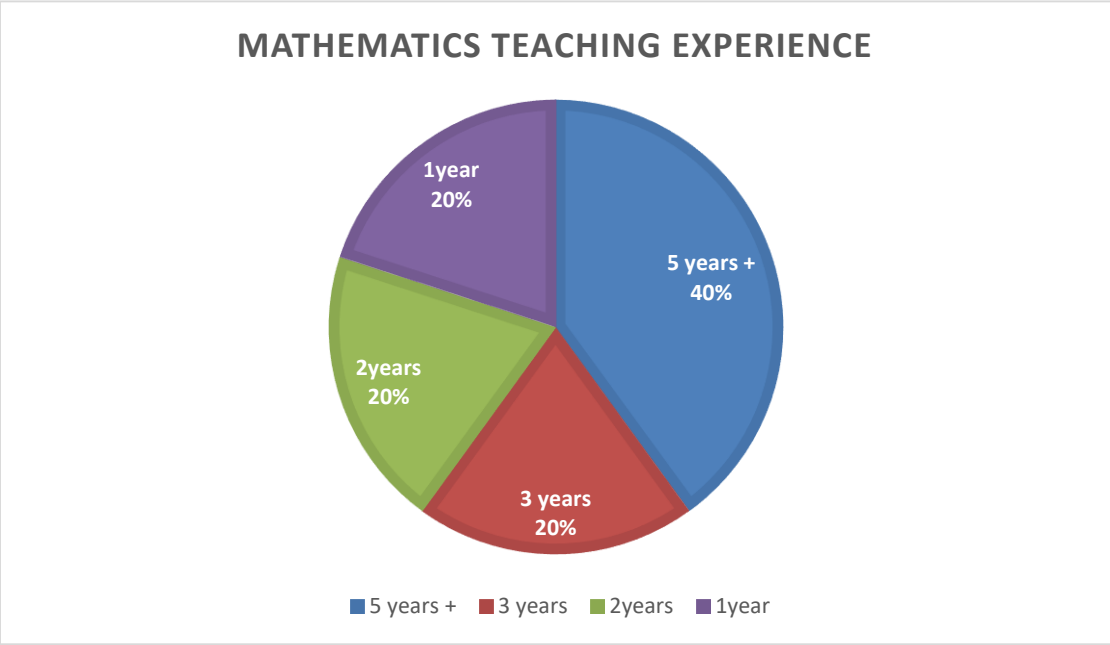

Figure 4. 4: Mathematics teachers teaching experience

4.3 Availability of mathematics resources at the school

The major factor that can affect the performance of learners in secondary schools, is the availability of resources, though gender has also impact. Mathematics resources required in the teaching and learning of geometric constructions such as interactive whiteboards, tablets with geometry apps, online resources and tutorials, for example, videos, websites and interactive lessons are scarce in rural secondary schools due to poor network, poverty and the unavailability of electricity. Teachers and students usually rely on textbooks. Adolphus (2011) suggested, among other factors, that insufficient provision of the teaching and learning materials and facilities does not motivate teaching and learning of geometric constructions. Teachers perform exceptionally well in their duties, if they are provided with all the required resources.

4.4 Availability of mathematics textbooks at the school

In the teaching and learning of mathematics, textbooks play a crucial role. Textbooks offer a platform for students to practice drawing and sketching. Mathematics textbooks are also used to

identify and address any gaps in students' understanding of different geometric concepts and they are a valuable resource for teachers, especially those who are new to teaching geometry, to learn different approaches and methods of teaching geometric constructions. In the next table, all the available mathematics textbooks at Chimoio secondary school from form one to form four are given.

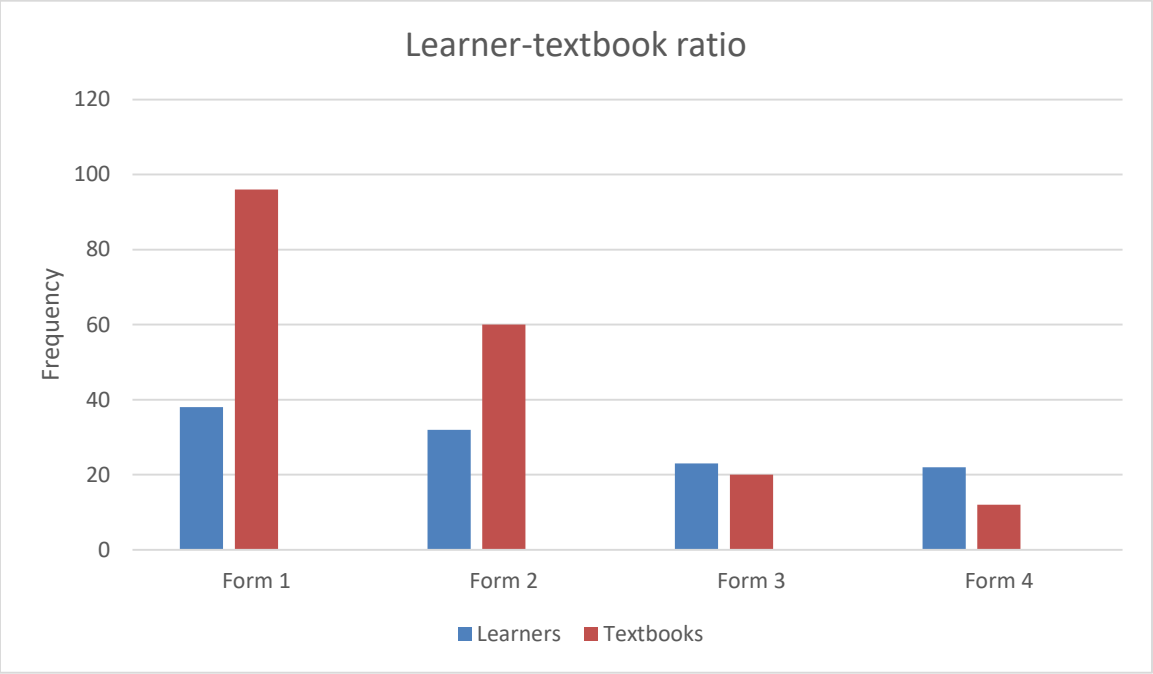

Figure 4. 5: Mathematics textbooks versus enrolment

The above figure presents the pupil-textbook ratio at the school. At Zimbabwe Junior Certificate (Z.J.C.) level, it is clearly shown that the number of textbooks the school has is more than the number of learners. This means that students have access to more than one textbook in Form 1 and Form 2. This gives every learner a better chance of having his/her own copy, so that they can have an increased opportunity of studying. This is not the same with the ordinary level. In Form three, the number of textbooks squarely corresponds to the number of learners. There is a shortage of textbooks, particularly in Form 4, where two learners tend to share one textbook. This makes a greater contribution, as well, to the poor performance of learners in secondary schools

4.5 Performance of learners in geometric constructions based on gender

From the findings obtained by the researcher in this paper, gender is associated with the performance of learners. Out of all twenty participants who took part in this research study, boys performed very well as compared to their female counterparts. Girls were facing challenges in solving geometric construction problems. Through the observations made by the researcher, quite a number of girls and a few boys had challenges with the handling of construction tools. Some of the girls were not able to use a protractor to measure the given angle. The researcher also observed that learners were using the protractor while placed upside down. As a result of using the protractor incorrectly, learners gave wrong sizes of the angles. However, many boys were able to use construction instruments satisfactorily, which included a straightedge, a pair of compasses and the protractor and got good results. The work done by boys was very different from that of girls. Most of the boys came up with very neat and presentable work as compared to the work presented by girls. Generally, it is believed that girls are always smarter than boys, but with geometric constructions it is a different story altogether. Boys produced neat work than that of the girls. Above all, boys were very fast at doing the construction as compared to girls. This shows that when we talk about gender and geometric constructions, boys perform better as compared to girls. Girls are very slow when presenting the work, the work they provide is not so neat as compared to boys and the logic of the work is not presentable. The results obtained from the task they wrote are given on the table below.

Table 4. 2 : Scores obtained in the task by gender

Mark Interval		$20<x\leq40$	$40<x\leq60$	$60<x\leq80$	$80<x\leq100$
Frequency	Males	1	3	2	4
	Females	3	5	1	1
	Total	4	8	3	5

From the table given above, it has been noted that boys scored higher marks in comparison to girls. In the mark interval of 21 to 40, we find one boy and three girls. From 41 to 60, we have three boys and five girls. From 61 to 80, the number of boys in that range is two, while there is only one girl. On the highest score range (81 to 100) there were four boys and a girl. This clearly indicates that the performance of girls on the given task was below the performance of boys.

4.6,0 Learner related challenges on construction

Learners face a lot of challenges when they are carrying out their geometric construction activities. Some of these challenges include lack of resources and learners' negative attitude towards geometric constructions.

4.6.1 Lack of resources

Most of the learners at Chimoio secondary school are from poor families where they survived from hand to mouth. In the geometric construction aspects, learners are supposed to have their own geometric construction instruments. Instead, most of the students were sharing these tools as noted by the researcher. This hinders learners from carrying out the required constructions within a specified period of time since one instrument is being shared among one or two learners. Even at the school, the teacher uses instruments that are improvised, especially a pair of compasses. As the teacher demonstrates on how to construct different geometric shapes, he faces a lot of challenges since the instruments used are improvised. Learners who are slow in grasping concepts can find them difficult to comprehend.

4.6.2 Learners' attitude toward the subject

The results have shown that the girls with positive attitudes toward mathematics is 10% while boys have 30%. However, 60% showed that the attitude is negative because of a lack of resources such as textbooks and tools for geometric constructions. 40% of the female learners have a negative attitude towards mathematics because of lack of resources at the school. From the results, it appears that the attitude of male learners is not a challenge to the subject as it is shown to be positive and the supply of geometric construction tools and textbooks will motivate those girls who are demotivated. 60% of the students have a negative attitude towards the subject and 40% of them have an interest to learning mathematics. The results agree with the findings of Chiromo (2010) who said pupils dislike sciences.

From the interview with pupils, it was found that their attitudes towards geometric constructions are negative as the two-thirds of the interviewed group agreed that they dislike mathematics, most particularly geometric constructions topic and one interviewee said;

I am doing mathematics simply because the school does not allow us to drop the subject, otherwise l would have quitted learning sums some time last year when l was doing form 3. I do not have the talent in doing those constructions.

Learners barely indicated that they have a negative attitude towards the learning of mathematics, especially girls who were underrating themselves as they said they are not gifted at science subjects like mathematics. Learners quickly pointed out that they have difficulties in understanding the instructions so as to execute the proper constructions. Clements & Battista (1992) discovered that many students do not understand the formal language, lack reading comprehension or wording and, therefore, have difficulty with this study subject. Studies in mathematics education have pointed out geometry as one of the subject topics which teaching methods and goals do not encourage students' motivation to study and therefore, alternative teaching methods should be taken (Abramovich, Grinshpan & Milligan, 2018). The combination of teaching methods of the subject, the tasks required of students and their difficulty in comprehending, accompanied by low achievements, impairs many of the students' confidence and self-esteem, and lowers the motivation to study this subject, causing many of them to take negative attitudes towards geometry (Rozgonjuk, 2020). Learners tend to ignore all that has to do with mathematics education due to some of these factors. Out of 20 learners who participated in this research, 70% of the girls claimed that mathematics subject is designed for men not women. However, 30% of them challenged the misconception, saying that there is no any difference between girls and boys. If some girls manage to pass the subject, nothing can hamper other girls from doing the same.

4.7 Mathematics pass rate at the school

For the past four years, the school where the research has been carried out, the researcher managed to obtain the following results as shown on the figure below

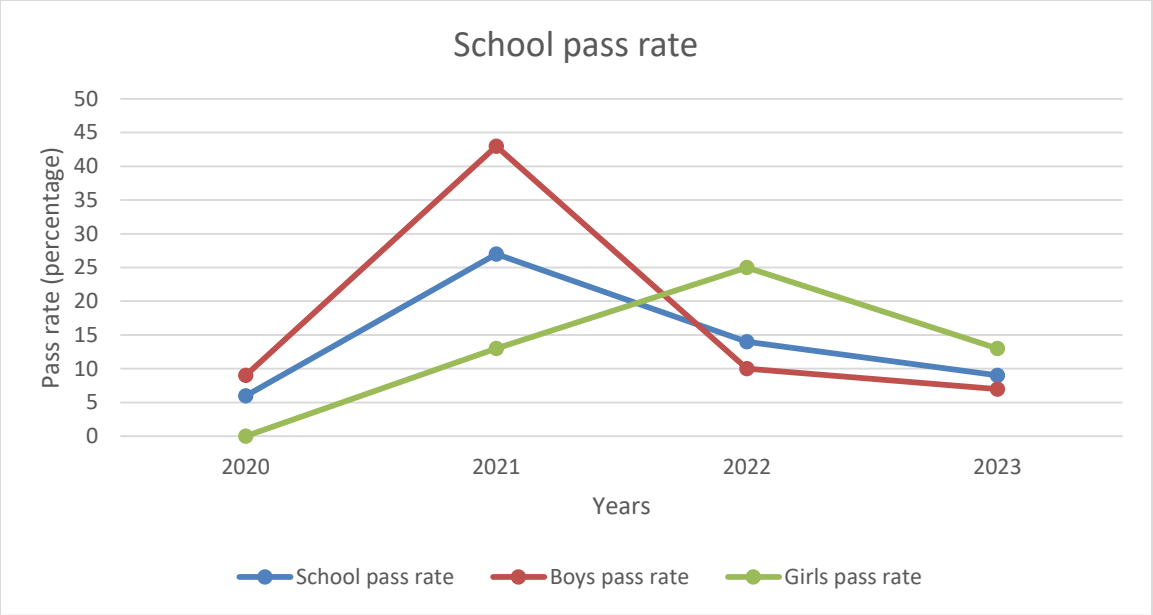

Figure 4. 6: School pass rate for the previous four years

The figure above indicates the school pass rate in mathematics for the previous four years including the pass rate of boys and girls. In 2020, the boys' pass rate was 9% while girls scored 0%. In 2021, boys got 43% and girls got 13% and the school pass rate stood at 26%. In 2022, the boys' pass rate fell to 10% while girls rose to 25%. Finally, in 2023, the boys' pass rate was below that of girls, 7% and 13% respectively. The school pass rate was 9%. It has been brought to the researcher's attention that when the pass rate of girls shot up, it was because of the numbers of girls which usually decreases as they attain ordinary level, that is, boys are more than girls in number.

4.8 Summary

The chapter looked at data presentation where quantitative data from the questionnaires filled out by the research respondents was presented in forms of pie charts, line graphs, tables and bar graphs. Below each graph, the researcher gave a brief explanation and interpretation of the information on the table or graph. Qualitative data from the research findings and observations made were coded into themes and the meaning has been explained.

CHAPTER 5: Summary, Conclusion and Recommendations

5.1 Introduction

This chapter outlines the summary of the study which was aimed at the investigation into the performance of ordinary learners on the geometric constructions area based on gender. Suggestions and recommendations based on the research findings will be addressed as well in this chapter.

5.2 Summary

The research was carried out at Chimoio secondary school in Muzarabani District. The study was aimed at giving the link between gender and academic performance of ordinary level mathematics learners on geometric constructions. The researcher consulted several literature sources conducted recently that looked at the effects of gender on learners' performance in mathematics. The research also focused on the challenges teachers and learners are facing as they do the teaching and learning of concepts on geometric constructions. Participants were given enough time to support this research through providing truthful information that has been requested by the researcher. The researcher mainly targeted the mathematics teachers and ordinary level mathematics learners. Both qualitative and quantitative research methods were employed by the researcher as he was conducting this research. This helped the researcher to gather all relevant information from all angles. Survey questionnaires were used by the researcher to collect data from different source points. The responses were presented in tables and the frequencies were used to calculate the percentages of occurrence. Also, graphs were used to compare obtained data so that a conclusion is made from the obtained information.

5.3 Conclusion

There is an on-going debate about the effects of gender on student performance at ordinary level mathematics in the concept of geometric constructions. The female to male ratio of mathematics teachers in the schools that participated in this research shows that there is a gap between boys and girls in academic achievements, where girls at Chimoio secondary school are considered to underperform in mathematics, specifically on geometric constructions. Moreover, the report shows that Zimbabwean women are generally under-represented in the education system and one possible reason for this could be that girls are simply not performing well enough in mathematics in secondary schools. Recent studies suggest that such gender gaps in performance on geometric constructions can be bridged by providing students with a curriculum that provides education that

suits all learners despite their gender. The empirical analysis conducted in this research analyses the effect of gender on student performance in geometric constructions at Chimoio secondary. The results obtained provide evidence that boys performed better in geometric constructions as compared to girls. An important issue to note is that this study uses fixed effects to reduce the threat of omitted variable bias in an attempt to deal with the issue of non-random tests for students. Nevertheless, it may be the case that not all potential biases are excluded which implies that caution should be exercised when it comes to formulating policy recommendations. With this in mind, the results from this study have an important policy implications. Curriculum designers are therefore encouraged to make use of this research when they review the existing curriculum so that all learners are catered for in the curriculum. In addition to this, it could also be beneficial to have programs in schools, such as role model programs, whereby girls are able to be associated with older females who they can look up to and who can advise them on the importance of schooling, especially on the study of mathematics. In high-income areas, where students already receive educational support from their parents, it is of great benefit for the learners to have seminars with other students from different educational backgrounds so that they encourage one another. In this way; girls who don't receive enough educational support from their parents, and society as a whole, could be motivated to perform better in school and are more prone to stay in school since they are encouraged to do so by their peers. This could contribute to closing the gender gap in educational performance in mathematics and, as a long-term result, girls will become more likely to participate in the future carriers. This could further enable girls to become more economically independent and empowered in the long run. As stated by Qian (2008), factors that increase the economic value of women are likely to increase the survival rates of girls and the education investment in all children. Therefore, improving the school performance of girls is a possible way to reduce the existing attrition level of girls' education for future generations. Results from this research indicate that also geometrical construction skills are not something that is in-born among individuals. These skills can be developed as one keeps on practicing more, since the aspects of geometric constructions are hands-on.

5.4 Recommendations

From the findings obtained in this research, suggestions were made that can help both teachers and learners to come up with solid ideas that can promote learning of geometric constructions in mathematics regardless of the difference in gender. Although results obtained and

recommendations made are likely to benefit rural schools like the one where the research study was carried out, these recommendations are also applicable even to schools that are not in rural areas. Especially to schools that are in Zimbabwe and that use the same educational curriculum that the researcher was using as he was carrying out this survey. Some of the recommendations are mentioned below:

Mathematics educators should always be equipped with current information through attending workshops and staff development meetings. These workshops and staff development meetings should provide teachers with gender sensitivity training to address biases and promote inclusive teaching practices.

Schools should fight very hard to look for adequate learning resources so that learners don't share the resources like textbooks.

Authors or writers should use gender-neutral language in textbooks and educational materials that will motivate the girl child to develop an interest in geometric constructions topic and the subject. Authors should also ensure equal representation of male and female figures in illustrations, examples, and case studies and include topics that address gender equality, empowerment, and challenges faced by both genders in the educational curriculum.

Use of advanced technology in schools is also encouraged as it provides a clean and clear picture when used and makes it easy for the learners to grasp key concepts, therefore, school administrators and the school development committees (S.D.C) are urged to procure the gadgets that will make it possible to use the advanced technology in the teaching and learning of geometric constructions.

Parents are advised to support learners financially so that they can purchase materials such as pairs of compasses, protractors, scale rulers and dividers. If learners make frequent use of these tools, they familiarise with them and it will be easy to use them.

Curriculum planners are recommended to consult educational stakeholders as they plan on what to include in the curriculum. The content that should be included in the curriculum should benefit all learners despite their gender. The curriculum planners should regularly review and update the curriculum to ensure gender equality and inclusivity.

Teachers are advised to encourage critical thinking in students to challenge traditional gender roles and stereotypes. It is also worthwhile highlighting Zimbabwean female and male role models in various occupations to inspire and motivate learners.

The school should offer gender-neutral subjects like science, technology, engineering, and mathematics (STEM) to encourage participation from both boys and girls.

School administrators and the staff should engage with local communities to promote gender equality and challenge harmful gender stereotypes through various awareness campaigns on gender equality, equity and sensitivity to uphold the value of the girl child.

References

Abramovich, S., Grinshpan, Z. A., & Milligan, L. D. (2018). Teaching Mathematics through Concept Motivation and Action Learning. Education Research International, 19(3), 3-13

Adabor, J. K. (2013). Harnessing formative and summative assessments to promote mathematical understanding and proficiency. AURCO Journal, 19(1).

Adolphus, T. (2011). Problems of teaching and learning of geometry in secondary schools in rivers state, Nigeria. International Journal of Emerging Sciences 1(2): 143-152

Achiron, R., Lipitz, S. & Achiron, A. (2001). Sex-related differences in the development of the human fetal corpus callosum: In utero ultrasonographic study. Prenatal Diagnosis, 21, 116-120.

AL-salahat, M. M. S. (2022). The Effect of Using Concrete-Representational-Abstract Sequence in Teaching the Perimeter of Geometric Shapes for Students with Learning Disabilities. International Journal of Education in Mathematics, Science, and Technology (IJEMST), 10(2), 477-493. https://doi.org/10.46328/ijemst.2403

Bakkalbasioglu, E.(2020). How to access elites when textbook methods fail: Challenges of purposive sampling and advantage of using interviewees as "fixers". The qualitative Report, 25(3) 688-699.

Battista, M. T. (1990). Spatial visualization and gender difference in high school geometry. Journal for Research in Mathematics Education, 21, 47-60.

Berenbaum, S. & Snyder, E. (1995). Early hormonal influences on childhood sex-typed activity and playmate preferences: Implications for the development of sexual orientation. *Developmental Psychology, 31*(1), 31-42. doi:10.1037//0012-1649.31.1.31

Bhandari, P. (2023). Descriptive Statistics| Definitions, Types, Examples. Scribbr.

Burger, L. (2013). *Math 250 geometry construction project*. Department of Mathematics, California State University, Fresno. http://zimmer.csufresno.edu/~lburger/Math%20250_%20Construction%20Project.pdf

Calvin, C. M., Fernandes, C., Smith, P., Visscher, P. M., & Deary, I. J. (2010). Sex, intelligence, and educational achievement in a national cohort of over 175,000 11-year-old schoolchildren in England. Intelligence, 38, 424-432.

Campbell, J. R., & Beaudry, J. S. (1998). Gender gap linked to differential socialization for high-achieving senior mathematics students. The Journal of Educational Research, 91(3), 140-147.

Carroll, W. M. (1994). Using worked examples as an instructional support in the algebra classroom. Journal of Educational Psychology, 86(3), 360–367.

Casteel, A., & Bridier, N.L., (2021). Describing populations and samples in doctoral student research. International Journal of Doctoral Studies, 16(1).

Catcher, S. and Synder, T. (2003) Organizational Commitment U.S.A: Atomic Dog.

Channon, J.B., McLeish-Smith., A., Head, H.C., Macrae, M.F., & Chasakara, A.A.(2011). New General Mathematics Book 3. Essex: Longman.

Chiromo, A.S. (2010). A History of Education in Zimbabwe. University of Teacher Education Publications, Harare, Zimbabwe

Clements, D. H., & Battista, M. T. (1992). Geometry and spatial reasoning. Handbook of research on mathematics teaching and learning, 420-464.

Dawadi, S., Shrestha, S., & Giri, R.A. (2021). Mixed methods research. A discussion on its types, challenges and criticisms. Journal of Practical Studies in Education, 2(2), 25-36.

Dee, T. S. (2007). Teachers and the gender gaps in student achievement. *Journal of Human Resources XLII*, (3), 528–554. http://dx.doi.org/10.3368/jhr.XLII.3.528

Deshpande, B.,& Girme, A. (2019). Sampling techniques. Advanced and Applications in Mathematical Sciences, 18(10), 1055-1062.

Duquia, R.P., Bastos, J.L., Bonamigo, R.R., Gonzalez-Chica, D.A., & Martinez-Mesa, J., (2014). Presenting data in tables and charts. Anais brasileiros de dermatologia 89, 280-285.

Dzwigol, H., (2022). Research methodology in management science: Triangulation. Virtual Economics 5(1), 78-93

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. Annual review of psychology, 53(1), 109-132.Felson, R. B., & Trudeau, L. (1991). Gender differences in mathematics performance. Social Psychological Quarterly, 54, 113-126.

Fennema, E. H. (1974). Mathematics, spatial ability, and sexes. Paper presented at the meeting of the American Education Research Association: Chicago, IL.

Fennema, E. H., & Sherman, J. A. (1978). Sex related difference in mathematics achievement and related factors: A further study. Journal for Research in Mathematics Education, 9, 189-203.

Greenberg, J. M. (2008). Euclidean and Non-Euclidean Geometries: Development and History. (4th ed.). W. H. Freeman.

Guay, R. B., & McDaniel, E. D. (1977). The relationships between mathematics achievement and spatial abilities among elementary school children. Journal for Research in Mathematics Education, 8, 211-215.

Hall, C. W., Davis, N. B., Bolen, L. M., & Chia, R. (1999). Gender and racial differences in mathematical performance. The Journal of social psychology, 139(6), 677-689.

Hanna G & De Villiers M (eds.) 2012. Proof and proving in mathematics education: The 19th ICMI study. Dordrecht, The Netherlands: Springer.https://doi.org/10.1007/978-94-007-2129-6

Hyde, J. S., Fennema, E., & Eamon, S. J. (1990). Gender difference in mathematics performance: A meta-analysis. Psychological Bulletin, 107, 139-155.

Janicic, P. (2009). Geometry Constructions Language. J Autom Reasoning, 44, 3–24.

Kennelly, L. & Monrad, M. (2007). Approaches to dropout prevention: Heeding early warning signs with appropriate interventions. Washington DC: National High School Centre at the American Institutes for Research. Retrieved from: http://www.betterhighschools.co/docs/NHSC_Approachestodropout prevention.pdf

Kimball, M. M. (1989). A new perspective on women's math achievement. Psychological bulletin, 105(2), 198.

Kornell, N., & Bjork, R. A. (2008). Learning concepts and categories: Is spacing the "enemy of induction"? Psychological Science, 19, 585-592. doi: 10.1111/j.1467-9280.2008.02127.

Laborde, C. (2005). Robust and soft constructions: Two sides of the use of dynamic geometry environment. In Proceedings of the 10thAsian technology conference in mathematics (pp. 22-35). Cheong-Ju Korea National University of Education.

Lawton, M. (1997). ETS disputes charges of gender bias. Education week, 1, 21.

Leal, J. (2007). Educational expectations and success: The contribution for the demystification of mathematics. Unpublished doctoral dissertation

Liao, C. (2019). Creating a STEAM Map: A Content Analysis of Visual Art Practices in STEAM Education. In M. S. Khine and S. Areepattamannil, *STEAM education: Theory and practice* (pp. 37-55). Springer. https://doi.org/10.1007/978-3-030-04003-1_3

Lindberg, S. M., Hyde, J. S., Linn, M. C., & Petersen, J. L. (2010). New Trends in Gender and Mathematics Performance: A Meta-Analysis. Psychological Bulletin, 136(6) p. 1123–1135 DOI: 10.1037/a0021276

Lindqvist, A., Sendén, M. G., & Renström, E. A. (2021). What is gender, anyway: a review of the options for operationalising gender. Psychology & sexuality, 12(4), 332-344.

Loong, Y., Vale, C., Widjaja, W., Herbert, E., Bragg, L. A. and Davidson, A. (2018). Developing a rubric for assessing mathematical reasoning: a design-based research study in primary classrooms. In J. Hunter, P. Perger and L. Darragh (eds.), Making waves, opening spaces: Proceedings of the 41st annual conference of the Mathematics Education Research Group of Australasia (pp. 503-510). Mathematics Education Research Group of Australasia. https://eric.ed.gov/?id=ED592421

Lynch, S. J., Burton, E. P., Behrend, T., House, A., Ford, M., Spillane, N. and Means, B. (2018). Understanding inclusive STEM high schools as opportunity structures for underrepresented students: Critical components. Journal of Research in Science Teaching, 55(5), 712-748.

Maccoby, E., & Jacklin, C. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

Mandina S, Mashingaidze SS & Mafuta J. (2013). Increasing female participation in advanced level mathematics: A perspective from students and teachers in Zimbabwe. African Educational

Research Journal, 1(3):183–190. Available at https://files.eric.ed.gov/fulltext/EJ1216892.pdf. Accessed 30 December 2017.

Matteucci, M., & Mignani, S. (2011). Gender difference in performance in mathematics at the end of lower secondary school in Italy. Learning and Individual differences, 21, 543-548.

McLeod, S., (2023). Questionnaire Method In Research.

Mejía-Rodríguez, A. M., Luyten, H., & Meelissen, M. R. (2021). Gender differences in mathematics self-concept across the world: An exploration of student and parent data of TIMSS 2015. International Journal of Science and Mathematics Education, 19(6), 1229-1250.

Miyakawa, T. (2002). Relation between proof and conception: The case of proof for the sum of two even numbers. In A. Watson, J. Mason, A. D. Cockburn, & E. Nardi (Eds.), Proceedings of the 26th Conference of the International Group for the Psychology of Mathematics Education (Vol. 3, pp. 353-360). Norwich, UK.

Mupa, P. (2015). Foundation for success in the teaching of O level mathematics in rural secondary schools in Masvingo District. Journal of Education and Practice, 6(19), 133-139.

Napitupulu, B. (2001). An exploration of students' understanding and Van Hieles of thinking on geometric constructions. (Unpublished master dissertation. Simon Fraser University, Canada)

National Council of Teachers of Mathematics (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: National Council on Teachers of Mathematics.

Osakwe, I. J., Egara, F. O., Inweregbuh, O. C., Nzeadibe, A. C., & Emefo, C. N. (2023). Interaction patterns: An approach for enhancing students' retention in geometric construction. International Electronic Journal of Mathematics Education, 18(1), em0720.

Oviawe, J. I. and Adeola, L. (2017). Effects of concept mapping instructional strategy on students' academic performance and interest in technical drawing in technical colleges in Edo State, Nigeria. IOSR Journal of Research and Method in Education

Pegg, J., Gutiérrez, A. and Huerta, P. (1998). Assessing reasoning abilities in geometry. In C. Mammana and V. Villani (eds.), Perspectives on the teaching of geometry for the 21st century (pp. 275-295). Kluwer.

Phellas, C.N., & Coxon, A.P. (2016). An overview of developments in research methods applied to non- heterosexual men. Researching Non-Heterosexual Sexualities, 9-26.

Priya, A. (2021). Case study methodology of qualitative research: Key attributes and navigating the cunundrumin it's application."Sociological Bulletin, 70(1), 94-110.

Qian, N. (2008). Missing Women and the Price of Tea in China: The effect of sex-specific earnings on sex imbalance, *Quarterly Journal of Economics*, vol. 123, no. 3, pp.1251–1285. doi: 10.1162/qjec.2008.123.3.1251

Radjl, C. (2014). Rubric for grading… Elements of art/design project. http://mrsrajdlsclass.weebly.com/uploads/3/1/1/4/31146965/art_rubric_for_grading_elements_art.pdf

Rahman, M.M., Tabash, M.I., Salanzadeh, A., Abduli, S., & Rahman, M.S. (2022). Sampling techniques (probability) for quantitative social science researchers: a conceptual guidelines with examples. Seeu Review, 17(1), 42-51.

Rozgonjuk, D., Kraav, T., Mikkor, K., Orav-Puurand, K., & Täht, K. (2020). Mathematics anxiety among STEM and social sciences students: the roles of mathematics self-efficacy, and deep and surface approach to learning. International Journal of STEM Education, 46 (7).

Sarfo, S.K., Eshun, G., Elen, J., & Adentwi, K. I. (2014). Towards the solution of abysmal performance in mathematics in Junior High Schools: comparing the pedagogical potential of two designed interventions. Electronic Journal of Research in Educational Psychology 12(3): 763-784

Sax, L. (2005). Why gender matters*: What parents and teachers need to know about the emerging science of sex differences.* New York, NY: Doubleday.

Sax, L.J. & KIM, Y.K. (2011). Are the effects of student-faculty interaction dependent on academic major? An examination using multilevel modeling. Research in Higher Education, 52, 589-615.

Schoch, K. (2020). Case study research. Research design and methods: An applied guide for the scholar-practitioner, 31(1), 245-258.

Schoenfeld, A. H. (2015). Summative and Formative Assessments in Mathematics Supporting the Goals of the Common Core Standards. *Theory In to Practice*, *54*(3), 183-194. doi:10.1080/00405841.2015.1044346

Shukla, S S. (2020). Non- probability sampling method 1

Tartre, L., & Fennema, E. (1995). Mathematics achievement and gender: a longitudinal study of selected cognitive and affective variables (grades 6-12). Educational Studies in Mathematics, 28, 199-217.

Theofanidis, D. & Fountouki, A. (2019). Limitations And Delimitations In The Research Process. Perioperative nursing (GORNA), E-ISSN:2241-3634, 7(3), 155–162. http://doi.org/10.5281/zenodo.2552022

Widener, S.K. (2010). An Empirical Analysis of the Levers of Control Frameworks. Accounting organisations and Society.

Yousefi, N.R., Sale, J. E., Marin, A., & Ross, L.E. (2020). Social network analysis: An example of fusion between quantitative and qualitative methods

(https//:en m.wikipedia.org/wiki/Questionnaire).

Appendix I

Teacher's Questionnaire

This questionnaire intends to gather your thoughts and experience about teaching geometric constructions. Your cooperation will help in understanding how teachers perceive and approach teaching geometric constructions and learning can be improved in this area. Please answer the questions honestly and truthfully. All the information provided will be kept confidential.

SECTION A: Demographics of mathematics teacher

1) What is your gender?

   Male. ☐ Female. ☐

2) How old are you?

   ……
   ……

3) What is your highest level of education?

……
……

4) How many years of teaching experience do you have?

……
……

SECTION B: Teaching Geometric Constructions

1) How often do you teach geometric constructions in your classes?

……
……

2) On average, how many exercises do you give to learners for the whole topic; geometric constructions?

……
……

3) How long does it take you to teach the whole topic?

……
……

4) What is your favourite teaching method for geometric constructions?

……
……
……

5) What resources do you find most helpful when teaching geometric constructions?

……
……
……

6) Have ever attended any geometric constructions workshop?

Yes. ☐ No. ☐

7) If yes, how many workshops have you attended?

……

……

8) Do you teach any other subject besides mathematics?

Yes. ☐ No. ☐

SECTION C: Learner Assessment

1) Which gender performs better than the other in geometric constructions?

……

……

2) From your teaching experience does gender contribute to learner's performance in geometric constructions?

Yes. ☐ No. ☐

3) If there is any difference in performance between boys and girls, what could be the reason(s)?

.....

.....

.....

.....

.....

.....

.....

.....

.....

4) As a classroom practitioner how would cope up with the differences?

.....

.....

.....

.....

.....

.....

Appendix II

Learner's Questionnaire

Introduction

This questionnaire aims to gather information about learning geometric construction. Your response will help us to understand how learners like you perceive and engage with geometric construction. Information gathered through the use of this questionnaire is strictly for academic purposes, therefore, responses made shall be treated as confidential. Do not write your name or append a signature anywhere on the questionnaire.

SECTION A: Learners' Demographics (tick the appropriate box)

1) What is your gender?

Male ☐ Female ☐

2) What is your age?

……

……

3) What is your current level of education?

Form 3 ☐ Form 4 ☐

SECTION B: Learners' Geometric Construction Experience

1) Have you covered the topic of geometric constructions?

Yes ☐ No ☐

2) How would you rate your prior experience with geometric constructions?

……..……

……

……..

3) How confident do you feel in your ability to perform geometric constructions?

……

……

……

……

……..

4) How do you prefer to learn geometric constructions?

……

……

……

……

……

…….....,.....

.....

.....

5) What resources do you find most helpful when learning geometric constructions?

.....…..... .

.....

.....

6) What challenges do you face when learning geometric constructions?

……

……

……

……

……

……..

Appendix III

Interview questions for learners

Thank you for participating in this interview. Can you please introduce yourself to me and tell me a little bit about your experience with geometric constructions.

1) Can you explain what geometric construction means to you?

2) Can you describe a time when you had to apply geometric constructions in a real life situation?

3) How did you learn geometric constructions at school and online?

4) What are the challenges that you often face in geometric constructions?

5) How do you decide which tools or methods to use when approaching geometric constructions task?

6) Can you describe a situation where you had to think critically and creatively while doing geometric constructions?

Thank you for sharing your thoughts and experience with me today. Is there anything else you would want to add about learning geometric constructions?

Appendix IV

Observational Schedule.

Geometric Construction for Ordinary Level Learners

Name:…….

Date:……

Task: Geometric constructions Question

Answer the whole of this question on a sheet of plain paper. Use ruler and pair of compasses only for all constructions and show clearly all construction lines and arcs. All constructions should be done on a single diagram.

(a) Construct;

(i) triangle PQR in which PQ=7.5cm, RPQ=90° and PQR=30° [4]

(ii) the locus of points equidistant from Q and R. [2]

(iii) a circle with diameter QR. [1]

(b) (i) Measure and write down the length of the

1. radius of a circle in a(iii), [1]

2. side PR in triangle PQR [1]

(ii) Mark and label the points X and Y on the circle which are equidistant from Q and R. [2]

(iii) Write down the special name given to quadrilateral PRYQ. [1]

Observation Rating

Observation criteria	**Novice**	**Developing**	**Proficient**	**Advanced**	**Mastery**
Understanding geometric concepts					
Tool usage and technique					
Problem solving and reasoning					
Accuracy					
Creativity					