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FACULTY OF SCIENCE EDUCATION DEPARTMENT OF CURRICULUM AND EDUCATIONAL MANAGEMENT STUDIES

EFFECTIVENESS OF USING MODELS IN TEACHING AND LEARNING OF MENSURATION TO ORDINARY LEVEL LEARNERS AT ST JOSEPH HIGH SCHOOL.

BY

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF HONOURS BACHELOR OF SCIENCE EDUCATION (MATHEMATICS).

30 September 2022

DECLARATION FORM

I, Mabinda Anesu P. declare that this is my original work that has not been submitted for any degree or examination in any other university and that all the sources I have used or quoted here have been indicated and acknowledged.

A.P. Mabinda

Signature: ***Date: 30/09/2022***

APPROVAL FORM

The undersigned certify that they have supervised, have read and recommend to the University for acceptance and examination a research project entitled: ***Effectiveness of using models in teaching and learning of Mensuration to Ordinary level learners at St Joseph High School*** submitted by Mabinda Anesu P. in partial fulfilment of the requirements for the award of Honours Bachelor of Science Education Mathematics.

Supervisor Signature: **Date: 30/09/2022**

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DEDICATION

This thesis is dedicated to my husband and my son for all the support throughout the study. Without their encouragement, this work would have been next to impossible to accomplish.

ABSTRACT

This study sought to explore the effectiveness of using models in teaching and learning of Mensuration to Ordinary level learners at St Joseph High School. The researcher adopted a mixed approach for data generation, analysis and discussion. The researcher used interviews, questionnaires and evaluation test in generating data. The researcher's findings were presented on statistical graphs such as pie charts, bar charts and frequency distribution tables. In this study a total of twenty learners and five teachers were purposively sampled to participate in the study .The major themes were derived from the research questions and these include: 1. How effective is the integration of models in teaching and learning of Mensuration at Ordinary level, 2. What challenges do teachers and learners face in integrating models in teaching and learning of Mensuration at Ordinary level, 3. What mechanisms can be implemented to improve the integration of models in teaching and learning of Mensuration at Ordinary level .From the findings, the researcher concluded that limited time available to prepare the models effectively and large classes do not allow the effective use of models. The researcher also found that use of plastic models on shapes particularly on solid shapes are being used in teaching and learning of Mensuration. The researcher recommends that schools authorities should avail models to teachers and learners so as to motivate them to develop interest in their use in Mathematics lessons. School administrators should keep class sizes relatively small using standardized teacher learner ratios to enable effective rationing of models during Mathematics lessons.

TABLE OF CONTENTS

Declaration form.....i

Approval form ii

Acknowledgements..... iii

Dedication iv

Abstract v

CHAPTER 1: PROBLEM AND ITS SETTING

1.1 INTRODUCTION.....1

1.2 BACKGROUND TO THE STUDY 1

1.3 STATEMENT OF THE PROBLEM 3

1.4 RESEARCH QUESTIONS.....3

1.5 RESEARCH OBJECTIVES

1.6 SIGNIFICANCE OF THE STUDY 3

1.7. ASSUMPTIONS ….....…….....

1.8 STUDY DELIMITATION 5

1.9 STUDY LIMITATIONS.....6

1.10 DEFINITION OF TERMS

1.11 CHAPTER SUMMARY 7

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION.....8

2.2. CONCEPTUAL FRAMEWORK

2.3 THEORETICAL FRAMEWORK 8

2.4 EMPIRICAL LITERATURE

2.5 RESEARCH GAP ANALYSIS

2.6 CHAPTER SUMMARY.....16

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION.....17

3.2 RESEARCH PARADIGM.....17

3.3 RESEARCH DESIGN 18

3. 4 TARGET POPULATION 18

3.5 SAMPLE SIZE 19
3.6 SAMPLING TECHNIQUE.....19
3.7 RESEARCH INSTRUMENTS 19
3.8 DATA PRESENTATION AND ANALYSIS 21
3.9 ETHICAL CONSIDERATIONS
3.10 SUMMARY

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 INTRODUCTION.....22
4.2 PRESENTATION, DISCUSSION, ANALYSIS AND INTERPRETATION OF TEACHER'S RESPONSES 22
4.3 ANALYSIS OF RESULTS FROM OBSERVATIONS.....23
4.4 PRESENTATION, DISCUSSION AND ANALYSIS FROM LEARNERS 28
4.5 SUMMARY

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION.....38
5.2 SUMMARY OF THE WHOLE STUDY.....38
5.3 SUMMARY AND CONCLUSION OF THE FINDINGS 39
5.4 RECOMMENDATIONS 39

REFERENCES 40
APPENDICES 43

LIST OF TABLES

Table 4.1: Frequency table showing ages of teacher respondents 30
Table 4.2: Frequency table showing years of teaching experience 31
Table 4.3: Showing challenges facing teachers in using models 32
Table 4.4: Showing mechanisms that can be used to improve the use of models in teaching and learning of Mathematics 36
Table 4.5: Frequency table showing pre-test and post-test results……38

LIST OF FIGURES

Figure 3.2 Showing research onion ……..25

Figure 4.1 Pie chart showing sex of teacher respondents …….31

Figure 4.2 Bar chart showing teachers' educational qualifications ……..33

Figure 4.3 Pie chart showing frequency of using models in teaching Mensuration …….34

Figure 4.4 Bar graph showing means of acquiring models by teachers in the sampled school..35

Figure 4.5 Pie chart showing learners' sex…….37

Figure 4.6 Bar chart showing learners'ages…….38

Figure 4.7 Bar chart showing pre-test and post-test results ……39

CHAPTER ONE

1.1Introduction

This chapter alludes to pertinent issues encircling the study. These encompass: a brief history of this study, sub-problems related to the study, as well as the objectives underpinning the study. As the chapter moves on, the researcher examines the significance of the study to relevant identified people, assumptions on which the study is based, as well as the physical and conceptual scope of the study. The chapter ends with challenges encountered by the researcher, the conceptual analysis of key terms used, and the chapter summary.

1.2Background To the Study

Models in teaching and learning of Mathematics are an important tool that opens teaching opportunities to the majority of secondary school educators. According to Buabeng-Andoh (2017), models contribute to the professional development of secondary school teachers through quality secondary education delivery. This means that through incorporating models in their Mathematics lessons, secondary school teachers stand a chance to reap positive results, as their learners are exposed to great learning opportunities. However, education delivery in Mathematics teaching has remained traditional, characterized with printed materials. Evidence shows that models are used only to a limited extent in delivery of Mathematics lessons in the secondary school (Mavhunga, 2019). Thus, the study seeks to investigate the effectiveness of integrating models in teaching and learning of the topic 'Mensuration' at St Joseph High School in Zaka District.

The use of models in teaching and learning has been a cause for concern worldwide. In the United States of America, and in developed nations like Britain, France, Russia, and other European countries, classes have been characterized with moderate teacher-pupil ratios,

coupled with widespread use of technologies such as models (Huselid, 2015). Due to the global, regional, national and local technological advancement, the use of models in teaching and learning is becoming a necessity. In other countries such as South Africa, Ghana and Zimbabwe, curricula have been adopted to suit the global village (Derek, 2017). This demand for integrating models, shortcomings facing classroom practitioners and learners notwithstanding, has encouraged the researcher to carry out this study. Numerous researches have been carried out on various issues pertaining to use of models in teaching and learning, among them: nature of models that can be used by secondary school educators, merits that can be realized from implementing models as an aid to teaching and learning, but they left a gap on the effects of integrating models in teaching and learning.

Since the 1990s, models were construed as major tools that can improve instruction and student learning (Badgett and Lucking, 2016). Meanwhile, several evaluations have shown that models help to increase the amount of both independent and collaborative learning. Instruction through models was found to be more student-centered in many situations (Buabeng-Andoh, 2017). In the same vein, Dewy (2019) condescends that models at school can have a beneficial effect, not only on student achievement, but on student motivation, as well as classroom atmosphere, and on the teacher's willingness to experiment with new innovative instructional approaches. There is a lot of evidence showing that using models to facilitate teaching and learning reaps numerous positive results, though little has been written about the challenges associated with integrating models in teaching and learning of Ordinary level Mathematics, particularly 'Mensuration' at secondary level (Chakawa, 2016). The need to fill this gap of knowledge has motivated the researcher to carry out this study.

Fabbry and Higg (2016) acknowledge that models can become the natural tool for teaching and learning that is so often required by educators and their learners if correctly integrated. The authors above suggest the use of manmade models as a possible solution to natural or real

models. Proponents on the use of models in the classroom opine that modelling in education could be fully utilized if each teacher and student are highly motivated to do the engagement. If models are properly used, then good results can be realized, but the reverse could be true if models are poorly used in a teaching and learning situation (Huselid, 2015). It is therefore against this background that the current research seeks to ascertain the effectiveness of integrating models in teaching and learning of Mathematics, particularly the topic 'Mensuration'.

1.3Statement Of the Problem

The new curriculum brought along a raft of changes that saw the need for teachers to devise new methods of teaching, as well as varied forms of media. In the secondary school curriculum, the need to embrace visual media such as models is heavily recommended, though numerous shortfalls bedevil the implementation of model-aided instruction in lessons. The researcher has observed that 'Mensuration' is a topic not effectively taught by teachers, but it is a vital topic featuring in the 'O' level Mathematics Paper 2 section (Chakawa, 2016). The researcher submits that notwithstanding the recommendations to incorporate models as a cross cutting issue, mostly to facilitate the teaching and learning process, there are a litany of challenges that militate on its proper implementation. While taking secondary school learners at St Joseph Secondary School, and observing other teachers at the same school, the researcher noted that there was hardly any integration of models in the teaching and learning of practical topics like 'Mensuration', prompting her to be motivated to find out the extent of success if models are roped in. Thus, this study sought to ascertain the effectiveness of integrating models in teaching and learning of the topic 'Mensuration' to 'O' level learners.

1.4 Research Questions

The researcher shall try to address the following sub-problems:

- How effective is the integration of models in teaching and learning of ‘Mensuration’ at Ordinary level?
- What challenges do teachers and learners face in integrating models in teaching and learning of ‘Mensuration’ at Ordinary level?
- What mechanisms can be implemented to improve the integration of models in teaching and learning of ‘Mensuration’ at Ordinary level?

1.5 Research Objectives

The study hopes to:

- Determine the effectiveness of integrating models in teaching and learning of ‘Mensuration’ at Ordinary level.
- Establish challenges faced by teachers and learners in trying to integrate models in teaching and learning of ‘Mensuration’ at Ordinary level.
- Suggest intervention strategies that can be adopted to improve the integration of models in teaching and learning of ‘Mensuration’ at Ordinary level.

1.6 Significance Of the Study

The researcher hopes that this study shall be of utility value to classroom practitioners, school managers, policy makers, curriculum developers, as well as the learners. This study will help teachers to identify benefits they can derive from integrating models in teaching and learning of ‘Mensuration’ at Ordinary level. The researcher submits that the majority of classroom practitioners are teaching the topic ‘Mensuration’ using the lecture and demonstration techniques, without according learners a chance to use models to practically show the concept. Thus, this study will unveil both benefits and challenges of using models in Mathematics teaching and learning, and give teachers recommendations on how to motivate their learners and increase use of models when tackling practical topics like ‘Mensuration’.

In addition, the findings of this study may be of great help to policy makers and those authorities at the helm of developing the curriculum. Thus, this study hopes to familiarize officials from the Curriculum Development and Technical Services (CDTS) with cultural and physical differences in Zimbabwean secondary schools, calling for them to design curricula that suit learners from various backgrounds. This study will also help Policy makers to recommend the integration of models in Mathematics teaching with the knowledge of their benefits, shortfalls that may militate on their effective implementation, as well as possible measures that can be put in place to avert the problems. This means this study will help to identify both benefits and challenges that can be faced by curriculum implementers, and how the latter can be solved before they militate on the curriculum implementation process.

Finally, the researcher concedes that this study may also be of great help to the learners. Since integration of models in teaching and learning targets to reap positive results, the researcher submits that this study may help learners to enjoy the numerous merits of incorporating models in the teaching and learning of 'Mensuration'. Again, the study may also help learners to benefit from the various mechanisms that will be enforced by teachers, school heads, policy makers and curriculum developers, in a bid to improve the integration of models in the teaching and learning environment in the secondary school.

1.7 Assumptions

The researcher assumes the following to be true for this study:

- Selected participants provided required data within set timelines.
- The respondents had a general understanding of models and mathematics teaching.
- Information collected from respondents was accurate, relevant and dependable.
- Variables under investigations remained constant throughout the period of the research

1.8 Delimitation

This study was carried out at St Joseph High School, located in Zaka District, Masvingo Province. Zaka District is located to the southern side of Masvingo Town, the capital of Masvingo Province. There are 43 secondary schools in Zaka District, and the researcher selected one high school – where she is a Mathematics teacher. The study worked with a total of 30 participants, among them: 25 learners and 5 teachers. The main aim of the study was to establish the effectiveness of using models when teaching the topic 'Mensuration' at Ordinary level. The study was completed in 2022.

1.9 Limitations

The researcher wanted to carry out this study in many schools in Zaka District, but due to financial resources required to travel from school to school, she restricted her study to only one secondary school. In the same vein, the researcher acknowledges that she could have intermingled schools in town with those in rural areas in this study, but financial imbalances compelled her to concentrate on one school in the rural area set up. The researcher was also apt to incorporate primary schools in her study, but she had limited time to do the study, hence the need to remain interested in one secondary school.

In addition, as a full-time teacher and a family woman studying on block releases, the researcher had limited time to fine tune her study. The researcher contends that a study of this magnitude should have suited full-time study, and would have required adequate time to produce exceptional findings. Due to pressure of her current employment, the researcher incurred costs to travel to Bindura University of Science Education to meet her tutor for discussions on how to move from chapter to chapter. To address time constraints, the researcher worked continuously, even on weekends and school holidays. This enabled her to meet deadlines, in spite of employment and other social commitments associated with a family

woman. Again, the researcher typed some of her research work personally and used her salary earnings to mitigate financial shortages. This also accorded her chances to regurgitate her research, at the same time editing it continuously to lessen errors.

1.10 Definition of Key Terms.

Mensuration – the study of the measurement of various two-dimensional and three-dimensional shapes (Mavhunga, 2019). Mensuration is also defined by the researcher as the branch of Mathematics that studies the measurement of geometric figures and their parameters like length, volume, shape, surface area, among others.

Model – a three-dimensional representation of a shape or proposed structure, typically on a smaller scale than the original (Chakawa, 2016).

Learning- coming to know or gaining knowledge about something through doing or practicing it (Erickson et al., 2016).

1.11Summary

The first chapter discussed an overview of the researcher's area of study in its entirety. The objectives of carrying out the study, the research's sub-questions, as well as the importance of the study to teachers, school heads, policy makers, and curriculum developers were scrutinized. Moreover, the researcher assessed the assumptions on which this study is based, the study's physical and conceptual delimitations, shortcomings that compromised the finesse of her findings, as well as a glossary of key terms related to the study. In the next Chapter, the researcher digs into the literature related to integration of models in teaching and learning**.**

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter examines the literature from earlier researchers who examined model use in the teaching and learning situation. To be analyzed are: the merits of integrating models on both teachers and learners, the challenges that militate on the use of models on secondary school learners, as well as viable ways through which teachers may help their learners to appreciate the use of model-aided instruction at secondary school level, particularly in Mathematics lessons.

2.2 What are the benefits of integrating models in teaching and learning to teachers?

2.2.1 Keep learners occupied

The widespread use of models in the teaching and learning situation does not only help to capture learners' attention, but it also keeps them occupied (Hennesy, Ruthven and Brindley, 2015). This implies that where activities are well planned, and the teachers give relevant assignments for learners, there is a high likelihood that the latter will keep glued to the task. This will consequently give the teacher ample time to move around the class to help those needing assistance. Similarly, Afshari et al. (2019) aver that the use of models helps to capture learners' attention, consequently making it easy for educators to sail through their lessons. Where models are used and the learners are given the opportunity to touch and analyze the models individually, there is a high likelihood that learners will be occupied in the given tasks, unlike a situation whereby the teacher uses the lecture mode of instruction without associated

media such as models. This study sought to establish if model use in teaching the topic 'Mensuration' kept learners occupied at St Joseph High School of Zaka High School.

2.2.2 Help teachers to cover subject matter quickly

Moreover, the use of models in the teaching and learning situation enables teachers to cover their concepts quickly. Tapan (2019) observes that teachers whose lessons are devoid of models spend a lot of time explaining concepts using the chalkboard, a scenario that involves a lot of writing and drawing. For example, when teaching Mensuration of Solid Shapes to Ordinary level learners, the teacher may require a lot of time to draw the shapes to be used in the lesson, and may fail to come up with the accurate diagram – hence the need for use of models. This entails that the use of models saves the teachers' time, and allows them to go over concepts as fast as possible. In the same vein, Gulbahar (2017) submits that the use of models in a teaching and learning situation makes it possible for teachers to logically arrange their subject matter, and to summarize their lessons without much difficulty. This study therefore sought to determine if teachers at St Joseph High School can use models to cover mathematical subject matter as quickly as possible.

2.2.3 Can be a form of media to show complex pictures

In another finding by Snoeyink and Ertmer (2021), models serve to give clearer illustrations of those diagrams that are difficult to draw on charts or on the chalkboard. This assertion is also supported by Afshari et al. (2019), who aver that instead of using shoddily drawn pictures; models can be used, easing the demonstration of complex diagrams that may be difficult to accurately draw. Kindiki (2018) is also of the same opinion, and adds that the use of models is akin to use of real media. Thus**,** models use can make it possible for the teacher to use pictures of desired diagrams and show them in real form, further making them comprehensible. For example, instead of drawing the diagram of a pyramid on the chalkboard, the teacher can use

a model for learners to have the real view. This study sought to establish if teachers can use models to show complex geometrical shapes to learners.

2.3 How does the integrating of models in teachings and learning of Mathematics concepts impact upon learners?

2.3.1 Enables use of learners' multiple senses

The use of models is also beneficial to learners specifically as they can use more than one sense during the teaching and learning process. Bullock (2020) acknowledges that when teachers entirely rely on the use of traditional forms of methodologies, e.g., the lecture approach, in which media and technology use is heavily limited, there is a likelihood of using mostly the senses of sight and hearing. This shows that learners' capabilities to acquire skills are also limited, unlike in a situation where models are used and learners can fully engage all their senses to facilitate effective learning (Farrel, 2017). For example, the use of models of geometrical shapes enables learners to acquire skills through seeing, listening, and feeling, which increases chances of effective learning. Carnoy (2020) also admits that models enable learners to form permanent mental images that take long to be erased.

2.3.2 Improves learners' concentration spans

Tinio (2018) contends that one of the common impediments characteristic with secondary school learners in a teaching and learning environment is a poor concentration span, a drawback that can be easily fought through the use of models. Models enable learners to keep focused on the items being explained for longer periods without tiring. This also enables them to accumulate a large body of knowledge without getting fatigued (Rao, 2018). Echoing the same sentiments is Nihuka (2019), who acknowledges that the use of appealing models helps to keep lessons lively and animated, resultantly capturing the attention of learners for longer. The

researcher also believes that learners whose attention has been captured by use of a wide variety of models are easy to control, as their energy will be expended on working with the models at their disposal.

2.3.3 Aid retention of concepts as they can be used as media

To a greater extent, Matyokurehwa (2018) posits that models can play a dual role; as a form of media and as an entertainment tool. Where models are incorporated in a teaching and learning situation as media, there is great retention of concepts learnt. In a similar assertion, Tonui, Kerich and Koros (2016) posit that the use of models as media enables learners to recall what has been learnt easily. Nihuka (2019) also supports the above sentiments, and adds that the transfer of knowledge and its application in an exam setting is made easier if teachers resort to the incorporation of models in their lessons. Moreso, Goktas, Yildirim and Yildirim (2019) postulate that unlike other forms of instructional media which call for the teacher's innovative attributes to design and use them, models are ready for use, and only the teacher's organizational capabilities are of great use when models are incorporated in the teaching and learning situation. This study sought to establish if models can be used to retain learnt concepts for so long.

2.3.4 Encourages both individual and collaborative learning

Most educational thinkers prefer the use of models like geometrical shapes since they can allow for both individual and group learning. Kessy, Kaemba and Gachoka (2016) aver that models can be used to promote guided discovery, while Carnoy (2020) observes that where resources are in short supply, models can serve a large group of people. This assertion supports the sentiments of Farrel (2017), who affirms that models are mostly learner-centered, and they encourage individual learning. Nonetheless, Tinio (2018) hints that if not monitored closely, some unscrupulous learners may misuse the models and use them for activities that do not

promote learning. Thus, clear instructions should be given as to how the tasks at hand should be done, lest the learners may do their own personal business. This study sought to verify if models encourage individual and collaborative learning.

2.4 Barriers to the integration of models in teaching and learning of Mathematics in the secondary school

2.4.1 Lack of buildings to house many models

While the majority of teachers and learners may be willing to rope in models in the teaching and learning situation, infrastructural deficiencies will be an inhibiting factor in most secondary schools. For most secondary schools in a town set up, the state of infrastructure is more bearable compared to their counterparts in the rural areas. Mukanga (2020) admits that some of the satellite schools in marginalized communities in Zimbabwe do not have adequate rooms not only to house delicate models, but to also safeguard some of the invaluable assets in schools. This has often witnessed some of the donated gadgets being vandalized by local dwellers. In the same vein, UNESCO (2015) laments that the infrastructural shortages in most schools makes it difficult for the large number of students to have access to models in spite of the latter's availability. This study sought to authenticate if models have adequate space to safely keep them at St Joseph High School of Zaka District.

2.4.2 Need for retrofitting to allow safety and ventilation

Furthermore, where infrastructure exists, it has been designed in such a way that it only allows use in the teaching and learning of other non-practical subjects in which furniture and other implements need not to be pre-designed. Tapan (2019) avers that in most institutions, there is need for retrofitting since the buildings that had not been designed for model use should be modified to accommodate models. The modification includes making some provision for

ventilation, safety of the gadgets, and security from thefts. The above sentiments are supported by Afshari et al. (2019), who posit that lack of proper buildings to house electrical models has witnessed demolitions or refurbishments of some of the buildings as a way to make them suitable for facilitating the upkeep of many models.

2.4.3 Inadequate models available for teachers

To a greater extent, the massive shortage of models in most secondary schools makes it a mammoth task for teachers to effectively rope them in the teaching and learning situation. In a study carried in Kenyan secondary schools by Kessy, Kaemba and Gatoka (2016), the majority of secondary schools were plagued by insufficient models to enable teachers and learners to have access. Moreover, the study by Kessy et al. (2016) noted that of the models required by teachers in schools, only charts were readily available, while globes, dioramas, maps and geometrical instruments were in short supply. The study also indicated that the available models were mostly owned by school administrators, a situation that made it impossible for them to effectively integrate them in the teaching and learning situation. In Zimbabwe, the researcher believes that some of the secondary schools are so impoverished that though teachers may improvise their own personal models, but it requires school efforts for use of these models in teaching and learning to materialize.

2.4.4 Lack of technical support

One of the impediments to model use is the lack of technical support by school authorities. Ihmeideh (2019) and Khan et al. (2017) observe that most secondary school teachers are incapacitated to rope in models in their lessons, and there is need for in-service training so as to equip these teachers with requisite skills on how to use models. In Zimbabwe, the CDTS recommends the use of models in teaching and learning but teachers lack the technical know-how on how to achieve this. Similarly, workshops in model usage have been availed in many

secondary schools (Mukanga, 2020), but not all the teachers have been exposed to these workshops. This study, thus, sought to determine if mathematics teachers at St Joseph High School of Zaka District have been inducted to enable them to rope in models in teaching and learning, particularly the topic 'Mensuration of Solid Shapes'.

2.4.5 Lack of knowledge on how to use models

The lack of technical support in schools worsens the teachers' inadequate knowledge of using models in many secondary schools. A Nigerian study in secondary schools by Trucano (2015) indicated that while models were available in schools, there was widespread lack of knowledge on how to use them by the majority of teachers. In Zimbabwe, may models donated by the Ministry of Primary and Secondary Education (MoPSE), politician and other well-wishers are lying idle in schools due to inadequate knowledge on how teachers can incorporate them in a teaching and learning situation (Mukanga, 2020). The EMIS (2020) submits that most donated models are being vandalized in schools instead of being used meaningfully in teaching and learning. This study sought to authenticate if teachers at St Joseph High School of Zaka District are well versed in the use of models in teaching and learning of Mathematics, particularly the topic 'Mensuration'.

2.4.6 Lack of adequate time to prepare models.

Preparing a lesson in which models are to be used needs a lot of time, and thus, chews up time for didactical preparations, or the time of being physically available to the students (Clark, 2020). This means that inadequate time may hinder the teacher from pre-testing models before lessons begin. There is need for ample time to devise alternative strategies in cases of failure, as well as trial and error of many items (Holmes et al., 2016; Salomon, 2017). These assertions entail that the use of models demands more than double the normal time used by teachers when they engage learners in their absence. Similarly, Ornstein & Hunkins (2020) opine that

educators who intend to use models should spare adequate time for planning how they intend to execute their lessons, as a way of avoiding presentation of inconsequential subject matter. This study sought to establish if teachers at St Joseph High School have adequate time to rope in models in teaching and learning of 'Mensuration'.

2.4.7 Over-enrolment

In most African learning institutions, the number of students per class is not consistent with prescribed professional standards (Mwamwenda, 2014), making it a mammoth task for educators to design and use models effectively (Victoria, 2017). In the Zimbabwean setting, most classes are characteristic with large numbers and this poses challenges for educators who may want to integrate model-assisted instruction in their lessons (Gwarinda, 2015). These over-enrolled classed consequently force the majority of educators to resort to classical teaching methodologies that suit over-crowded classes (Lawan, 2015; Hartley, 2005). The researcher observed that the lecture mode of instruction, which is heavily teacher-centred, is the most common method prevalent in most secondary schools when teaching Mathematics. Thus, this study sought to determine if Mathematics classes at St Joseph High School are not overcrowded to impede the use of models in the teaching and learning process.

2.5 What mechanisms can be implemented to improve the integration of models in teaching and learning of Mathematics in the secondary school?

2.5.1 Schools should give technical support to teachers

One of the recommended strategies to fight knowledge deficiency in model use is to encourage school heads to accord teachers intending to rope in models in their lessons an opportunity to upgrade themselves through workshops or seminars. Carnoy (2020) acknowledges that teachers may be interested in using models but without refresher training, it will be an uphill

battle for them to cope up and live to the expected standards. In a similar call by Bullock (2020), it should be the role of school administrators to ensure that their staff members are well-versed in contemporary methods of teaching and learning, the use of models included. This study sought to verify if Mathematics teachers at St Joseph High School have been workshopped to enable them to integrate models in their lessons.

2.5.2 Parents should chip in with provision of models

In another strong recommendation, Whitehead et al. (2018) observed that some parents in higher social strata may also come to the rescue of schools, and provide some of the models required in the teaching and learning situation. The above assertion is heavily supported by Kent and Facer (2020), who proclaims that the use of models in the school should get the nod of the parent community, which should offer any material support in all possible ways. Similarly, Kent and Facer (2020) further indicate that learners who have models at home, e.g., maps, globes, toys as well as geometrical instruments, have no great challenges of using them if they meet them at school. This study sought to verify if parents at St Joseph support their children with models to use in teaching and learning of Mathematics.

2.5.3 Schools should have extra store rooms to house models

In a study carried out by Kessy et al. (2016) in Kenya, it emerged that infrastructural deficiencies were a major hindrance to the smooth implementation of the use of models to aid learning. In Zimbabwe, due to population explosion in schools, there is over-crowdedness owing to over-enrolment (Mavhunga, 2018). This has resulted in shortage of classrooms to use as base rooms or store rooms for storage and use of models. To aggravate the situation, there is inadequate furniture to use when handling models, most of which are very delicate and require meticulous handling. Tinio (2018) avers that the use of models like geometrical shapes, globes, and maps requires the availability of large tables or benches – facilities that are scarce

in most secondary schools. The researcher submits that the state of furniture in most secondary schools does not permit a conducive climate to incorporate models; hence teachers resort to teacher-centered methodologies like the lecture method of instruction. This study sought to ascertain if the state of furniture at St Joseph High School permits the use of models in teaching and learning.

2.5.4 Strict monitoring is required during model use in teaching and learning

Since it is probable that the use of models in the teaching and learning situation thrills the learners, it may resultantly be evident that some of the learners may get carried off by the animation prevailing, and thus close monitoring is required if instructional objectives are to be achieved. Tapan (2019) observes that when learners are instructed to use models to facilitate teaching and learning, there is need for educators to move around and see the work done by individual learners, lest the majority may pretend to be working on the intended tasks. In the same line of opinion, Ihmeideh (2019) contends that there is need by teachers to move around the class, and ensure that all the learners have understood the given instructions. This entails that moving around the class to monitor individual or group progress enables the teacher to assist those learners struggling with the use of models. This study sought to establish if model use at St Joseph High School is done under teacher supervision.

2.5.5 Equipping Teachers with Techniques of Evaluating Models

The majority of teachers cannot design and use models effectively since they lack evaluative tendencies (Bloom, 2016). The above author is supported by Lawan (2015), who advocates that for educators to skillfully and effectively use models for learning, they should have knowledge of evaluating their extent of usefulness. Countless key issues when evaluating models should be adopted, ranging from selecting content that is media-appropriate, current, and appropriate to curriculum standards, as well as promoting student interest (Percival &

Ellington, 2018; Bloom, 2016). In addition, the researcher also believes that the majority of teachers are incapable of using models to assess learners' work, a process that should have been used to save considerable time. This means that teachers should be adequately trained not only to use models in teaching and learning, but in assessing effectiveness of their methods. This study sought to verify effectiveness of models in teaching of 'Mensuration'.

2.5.6 Material support from the school, government or curriculum developers

To a greater extent, without support from school authorities, curriculum developers, well-wishers and the government ministry responsible for education, the implementation of model-based teaching and learning will resound an unmanageable task (Schon, 2016; Kemp & Dayton, 2015). This calls for interested stakeholders to prioritize procurement of models for educators as a way to motivate them. Besides, Mavhunga (2018) insists that consistent replenishing and procurement of more instructional models is necessary to avoid outdating and deficiencies of models in the school. The researcher notes with dismay that the majority of models donated in schools to facilitate effective teaching and learning of Mathematics are now outdated and wearing away owing to lack of attention and replacement. Thus, this study sought to corroborate if there is any external assistance in the procurement of models to facilitate teaching and learning of Mathematics at St Joseph High School.

2.6 Summary

This chapter assessed a good number of factors associated with the use of models in the teaching and learning of Mathematics in the secondary school. The researcher highlighted the benefits of models to both teachers and their learners, the challenges that can scuttle the use of models when teaching Mathematics to secondary school learners, as well as possible techniques that can be put in place to motivate both teachers and learners at secondary school level to embrace the use of models effectively.

CHAPTER 3

3.0 RESEARCH METHODOLOGY

3.1 INTRODUCTION

This section highlights the research methodology that the researcher will use in the study. The research design, target population and sampling procedures, research instruments, data analysis procedures and a conclusion are also presented in this chapter to meet the demands of the main research topic. The researcher also gives justifications for the research design and research tools used to collect data for this study.

3.2 Research Paradigm

The researcher selected the research paradigm, commonly called the research philosophy, from Saunders' most acclaimed 'Research Onion' (Saunders, Lewis and Thornhill 2019).

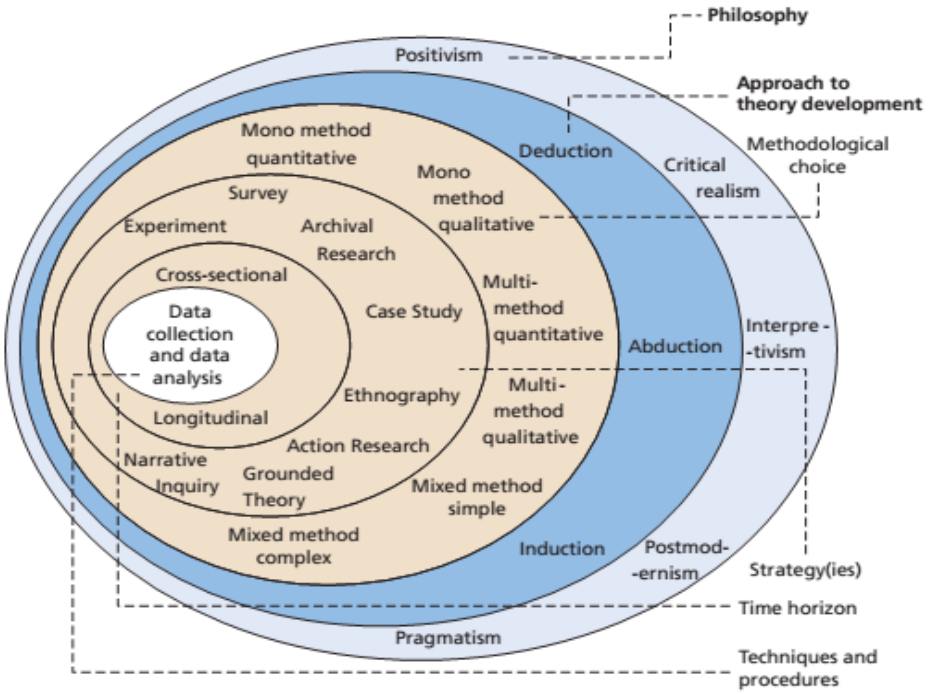


Figure 3.2 Research Onion (SOURCE: Saunders et al., 2019).

According to Creswell (2014), a research paradigm is a set of commonly held beliefs and assumptions within a research community about ontological, epistemological and methodological concerns. This entails that such a paradigm constitutes a mental model that influences and structures how the members of a research community perceive their field of study. Similarly, Mittwede (2017) defines a research paradigm as a template of deeply held conjectures or conceptual frameworks that undergird and influence research. Saunders et al. (2019) define a research paradigm as a system of beliefs and assumptions about knowledge development done when embarking on research. From the 'Research Onion' in Figure 3.1, the research philosophy could be: positivism, realism, interpretivism, postmodernism or pragmatism -with each philosophy having its tenets that govern it.

For the sake of this study, the researcher adopted the post-modernism research paradigm, which highly recommends mixed-methods research. The post-modernism philosophy advocates that theories and concepts are too simplistic hence focus should be on narratives, stories, perceptions and interpretations (Saunders et al., 2019). The post-modernism approach also insists that new understanding by researchers and worldviews are contributory to new knowledge. The researcher employed the post-modernism paradigm in this study since it involved the use of both quantitative and qualitative methods of data gathering, presentation and interpretation. This is because qualitative and quantitative research methods are not mutually exclusive (De Villiers, De Villiers, & Kent, 2015). A variety of research benefits were derived from adopting mixed methods; since the researcher was part of the study, researcher interpretation to the problem under study was highly valued by the majority of stakeholders and the researcher was reflexive (Punch, 2015; Burrell and Morgan, 2016).

In this study, the post-modernism mixed methods approach fitted well because the researcher used fairly large samples, carried out an in-depth investigation and collected a wide range of data using both quantitative and qualitative analysis (Creswell, 2014; Saunders et al., 2019).

3.3 The Research Design

A research design, according to Popper (2014), is defined as a programme that guides the investigation in the process of collecting, analysing and interpreting data. In this study, the researcher will use the descriptive survey design the merits of the descriptive survey research design are that it enables the researcher to use research tools such as an evaluation test, interviews as well as observations to gather data for the study. According to Leedy (2019), the descriptive survey means observation with insight, and describes what we see. Creswell (2012) defines a descriptive survey method as an attempt to obtain data from members of a population or a sample to determine the correct status of that population with respect to one or more variables. Popper (2014) concedes that a survey entail studying a limited number of cases with a view of drawing conclusions that cover the generality of the whole group under review. Thus, a survey involves drawing conclusions about a population based on a sample.

3.4 Target Population

Phillips and Pugh (2016) define a research population as the group which the researcher is interested in gaining information from and drawing conclusions. Leedy (2019) defines population as the group from which the researcher would like the results of the study to be generalizable, and it includes all individuals with certain specified characteristics. The population was from St Joseph High School of Zaka District, Masvingo Province. There are 435 Ordinary level students at St Joseph High School, among them 216 Form three and 219 Form 4 Mathematics students. The school used in this study was selected by convenience sampling, that is, by its proximity to the researcher. Due to cost, time and lack of resources it was not be possible for the researcher to solicit for data from the whole population, hence need for a sample a representation of the population. Thus, the researcher trimmed down the population to a sample of 25 participants, among them, 5 teachers and 20 learners.

3.5 Sample size

A sample is a given number of subjects from a defined population which is representative of it (Borg and Gall, 2019). Thus, it is a group of subjects on which information is obtained and the sample subjects should be selected in such a way that they represent the population from which they were obtained. In this study, 5 teachers and 20 learners were selected from the 5 mathematics teachers and 435 mathematics ordinary level learners taken from the sampled school. The researcher selected 5 mathematics teachers and 20 Ordinary level mathematics learners from the population to work with on this study. Form 3 learners were not part of the study sample and all the mathematics teachers at the school qualified for the study.

3.6 Sampling Technique

All the teachers and learners in the sampled school stood an equal chance of being selected into the study, thus, simple random sampling was employed in selecting participants in the study (Child, 2016). For learners, the researcher made 219 small manila cards with 20 written YES mixed with others written NO, which she issued to learners to come out with the 20 learners from the population. All the five teachers at the sampled school qualified for the study. This method was very easy to use, cost effective and reduced bias in sample collection (Cohen Manion, 2019). These sampling procedures also made it easier for the researcher to quickly obtain a desired sample without incurring much costs.

3.7 Research Instruments

These are apparatus used by the researcher to gather data for the study. For the sake of this study, the researcher used an evaluation test, observations as well as interviews. An evaluation test collected quantitative data and was administered to learners, while interviews were conducted with teachers and they gathered purely qualitative data. Observations were done on

both teachers and learners, and they collected qualitative data. The discussion of merits and demerits of each of the research instruments used is given below.

3.7.1 Evaluation Test

To ascertain the effectiveness of models in the teaching and learning of the topic 'Mensuration', the researcher used an evaluation test which was given in two phases. One of the tests was given before lessons using models while the other test involved content learnt after using models in Mathematics lessons. The researcher wanted to see if a comparison could be made on the effectiveness of models in teaching and learning of Mathematics. According to Bell and Cowie (2017), testing is one of the ways through which educators can measure the strengths and weaknesses of their teaching and learning approaches, and evaluate themselves to improve their teaching and learning skills.

Mpofu (2019) acknowledges that testing can be used by teachers and learners without the latter realizing the intentions of teachers. This implies that evaluation tests can be used and learners may exhibit their actual performances, without realizing that the educator intends to use the results for research purposes. Thus, the researcher is bound to have authentic evidence from the use of tests, especially on use of models in teaching and learning of Mathematics. Popham (2018) also submits that testing is one of the most viable way to measure the progress of learners and the teacher competencies in managing the entire teaching and learning situation.

Nonetheless, Mpofu (2019) condescends that testing may bring tension among learners, and hence teachers may not be able to collect uniform results each time they administer them. This implies that test results may fluctuate depending on many environmental factors that may militate upon their administration. Again, testing is disadvantageous since it is affected by the presence of gifted or backward learners (Punch, 2015). This implies that some learners may perform dismally or exceptionally well irrespective of the teaching and learning approach used.

3.7.2 Interviews

Creswell (2014) defines an interview as a process which involves collecting data through direct verbal interaction between two or more individuals. Like any other research tools, interviews have got advantages and disadvantages. The author above contends that interviews are suitable when one intends to solicit for information, even from illiterate respondents, as the wording of interview items can be brought down to suit the level of interviewees. Moreover, with interviews, respondents cannot falsify data such as age, sex and race (Creswell, 2014). Again, interviews help to build relations between the researcher and her subordinates, as there is a greater need to confide in each other, especially when dealing with sensitive information (Popper, 2014). This implies that apart from allowing researchers an immense opportunity for screening, inter-personal relations between the interviewer and interviewees improve tremendously.

The researcher preferred information about personal feelings, opinions and perceptions. Thus, another advantage of oral interviews was that, they allowed for soliciting of sensitive information from respondents (Phillips & Pugh, 2016), and the respondents' own words were recorded and ambiguities were clarified. Respondents were able to give reasons for their responses. Interviews are not influenced by others in the groups (Best and Khan, 2013). Again, the researcher recorded first-hand information directly from the participants, e.g., their emotions.

However, oral interviews are disadvantageous in that they may be subjective and biased, and they are time consuming, especially when dealing with very large populations. Probes should be neutral and the interviewer must allow sufficient time for the respondents to answer and should stop anticipating and cuing potential answers (Creswell, 2014). Again, with interviews, at times respondents felt uneasy and adopted avoidance tactics if the questioning was too long,

sensitive or deep. To mitigate this disadvantage, the interviewer built trust and rapport with respondents, thus, making it possible to obtain information that the respondents probably would not reveal by any other data collection method. Moreover, Borg & Gall (2019) suggest that interviews cannot provide anonymity for the respondents. This means that they are not suitable when highest levels of privacy are required. To carry out face-to-face oral interviews on her sample, the researcher arranged to have her interviews in a single day.

3.7.2 Observations

In addition to the interviews and an evaluation test, the researcher also physically observed the respondents, that is, the teachers and learners, and took down necessary information for appropriate analysis. She also observed availability of infrastructure and models in the school to aid the teaching and learning of Mathematics at Ordinary level. Best & Kahn (2013), define an observation as a systematic data collection approach, in which researchers use all of their senses to examine people in natural settings. Having been so defined, it implies that observations have their own merits and demerits as instruments of research.

Wandelt (2015) believes that observations are advantageous since they provide direct access to the participants under study. The researcher physically sees the subjects and records what he/she wants unlike relying on reports or responses from asking people. Where people may need to falsify data, direct observations will guard against this drawback. Further to that, Leedy (2015) also contends that with observations, there is a greater provision for a permanent record. He argues that much of the physical behavior which is of high interest to the researcher is highly transient, and without quickly observing and recording the behavior, it is a mammoth task to have a permanent record of the behavior. The fact that all observation entails some form of recording means that it provides a permanent record of such events or behavior, thus permitting prospective analysis or future comparisons to be done easily.

However, Leedy (2015) argues that direct observation is time consuming and is highly susceptible to bias from the observer. This means that the observer may be tempted to record events that did not take place, and this may consequently undermine the validity and reliability of such observed data. Observer effect is also another potential weakness of observations, where the presence of the observer may influence the behavior of those participants under observation (Popper, 2014). Thus, strict care was taken, lest the participants being observed hid their actual behaviors when being observed.

3.8 Data Presentation and analysis

The responses were presented in form of tables and coded as using frequency and percentages. Pie charts and bar charts were used to present the data to be gathered in this study. The presented data was analysed objective by objective, and the data was analysed with a view to correlate it with the ideas of other earlier researchers as alluded to in the literature review section. The researcher used statistical graphs such as pie charts, bar charts and frequency distribution tables to make comparisons, to identify modal appearances and to establish the mean scores of teacher perceptions to the effectiveness of using models in the teaching and learning of the topic 'Mensuration' to Ordinary level learners.

3.9 Ethical considerations

The researcher took cognizance of all potential ethical issues by addressing individual concerns and upholding anonymity and confidentiality of all participants. Assurance of dealing with ethical issues was also done through telling participants of their rights during the research, with an emphasis on their right to withdraw from participating in the study even amidst the research process (Popper, 2014). Participants were also made fully aware of the nature of the research and their role within it. The participants were also encouraged to sign consent forms showing that they were not coerced to partake in the study (Punch, 2015).

3.10 Summary

This chapter examined the methods and techniques that were used by the researcher to gather data for this study. The researcher used the descriptive survey research design in which an evaluation tests, oral interviews and non-participatory observations were used to collect data for the study. The chapter discussed the merits and demerits of the research design and research tools used, and techniques adopted to lessen the challenges they pose. The study's population, sample, sampling procedures, as well as ethical issues prioritized were also analyzed in this chapter. The next section, Chapter 4, presents, analyzes and interprets the researcher's collected data.

CHAPTER 4

4.0 DATA PRESENTATION, DISCUSSION, ANALYSIS AND INTERPRETATION

4.1Introduction

This chapter presents the researcher's findings on pie charts, bar graphs and frequency distribution tables. The above statistical tables do not only make the researcher's data amenable for analysis, but also compact the data, at the same time retaining original findings. The presented data shall then be analyzed and interpreted with the aim of answering the study's research questions. The analysis and interpretation shall also seek to reveal any correlations between the researcher's findings and the findings of other earlier authorities.

4.2 Presentation, Discussion, Analysis and Interpretation of Teachers' Responses.

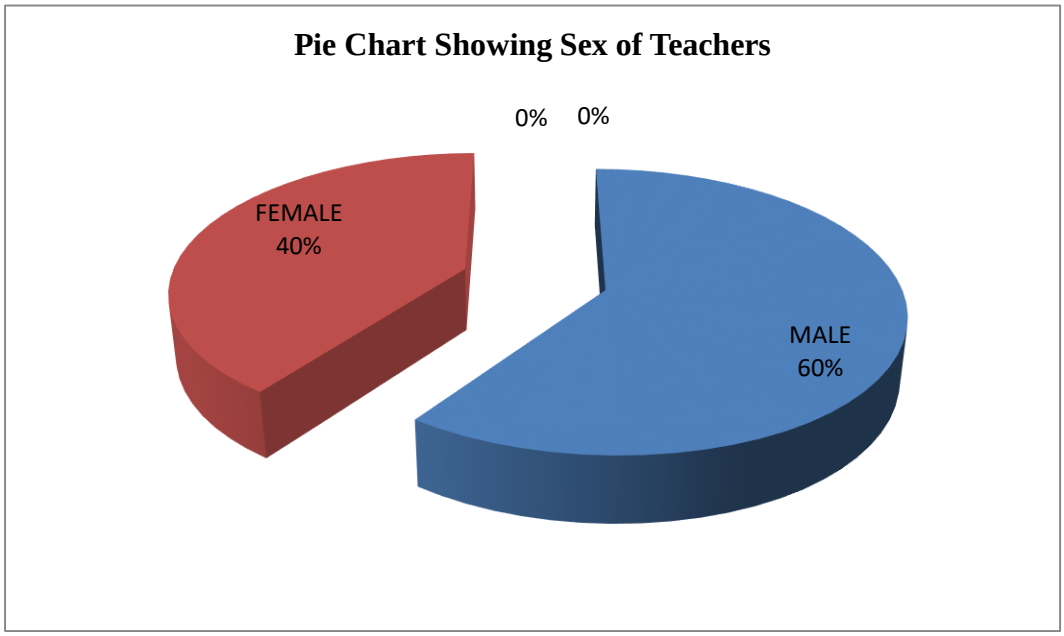
Table 4.1 Frequency Table Showing Ages of Teacher Respondents

AGE (YEARS)	FREQUENCY	PERCENTAGE (%)
Between 20 and 40 years	6	60
Between 40 and 50 years	3	30
Above 50 years	1	10
TOTAL	10	100

Of the ten teachers who participated in the study, 60% (six) were between twenty and forty years of age, while 30% (three) were between forty and fifty years, and only 10% (one) was above 50 years.

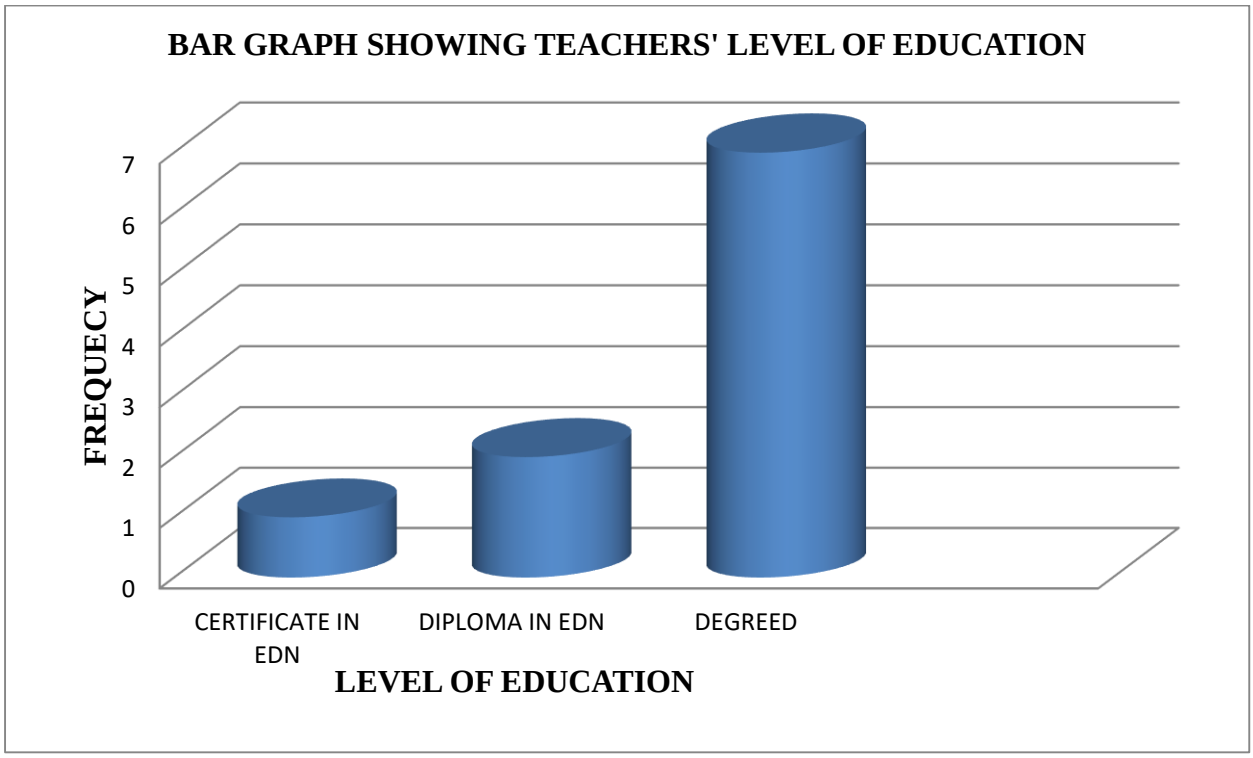
The above ages reflect that, from the sampled schools, teachers in the mathematics department are mostly middle-aged, who could be fresh from college, and could be conversant with techniques of effectively developing and using models in the secondary school. The teachers are also not too young to be novices in teaching secondary school learners; hence the researcher gathered reliable and valid data from the teacher respondents.

Figure 4.1: Pie Chart Showing Sex of Teacher Respondents



The pie chart above shows that there are 40% (4) male teachers, and 60% (six) female ones, who worked with the researcher in this study. The inclusion of both sex groups in the study indicates that the researcher was able to authentic data from both male and female respondents. This ensured credibility to the information gathered, and the researcher was assured that the findings are generalizable. Creswell (2012), advises researchers to select their research populations with discretion, lest they fail to gather evidence that is not only valid or reliable, but also fail to gather data that can be generalized on various similar populations.

Figure 4.2 Bar Chart Showing Teachers' Educational Qualifications



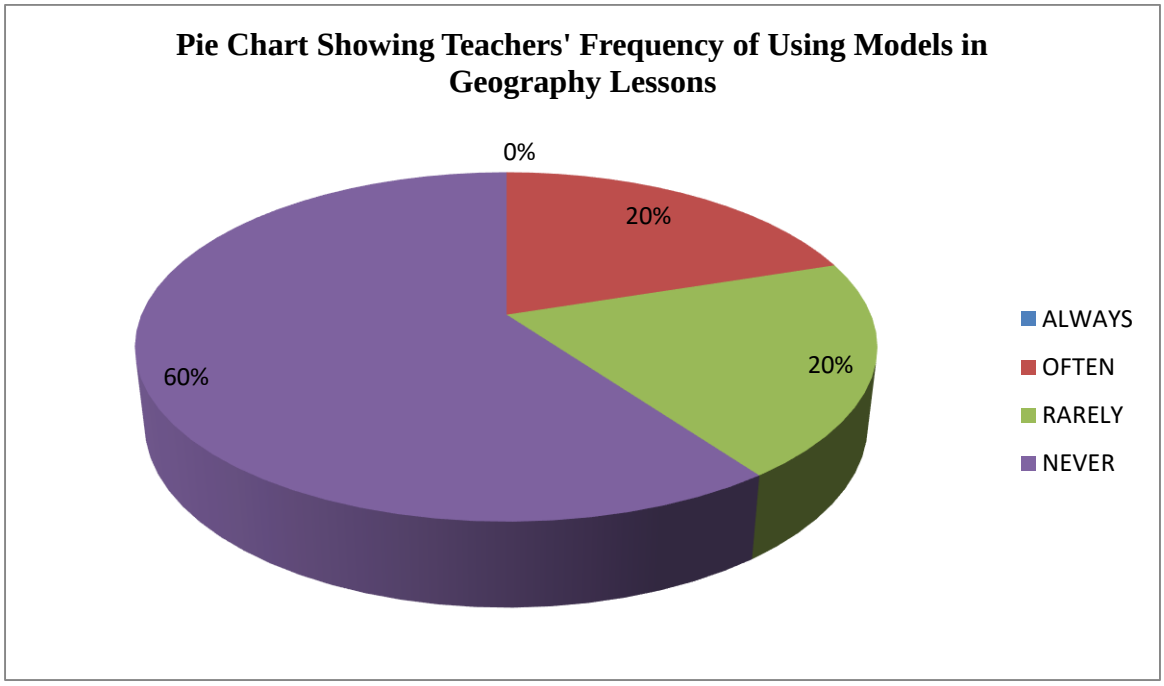
Of the ten teachers used by the researcher in this study, there were 70 % (seven) teachers who were Degree holders, while 20% (two) of them held Diplomas in Education, and only 10% (one) teacher was a Certificate in Education holder. The data above indicates that the teachers used in this study are properly qualified, and conversant with the need to incorporate models in their lessons. The evidence above also indicates that in many secondary schools in Zimbabwe, there are no classes taught by relief teachers, as there is ample manpower, and mostly degreed teachers. The researcher also wants to believe that the properly qualified teachers he used in this study opened up their hearts, as regards the challenges they encounter in their everyday interaction with use of models in teaching and learning of Mathematics.

Table 4.2 Frequency Table Showing Years of Teaching Experience

Working Experience	**Frequency**	Percentage (%)
Less than or equal to 5 years	0	0
Between 5 and 10 years	4	40
Between 10 and 15 years	4	40
Above or equal to 15 years	2	20
TOTAL	**10**	**100**

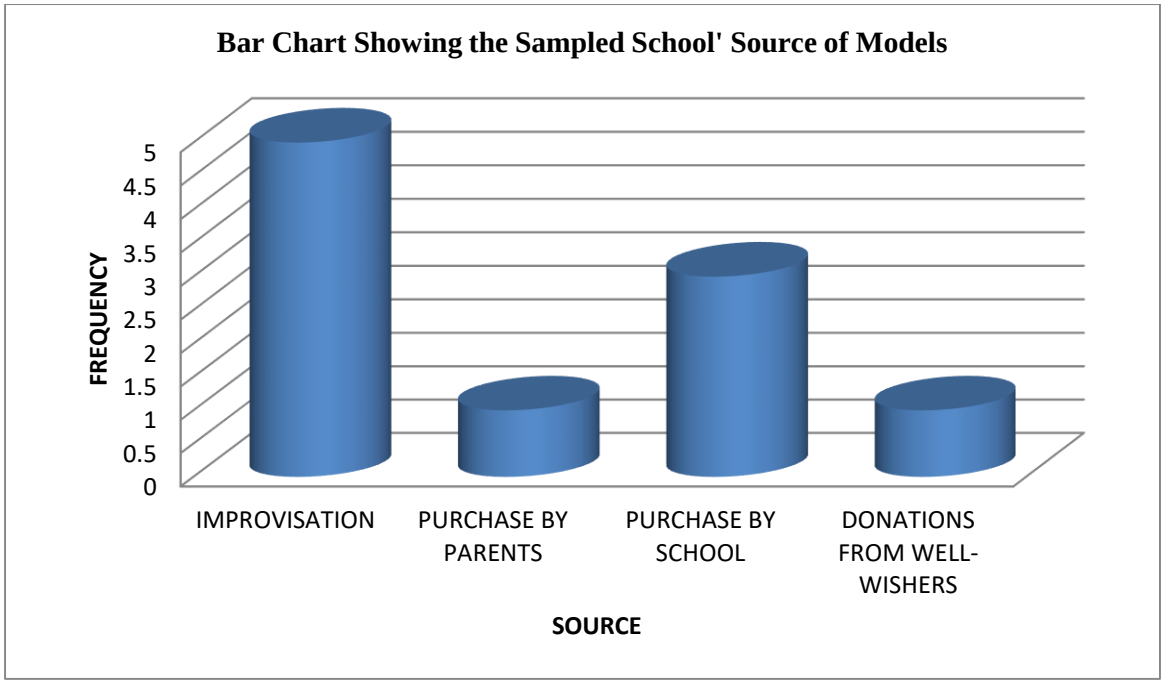
As shown on the frequency table above, 40% (four) teachers had teaching experience of between five and ten years, 40% (four) others had teaching experience of between ten and fifteen years, and 20% (two) of them had more than fifteen years' experience as a classroom practitioner. No teacher had less than or five years of teaching experience. The levels of teaching experience were ideal for this study, since the researcher intended to unravel challenges which these educators have been facing, or continue to meet as they design and use models in their lessons. Though these highly experienced teachers could be maintaining the status quo, and failing to completely find possible solutions to challenges they face when using models, the researcher felt that they must have found possible intervention mechanisms to address the above challenges during their countless years of teaching experience.

Figure 4.3 Pie Chart Showing Frequency of Using Models in Teaching Mathematics Lessons.



The majority of educators' lack of technical expertise makes them have a phobia for incorporating models in their lessons. This is shown by 60% of the respondents (6 teachers), who revealed that they never use models in their lessons. 20% of the respondents, i.e., 2 teachers, accepted that they rarely used models in their lessons, while the last 20% (two teachers) offered that they sometimes used models to facilitate learning of Mathematics concepts. Overall, it can be deduced that model use in Mathematics lessons is very minimal in the sampled school due to lack of knowledge or unavailability of resources. Kemp and Dayton (2007), lament on the inadequate mobilization of resources in most schools as detrimental to the inclusion of models in the teaching and learning situation.

Figure 4.4 Bar Graph Showing Means of Acquiring Models by Teachers in the Sampled School



Asked as to how they acquire models to use in their everyday teaching and learning situations, five teachers, 50% of the respondents, offered that without improvisation, the development and use of models would be non-existent. These teachers offered that most schools are incapacitated to provide for a wide range of instructional materials required by teachers in their day-to-day lesson delivery. Though Robler (2009) argues that instructional resources like models are difficult to improvise, handle and maintain, Zenger and Zenger (2009), posit that a wide range of models can be locally assembled, to reduce procurement costs.

Three other teachers, 30% of the respondents offered that the school plays an important role in the acquisition of visual instructional materials like models used by teachers and learners. These teachers agreed that for improvisation to materialize, the school would have chipped in with funding. Again, the teachers claimed that, without the school administrators' consent, the use of models in the school would not be possible. The sentiments of the three teachers are a reflection of the views of Kemp and Dayton (2007) and Schon (2006), who insist that the procurement, safekeeping and maintenance of instructional materials such as models are roles

of school authorities. This implies that schools which underfund departments in terms of supplying teaching and learning resources deprive teachers of invaluable opportunities of designing and using models in their lessons. Moreover, two other teachers, 20% of the respondents affirmed that parents and the donor community could be other vital providers of instructional materials.

Table 4.3Showing Challenges Facing Teachers in Using Models

Challenges	SD %	A %	D %	SD %
a. Lack of time to improvise models	30	70		
b. Lack of knowledge on use of models	80	20		
c. Insufficient resources in the schools		30	70	
d. Lack of technical assistance	80	20		
e. Over-enrolment	90	10		
f. Lack of teacher interest			70	30
g. Lack of support from school administrators	70	10	20	

KEY: SA-Strongly Agree, A- Agree, NS- D- Disagree, SD-Strongly Disagree

As regards the challenges teachers encounter in their bid to use models effectively, teachers strongly agreed that insufficient knowledge on use of models (80%), lack of technical aid (80%), too large classes (90%), as well lack of adequate funding from the school (80%), were chief factors that derailed the pace with which teachers wanted to embrace the use of visual instructional materials like models in teaching and learning of Mathematics. This evidence

means that lack of enough knowledge of model making (Williams et al, 2008; Chetsanga, 2002), failure by schools to train teachers on use of models (Hartley, 2005), over enrolment (Lawan, 2005), and failure by school authorities to adequately avail money to purchase instructional resources for use to make models (The Chronicle, January 30, 2012), are contributory factors to the reluctance by educators to incorporate models in their Mathematics lessons.

Similarly, the educators agreed, though not strongly, that changing times (80%) and lack of time to design models (70%), were also detrimental factors that can cause teachers to shun using models in their Mathematics lessons. The ideas of technological advancements, causing teachers to opt for maintenance of the status quo, are propounded by Gwarinda (2005), who laments that teachers who do not want to give up existing belief and practices, are obstinate when it comes to the use of contemporary teaching approaches like models. Again, Clark (2009), and Holmes et al (2012), argue that it is often time-consuming to adequately plan on how to design and use models in their lessons, compelling the majority of educators to completely avoid them. However, another group of teachers disagreed that teachers lacked interest in using ICT tools (70%). The teachers were quick to refute that they do not lack interest in using models but that they were not knowledgeable on how to use them. This finding goes in tandem with Chetsanga (2012), who claims that models could be available in the school, but without equipping educators with requisite skills to manipulate them, they will not attain instructional goals.

Table 4.4Showing Mechanisms That Can Be Used to Improve the Use of Models in Teaching and Learning of Mathematics

Possible Mechanism to Improve use of Models	SA%	A%	D%	SD%
Schools should give technical support to teachers	90	10		
Schools should procure instructional materials	10	60	20	10
Teachers should improvise instructional resources		20	40	40
Teachers should safeguard existing resources	100			
Teachers should be involved in designing of models		20	80	

KEY: SA-Strongly Agree, A- Agree, NS- Not Sure, D-Disagree, SD-Strongly Disagree

The table above shows that teachers strongly believe that schools should assist them with technical assistance to empower them on use of models (90%), and educators should have a culture of properly managing existing instructional resources (100%). Though it will involve costs, empowering teachers with capabilities to reign in models in teaching and learning will pay dividends in the future if the school decides to inculcate a spirit of including model-based instruction in Mathematics lessons. This observation means that models will end up being used by all teachers, and will end up being a school culture as a way to safeguard them. This finding is in support of Mcnabb (2011), and Johnson (2011), who argue that if teachers are trained on proper use of models, they will use this knowledge to integrate these models in the teaching and learning situation.

In addition, educators highlighted that schools should not only procure or source visual instructional resources such as models (60%), but they should also ensure consistently availing these teaching and learning aids to the learners (100%). This means that school authorities should provide adequate funding for the purchase of teaching and learning materials like models, and should not keep these under lock and key, but ensure that conditions are permissive for both teachers and learners to have ample access to them. The need to source materials for teachers by schools and avail them is a recommendation by reporters of The Chronicle (May 14, 2015), and The Daily News (June 24, 2014), which advise school authorities to desist from denying students and teachers access to instructional resources like models and other accessories that can be used to implement instruction. Yet, another group of classroom practitioners (80%), opined that they are against the idea of teachers improvising models, when schools are not supportive to the extent of assisting with some of the raw materials beyond their reach.

4.3 Analysis of Results from Observations

4.3.1The quantity and quality of Mathematics models available in the sampled school

The researcher noted that there were a lot of models in the sampled school but they were not put to use by concerned teachers. For example, it emerged that the model of the globe was available at the sampled school, but some of the mathematics teachers were not interested in using the model. Moreover, the researcher observed that other models in the school were aged enough to have passed their time of being roped in the teaching and learning of the contemporary Mathematics lesson. Holmes et al. (2012) notes that it is not only the availability of instructional materials in a school which matters, but also the accessibility of the materials to the end users (teachers and learners).

4.3.2 Teacher-pupil ratios in classes of the sampled schools

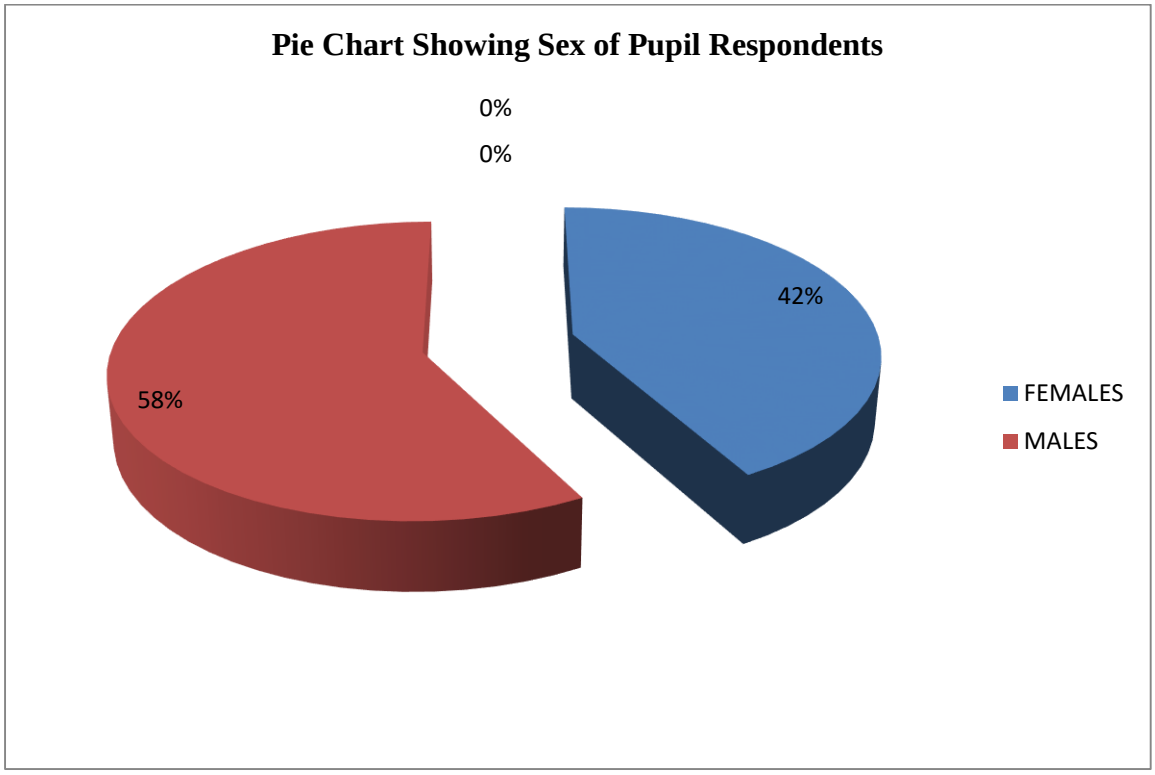
The researcher also managed to observe teachers as they partook of the teaching and learning process and noted that classes were fairly large (45-50 learners per class). At the sampled school, one of the O level classes had over 70 learners. Since the Ministry of Primary and Secondary Education recommends that teacher-pupil ratios should be around 30 learners per teacher, the researcher noted that the 45-50 learners in each class were not feasible for individual attention when using models. If there was anything the teacher wanted to impart to learners using models, they had to go in turns. Again, the researcher observed that though Mathematics rooms were well equipped they were not in a position to accommodate more than 40 learners each time. Kasambira (2017) emphasized that large classes caused by over-enrolment were a cause for concern for educators who wanted to employ visual instructional resources in teaching and learning.

4.3.3 State of infrastructure to safeguard existing models.

In addition, the researcher also observed that there were Mathematics rooms, storerooms, as well as subject base rooms to use for the upkeep of many instructional technologies such as models. Most models were either kept in the main Mathematics room, the schools' storerooms or the teachers' base rooms. It was also observed that limited models were kept in the teachers' offices at the sampled school by virtue of their sizes. There was adequate infrastructure to safeguard existing instructional resources such as models. This assertion indicated that all the sampled schools had adequate infrastructure, contrary to the sentiments of Clark (2009) who hinted that infrastructural deficiencies were an inhibition factor for the upkeep of instructional resources such as models in many schools.

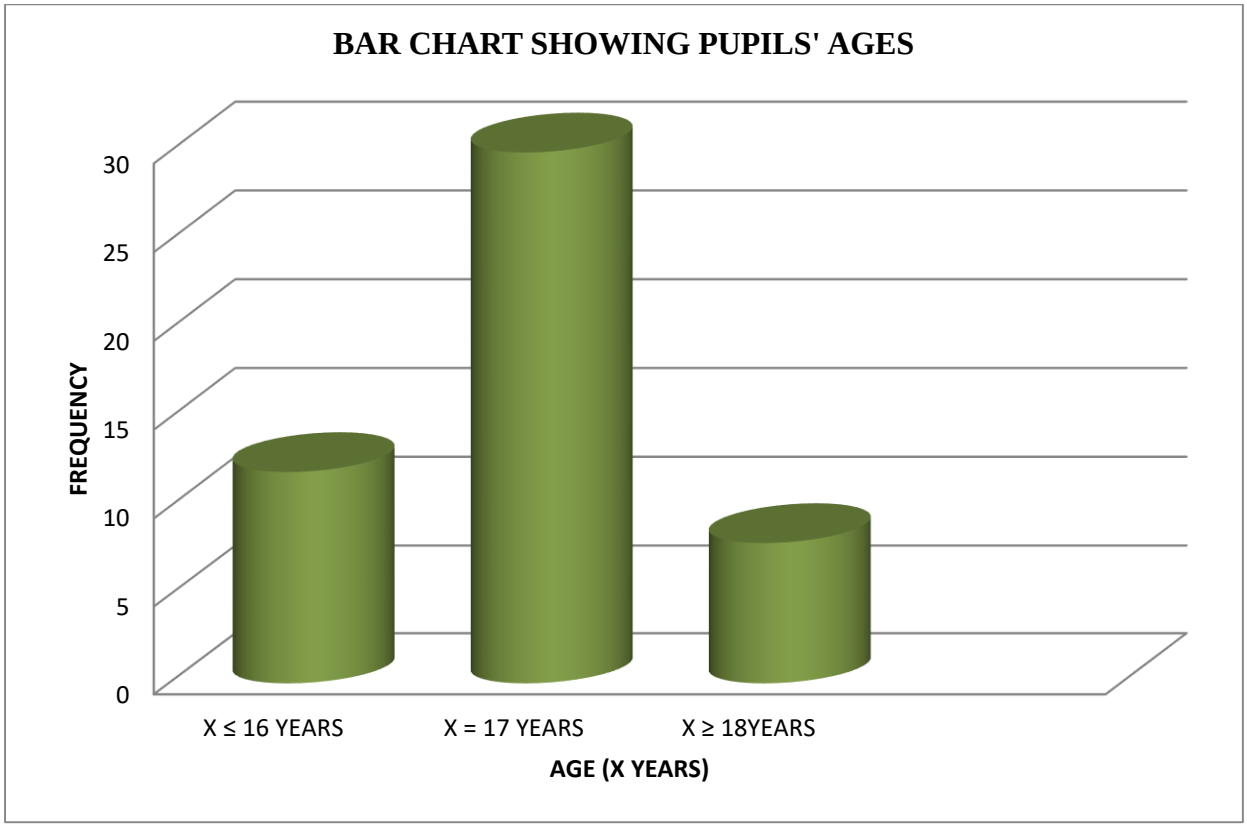
4.4Presentation, Discussion and Analysis of Results from learners

Figure 4.5 Pie Chart Showing Learners' Sex



Data revealed on the pie chart above indicates that the researcher worked with 60% (15) male students, as well as 40% (10) females, in this study. The same data also shows that the researcher worked with a population of fifty (25) students, with the figure of males surpassing that of females. This data indicates that, in the school where this study was done, the population of female students is below that of their male counterparts, and the researcher got views of both boys and girls, regarding the challenges they encounter when using models in teaching and learning of Mathematics.

Figure 4.6 Bar Chart Showing Learners' Ages



On the bar graph above, it is shown that 24% (6) students are 16 years or less, while 60% (15) students are 17 years old, and 16% (4) students are 18 years or above. In Zimbabwean secondary schools, this is the most appropriate age group for pupils Ordinary Level, after starting Grade 1 with seven years or less. To the researcher's line of thought, these students are now grown-ups, who can understand the concepts of model use in teaching and learning, and who can also identify those areas which pose challenges to them. Thus, the researcher feels that he collected reliable and valid data from her student respondents.

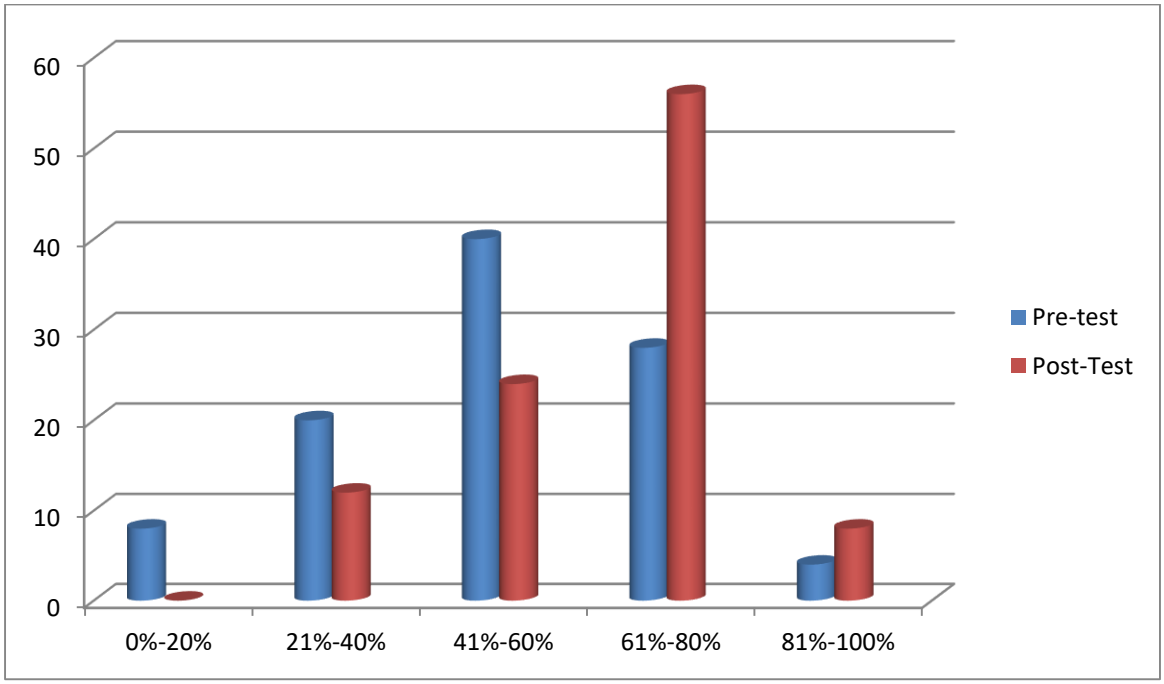
Table 4.5 Frequency Table Showing Pre-test and Post-test results

Pre-test	Frequency	%	Post-test	Frequency	%	% Increase
0-20%	**2**	**8**	**0-20%**	**0**	**0**	**-8**
21-40%	**5**	**20**	**21-40%**	**3**	**12**	**-8**
41-60%	**10**	**40**	**41-50%**	**6**	**24**	**-16**
61-80%	**7**	**28**	**61-80%**	**14**	**56**	**28**
81-100%	**1**	**4**	**81-100%**	**2**	**8**	**4**
TOTAL	**25**	**100**		**25**	**100**	**0**

The researcher administered two separate tests to ascertain if models were really effective in the teaching and learning of Mathematics. One test was given before the use of models while the other test was given after models were introduced in the mathematics lesson. The tabulated data indicate that in the pre-test, 2 learners (8%) obtained less than 20%, 5 learners (20%) obtained between 21% and 40%, 10 learners (40%) scored between 41% and 60%, 7 learners (28%) got marks between 61% and 80% and only one learner (4%) obtained a mark above 80%. On the post-test, it is also noticeable that no learners (0%) obtained less than 20%, 3 learners (12%) obtained between 21% and 40%, 6 learners (24%) scored between 41% and 60%, 14 learners (56%) got marks between 61% and 80% and only 2 learners (8%) obtained a mark above 80%. The tabulated results showed that there was a marked improvement on learners' performances from the pre-test mark to the post-test mark. For example, it could be

established that the mode for the pre-test marks lied in the 41% - 60% range, while the mode for the post-test is between 61% - 80%.

Figure 4.7 Bar Chart showing Pre-test and Post-test results



From the data presented in Figure 4.7, it is also noticeable that the frequencies for the pre-test results were higher for marks below 60%, while the frequencies for the post-test results were also higher for marks above 60%. This data indicates that models have an input in the teaching and learning of Mathematics. () acknowledges that teachers who incorporate models in their teaching and learning will reap positive rewards. The same results also indicate that there are other learners with a tendency to perform better despite any teaching method used. The researcher noted that one of the students scored above 80% in both the pre-test and the post-test and this was construed as giftedness. Overall, it can be deduced that models have the potential to increase learner performance if they are put to good use in the teaching and learning of Mathematics. The researcher also notices that there are other topics better taught using models, hence the teachers' discretion is required when using them in teaching and learning.

4.5 Summary

This chapter displayed, discussed, analyzed and then interpreted the data gathered by the researcher. The statistical used to present the researcher's findings include: frequency tables, pie charts and bar graphs. Presentation of the data on the statistical graphs helped to compress the data, at the same time maintaining the original findings. This means that the statistical graphs enabled the data to be displayed in summarized form that eventually allowed the researcher to analyze and interpret it with ease. The presented data was analyzed in line with the demands of research questions. Thus, the researcher tried to strike a balance between her findings, and the findings of earlier researchers. The researcher noted that there were no great disparities between her findings and those by other early educationists. Above all, the researcher discussed her findings, all the time noting the extreme values in the distribution of the respondents' responses.

CHAPTER 5

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter serves to summarize the absolute study, outline the conclusions drawn from the findings, propose possible recommendations, and suggest other research topics for further study. The findings of the study shall be given in relation to the research questions and objectives.

5.2Summary of the whole study

This study was carried out at St Joseph High School found in Zaka District, Masvingo Province. The main purpose of undertaking the study was to ascertain the effectiveness of using models in the teaching and learning of Mathematics at Ordinary level. The main objectives of the study were to: identify nature of models used in teaching and learning of Mathematics, if models offer any benefits, the challenges facing teachers and learners in the teaching and learning of Mathematics using models, as well as the possible intervention techniques that can be adopted to improve the teaching and learning of Mathematics using models.

The literature review section identified the nature of models used in teaching and learning of Mathematics, the merits of models to both learners and their educators, the challenges encountered by both teachers and learners in the teaching and learning of Mathematics using models as well as mechanisms that can be adopted by teachers and learners to stimulate interest among the learners, and motivate them to have positive perceptions of using models in teaching

and learning of Mathematics at Ordinary level. The researcher tried by all means to correlate what earlier authorities said about use of models in teaching and learning of Mathematics with what really obtains on the ground.

The study adopted a descriptive survey research design that was both quantitative and qualitative in nature. The researcher used questionnaires, direct observations and evaluation tests to gather evidence for this study. Questionnaires were administered to teachers; evaluation tests were administered to learners and direct observations were done in the sampled school on their feasibility of using models in teaching and learning of Mathematics to Ordinary learners. The researcher worked with a total of 30 participants, among them 5 teachers and 25 learners selected purposively and randomly from St Joseph High School.

5.3 Summary of Findings

5.2.1 What is the nature of models used in teaching and learning of Mathematics at Ordinary level?

As regards the nature of models that are characteristic in Mathematics lessons at Ordinary level, it emerged that the most commonly used forms of models include geometrical shapes, globes, diorama, charts as well as man-made soil and plastic models. The teachers and learners acknowledged that they were using man-made models, real global maps and charts to demonstrate concepts related to mathematical concepts. Dioramas were also regarded as instrumental instructional materials used to show successive pictures of mathematical materials to learners. The respondents also consented to the use of plastic models on shapes, particularly to represent the various solid shapes. All the models which the teachers and learners agreed to be using were construed as beneficial in Mathematics lessons as they engraved the concepts to be learnt to the learners.

5.2.2 How do teachers and learners benefit from using models in Mathematics lessons?

As regards the merits of employing models in Mathematics lessons at Ordinary Level, the respondents indicated that models capture leaners' attention and heavily engages them. This attention capture and engagement was interpreted as instrumental in improving the concentration span of the learners. To add to that, both teachers and learners strongly agreed that models were beneficial in Mathematics lessons since they save time for the teacher when covering content. Models used to quicken the teaching and learning process include: flip charts, maps and soil-made animals. Finally, the teachers and learners also strongly agreed that models allow for the use of multiple senses, aid retention and consolidation of learnt concepts and initiate meaningful discussion when they are presented to the class. The responds argued that models enable learnt materials to recall much of the taught content during examination times.

5.2.3 What are the challenges facing teachers and learners when using models in the teaching and learning of Mathematics at Ordinary Level?

The teachers also gave varied responses regarding the challenges of roping in models in teaching and learning of Mathematics at Ordinary Level. The respondents strongly agreed that apart from lack of technical support and technical expertise to manipulate some of models, there is also very limited time available for them to prepare the models effectively. This entails that the respondents strongly indicated that they were not well versed in the use of models and the allocated time was insufficient to enable the preparatory phases of the lessons. Again, the respondents indicated that most classes were over-crowded to allow teachers to effectively use instructional models, and as a result, teachers faced difficulties to attend to pupils' individual needs, as well as to offer remedial assistance to the struggling students. The results obtained also indicated that resources to make models could be availed and teachers were interested in making models, only if schools were supportive.

5.2.4 Which intervention strategies can be adopted by Ordinary Mathematics teachers and learners to improve the use of models in their lessons?

Both teachers and learners suggested a raft of intervention strategies that they thought would help to avert the challenges that were highlighted above. The respondents indicated that when they are given adequate technical support, especially in the form of technical expertise and availing of resources, they would not see it as a challenge to incorporate models in the teaching and learning of Mathematics at Ordinary level. The respondents also indicated that it was useful for both teachers and learners to safeguard the instructional gadgets already available in the school and that school administrators should procure more of these. Nonetheless, the teachers refuted that they should be involved in the design of models and that they should improvise models when school administrators could support financially.

5.4 Recommendations

In light of the above findings, the researcher would like to offer the following recommendations:

- Since it emerged that lack of technical support hindered adoption of models, school authorities should avail models to teachers and learners, so as to motivate them to develop interest in their use in Mathematics lessons.
- Since it was established that there is massive lack of technical expertise among teachers and learners on model use, school authorities should also offer refresher training, workshops and seminars to both teachers and learners, as a way to improve their capabilities in manipulating models in Mathematics lessons.
- Since the study found that over-enrolment was also contributory to challenges militating on model use by teachers and learners, school administrators should keep class sizes relatively small, using standardized teacher-pupil ratios, to enable effective rationing of models during Mathematics lessons.

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RESEARCH INSTRUMENTS

OBSERVATIONS GUIDE

The researcher shall observe the following:

OBJECTIVE 1: Determine the effectiveness of integrating models in teaching and learning of 'Mensuration' at Ordinary level.

VARIABLE OBSERVED	**COMMENTS**
Do models keep learners occupied?	
Pace at which teachers cover content when using models	
Use of multiple senses when models are present	
Do models improve concentration spans	
Do models promote individualism and collaboration	

OBJECTIVE 2: To establish challenges faced by teachers and learners in trying to integrate models in teaching and learning of 'Mensuration' at Ordinary level.

VARIABLE OBSERVED	**COMMENTS**
Availability of store rooms for models' upkeep	
Quantity of models available	
How teachers use the models in lessons	
Amount of time required when using models	

Teacher-learner ratios when using models	

OBJECTIVE 3: To suggest intervention strategies that can be adopted to improve the integration of models in teaching and learning of 'Mensuration' at Ordinary level.

VARIABLE OBSERVED	**COMMENTS**
Nature of support from school	
Nature of support from parents	
Nature of support from government	
Efforts to increase infrastructure	
Monitoring of learners when using models	

INTERVIEW GUIDE FOR TEACHERS

A. INTRODUCTION

My name is Mabinda Anesu, a student at Bindura University of Science Education (BUSE) studying for a Bachelor of Science Honors Degree in Mathematics Education. I intend to gather data on the impact of using models in the teaching and learning of Mensuration at Ordinary level. Please assist me by responding and discussing the following questions. The information that you provide will be used for academic purposes only.

B: RESEARCH QUESTIONS

OBJECTIVE 1: Determine the effectiveness of integrating models in teaching and learning of 'Mensuration' at Ordinary level.

QUESTION

What are the benefits of using models in the teaching and learning of 'Mensuration' at Ordinary level?

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OBJECTIVE 2: To establish challenges faced by teachers and learners in trying to integrate models in teaching and learning of 'Mensuration' at Ordinary level.

QUESTION:

Which challenges are faced by teachers and learners when using models in the teaching and learning of models in teaching and learning of 'Mensuration' at Ordinary level?

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OBJECTIVE 3: To suggest intervention strategies that can be adopted to improve the integration of models in teaching and learning of 'Mensuration' at Ordinary level.

QUESTION

What intervention strategies can be adopted to improve on the use of models in the teaching and learning of 'Mensuration' at Ordinary level?

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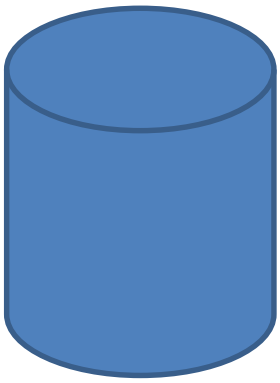
EVALUATION TEST

The evaluation test was administered to determine the effectiveness of integrating models in teaching and learning of 'Mensuration' at Ordinary level.

Revision Test: Mensuration of Plane and Solid Shapes

Use = 3.142 where necessary and where there is no diagram, draw a sketch before attempting each question.

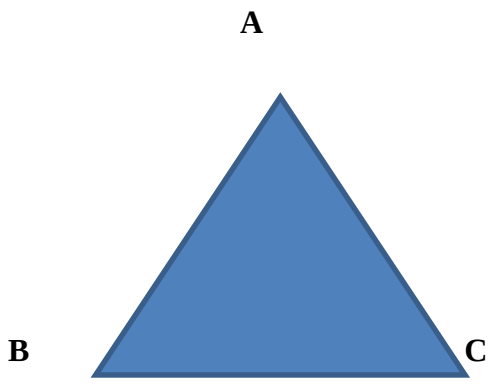
1.



(a). In the cylinder above, calculate the total surface area in terms of if the radius is 3cm and the height is 4cm [3]

(b). If the cylinder is metallic, calculate the volume of metal used. [3]

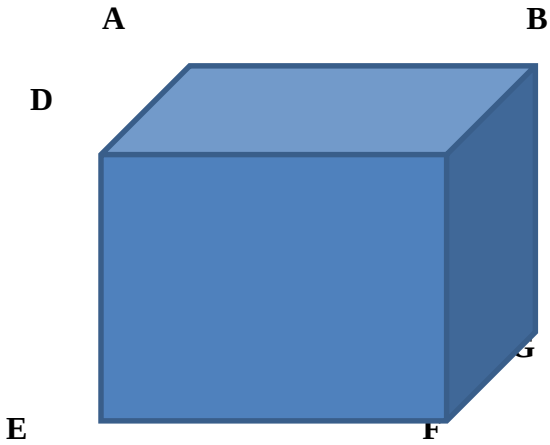
2. Study the triangle below:



(a). Find the area of triangle ABC to the nearest square centimeter if BA= 6cm, BC=7cm and angle B=34°. **[3]**

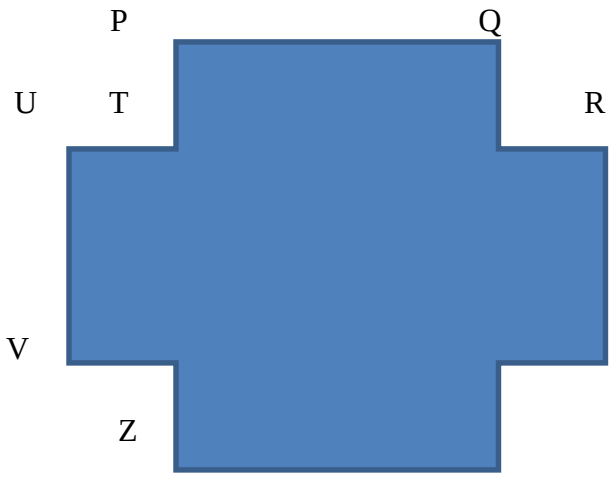
(b). If ABC is a base of a triangular prism of length 8cm, calculate the volume of the prism **[2]**

3.



(i). The cube above has a volume of the cube is 2744 cubic centimeters. Calculate the length of one of its sides. [3]

(ii). Hence calculate the total surface area of the cube [4]



(i). It is given that PQ = ZN = 8cm, RY = UV = 6cm, QS = XN = 2cm. Calculate the area of

(a). USXV

(b). PQXW

(c). TSXW [3]

(ii). Calculate the area of the shaded region. [3]

(iii). If the shape above represents a foundation of a house, calculate the number of square tiles each 60cm required to cover the floor [4]

5. A triangle is equal in area to a rectangle which measures 10cm by 9cm. If the base of the triangle is 12cm, find its altitude. **[3]**

6. The area of a trapezium is 14,7square cm. If the parallel sides are 5,3cm and 3,1cm long, find the perpendicular distance between them. **[3]**

7. The length of a rectangle is three times its width. If the perimeter is 72cm, calculate the width of the rectangle. **[3]**

8. The parallel sides of a trapezium are 11cm and 13cm. If the area of the trapezium is 84 square cm, calculate the distance between the parallel sides. **[3]**

9. An arc subtends an angel of 105° at the centre of a circle of radius 6cm. Find the length of the arc. **[3]**

10. Calculate the perimeter of a sector of a circle of radius 7cm, the angle of the sector being 108°**.** **[3]**

11. What angle does an arc 6,6cm in length subtend at the centre of a circle of radius 14cm? **[2]**

12. An arc subtends an angel of 72° at the circumference of a circle of radius 5cm. Calculate the length of the arc in terms of π. **[2]**

[50 marks]