INVESTIGATING MATHEMATICS TEACHERS' STRATEGIES FOR ADDRESSING GRADE 12 LEARNERS' CHALLENGES IN ALGEBRA IN KATIMA MULILO CIRCUIT IN ZAMBEZI REGION, NAMIBIA

A THESIS SUBMITTED IN FULFILMENT

OF THE REQUIREMENTS FOR THE DEGREE

OF

MASTER OF EDUCATION

[10MEDR]

OF

THE UNIVERSITY OF NAMIBIA

FOR

MARTIN MUSOKOTWANI SEZUNI

201027968

APRIL 2022

MAIN SUPERVISOR: DR. M. MUKWAMBO

CO-SUPERVISOR: DR. M. CHIRIMBANA

APPROVAL PAGE

This Research Project was been examined and is approved as meeting the required standards for the fulfilment of the requirements of the degree of the Master of Education.

________________________ ________________________

Internal Examiner (1) Date

________________________ ________________________

Internal Examiner (2) Date

________________________ ________________________

Dean of Faculty Date

________________________ ________________________

External Examiner Date

____

Supervisor signature

____

Co-supervisor signature

ABSTRACT

The purpose of this study was to investigate and establish Mathematics teachers' teaching strategies that were been used in addressing Grade 12 learners' challenges in Algebra in Katima Mulilo Circuit in Zambezi Region. The research study was a descriptive qualitative approach, which used a convenient sampling in order to select three Mathematics secondary school teachers to elicit the strategies that the teachers at the sampled schools used in solving problems in Algebra. The research study used observations, document analysis and interviews to generate data from teachers. The secondary school teachers' observations and interviews were analyzed into different categories. This was done in order to determine differences and similarities with the strategies identified. When social constructivism learning theory was used as a lens, the study revealed that the main challenges with Grade 12 learners in solving algebraic problems was the lack of solving skills, the inappropriate use of the teaching strategies by Grade 12 learners and their negative attitudes towards Algebra. The other findings of the study showed that, teachers used the strategies like *visualizing problems, step procedure, identifying key words, guessing and checking, and choose suitable operations*. The recommendations in this study are for the teachers to use the teaching strategies for solving algebra problems and teaching strategies to make Grade 12 learners understand Algebra. The examples used in teaching should be more practical as pointed out by some of the teachers. Thus, the strategies that came up from the teachers fall into categories. These categories of teaching strategies in algebraic problem solving involve; *choosing an operation, identifying key words, step procedure, visualizing the problem, pattern sniffing, re-reading the words*, and lastly *guessing and checking*. The teaching strategies used by teachers to make Grade 12 learners understand

Algebra fell into three categories. The strategies were been used to develop the habits of mind by integrating the Concrete-Representational-Abstract (CRA) approach, where concrete materials are used in teaching Algebra.

TABLE OF CONTENTS

Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

NSSCO: Namibian Senior Secondary Certificate Ordinary level

DNEA: Directorate of National Examination and Assessment

NAEP: The National Assessment of Educational Progress

KE: Kinetic energy

LCA: The Learner-Centered Approach

CRA: Concrete-Representational-Abstract Approach

IES: The New Institute of Education Sciences

WWC: What Works Clearinghouse

SCT: Vygotsky's Socio-Constructivist Theory

ZPD: The concept of Zone of Proximal Development

SEO: The senior education officer

UREC: University of Namibia Research Ethics Committee

ACKNOWLEGEMENTS

I would like to thank God for the knowledge and strength that enabled me to attain this educational level. He gave me wisdom, courage, strength and perseverance during the period the study was been carried out. His gracious mighty power energized me to persevere in this research study.

I would also like to express my sincere thanks and gratitude to my supervisors Dr. M. Mukwambo and Dr. M. Chirimbana for their patience, support and encouragement. Their expertise and professional support helped me to carry out this thesis to the standard it holds. My supervisors, I really treasure all your support and teaching; you are my heroes.

I want to thank my colleagues, Miss Meriam Chuma, Miss Mulela Matengu and Mr. Karen Muswalali for their support in sharing all the information concerning the course with me. They also encouraged me in many ways in carrying out this research study. It is also very important to thank our class for 2018 – 2019 at the University of Namibia for their professional contributions and support.

I would like to thank my wife, Mrs. Mercy Sezuni and my children, Martins Sezuni (Juju), Nancy Sezuni, Tracy Sezuni and Mukaya Matengu for allowing me to carry out this research study. Thank you my family for your understanding and support. You were patient and I apologize for the time and finance I took from you. I used Money for the family up keep to pay for my studies, you understood me when I left you to do this research study and when I took out money to pay the University.

My friends, who supported me, thank you so much. I want to thank our Education Minister and the Permanent Secretary of education, school principals, sampled teachers and learners who allowed me to carry out this research study. I acknowledge your permission and participation in the research study.

Lastly but not least, I would like to thank my colleagues at my previous school, Ngweze Secondary School for their support and help rendered during my studies. Everyone else, I may have left out, thank you so much, and may God bless you.

DEDICATION

The research study is been dedicated to my late parents, my beloved father and dad, Mr. Joseph Wasilota Sezuni and my beloved mother, Mrs. Clementina Queen Mwizabi. Their memories are been cherished. I wish they were here with me to celebrate this success. They were the pillars of my life, the people who raised me despite the financial challenges they had. I salute my parents and wish for their souls rest in eternal peace.

Part of the dedication goes to my late brother, Mushanana Patrick Sezuni. He took up the full responsibility of raising me with my sisters, Numbe and Miyaze Sezuni. I salute.

Lastly, my dedication goes to my wife, Mercy Namataa Sezuni who stood by me in all situations, sacrificing her money and time in supporting me to carry out this study. She came into my life and took up the place of my mother, my beloved wife I salute you.

DECLARATION

I, Sezuni Martin Musokotwani, hereby declare that this study, entitled "Investigating Mathematics Teachers' Teaching Strategies for Addressing Grade 12 learners' Challenges in Algebra in Katima Mulilo Circuit in Zambezi Region", is a true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education. No part of this study may be reproduced, stored in any retrieval system, transmitted in any form or by means without the prior permission of the author, or the University of Namibia in that behalf.

I, Mr. Sezuni Martin Musokotwani permit the University of Namibia the right to reproduce this thesis in whole or in part. It has the right to reproduce it in any manner or format, which the University of Namibia may deem fit, for any person or institution requiring it for study and research provided that, the University of Namibia shall waive the right if the whole thesis has been or is being published in a manner satisfactory to the University.

28/06/2021

Signature of Student

Date

CHAPTER 1

INTRODUCTION

1.1 Introduction

The study investigated Mathematics teachers' strategies for addressing Grade 12 learners' challenges in Algebra in Katima Mulilo Circuit in Zambezi Region. The study's discussion in detail is in the background below. The background of the research study included the review of the mathematics teachers' strategies in teaching Algebra. Furthermore, the researcher enlisted the current information surrounding the issue discussed and previous studies on the issue of teaching strategies. Thereafter, the statement of the problem, research questions, significance of the study, limitations and delimitations of the study, the definitions of terms and the overview of chapters were been discussed.

1.2 Background of the study

Seeking various strategies to assist learners improve the learning of Algebra and develop mathematical practices are a primary goal for all Algebra teachers (Zbiek & Larson, 2015). Thus, exposing various teaching strategies that help to mitigate learners' challenges in Algebra is vital. Algebra is one of the foundational components of mathematical understanding and competence, but unfortunately, it comes as a challenge for many learners for decades (Chow, 2011). However, Algebra is one of the topics that present difficulties and as a result, the study focus on how the challenges can be alleviated through effective teaching strategies is necessary.

The researcher concurs with Chow (2011) in believing that, the challenge in teaching nowadays is to teach learners of various capabilities and differing rates of learning success. However, the study was been done in a way that enables learners to learn mathematical concepts with understanding, developing positive attitudes towards the teaching and learning of Mathematics. Effective teaching strategies in Mathematics have been widely acknowledged as a key concern in teaching practice to add knowledge of learners. Thus, the challenges that learners may have in Algebra include lack of knowledge and skills in algebraic problem solving strategies (Sikukumwa, 2017) and their poor attitude towards Algebra (Keierleber, 2015). Despite that, ineffective teaching leads to poor problem solving in Algebra by learners and eventually poor performance in Mathematics. This is evident in Namibia especially Zambezi Region as indicated in Table 1.1. In addition, in order to curb challenges in Algebra, schools globally intervene by tasking learners to do Algebra as early as lower primary. Algebra as a syllabus topic was formally introduced in Namibia in 2016 in Grade 7, but concepts of Algebra start at lower primary, which is Grades 0- 3. For example, finding the missing numbers in addition and subtraction at lower primary, such as $\blacksquare + 4 = 7$. See Figure 1.1 in the next page.

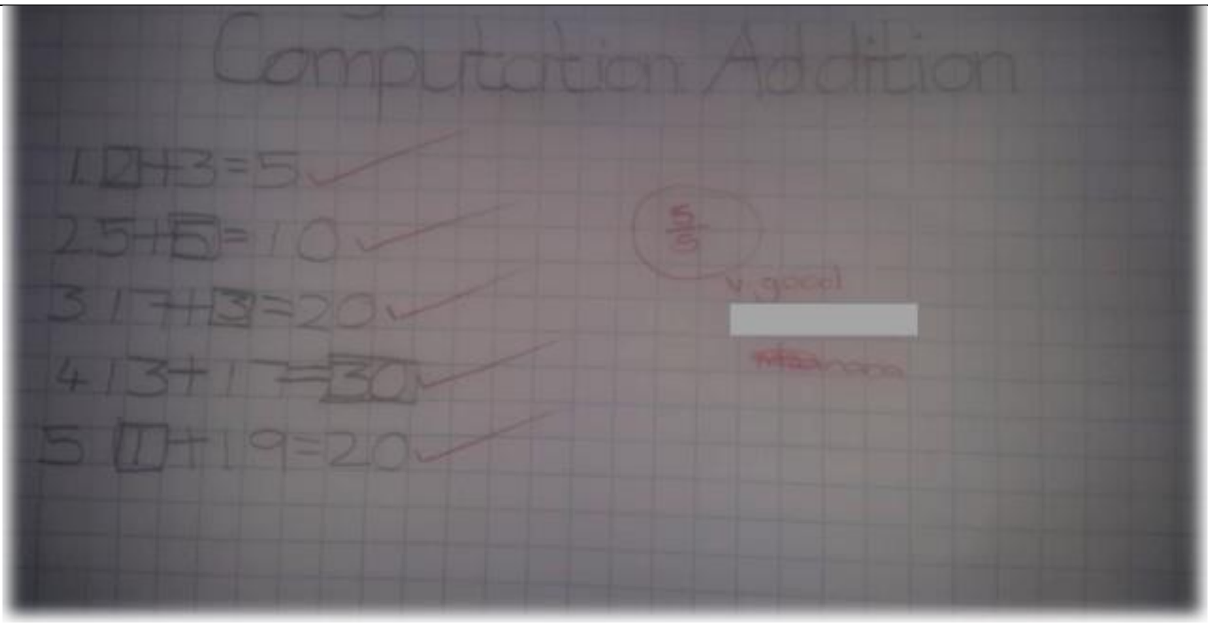


Figure 1.1: Computation activity for Grade 3 at one of the primary schools in Katima Mulilo Circuit

At lower primary level, ‘a’ geometric shape is been used to represent the unknown value or variable. In Grade 7, x and y variables are used. For example in a linear equation, x + 3 = 5 is the representation used at upper primary. The problem given in Figure 1.1 above, especially, in question 1’ is a typical example of how Algebra is been presented at lower primary such as $\blacksquare + 3 = 5$.. At this level, the learners go through the rhetorical stage, the syncopated stage and to a lesser extent the symbolic stage especially in Grade 12. The rhetorical stage is an algebraic stage where equations are been written in full. For example x + 3 = 5. On the syncopated algebraic stage, symbolism is used. Symbols are been used at this stage to represent the variable (Katz & Parshall, 2014). In between the rhetorical and syncopated stages, there is a geometric stage where most of the concepts in Algebra are geometric. Geometric shapes are used to illustrate algebraic concepts/ideas and equations as explained in detail in Figure 2.4. In almost all instances, success in Algebra is been realized through using teaching strategies, such as direct modelling and manipulatives, physical objects representing mathematical ideas, involving habits of minds (Cuoco, Goldenberg & Mark, 1996; Puteh, 2002; Kierleber, 2015; Sikukumwa, 2017).

Furthermore, in the Namibian mathematics classrooms there is little learning of Algebra for understanding and the discussion of learners' challenges, solving methods and correct solutions rarely come to pass (Sikukumwa, 2017). Many learners in most of the Namibian schools lack mathematical vocabulary; hence, this might be a contributing factor to the poor performance in Algebra despite the fact that it is been started at an early stage. It has been widely acknowledged that when the strategies of instruction are appropriate for the context, performance of struggling learners can significantly be improved (Puteh, 2002; Cankoy & Darbaz, 2010; Sikukumwa, 2017). It is argued that if the learner does not understand the problem that needs to be answered, the mistake on the appropriate teacher' strategies used to solve the algebraic problem may occur (Cankoy & Darbaz, 2010). Moreover, for the learners to achieve skills in abstract reasoning and mathematical structure within the learning of Algebra, effective teaching strategies that resolutely target the needs of learners are required (Chow, 2011). Therefore, the challenges that Grade 12 learners face maybe minimized by the use of effective teaching strategies.

Consequently, the researcher is been prompted to embark on a lengthy research project, to find out new knowledge, principles and ideas about effective teaching strategies that may help Grade 12 learners to solve problems in Algebra accurately. However, in order to mitigate Grade 12 learners' challenges in Algebra, effective strategies need implementation fully. The major problem, which motivated the researcher to come up with this study, is been discussed below.

1.3. Statement of the problem

The Grade 12 learners showed the challenges in solving problems in Algebra as discussed by Sikukumwa (2017), that learners have little knowledge and skills in solving problems in Algebra. The change from Arithmetic to Algebra is a particularly difficult, and improvements in Algebra teaching are greatly needed (Star & Johnson, 2009). In support of what is stated above, the challenges in Algebra encountered by Grade 12 Ordinary Level learners are also supported by an analysis of Algebra performance from 2013 to 2017 Namibian Senior Secondary Certificate Ordinary level (NSSCO) Mathematics final examination by the Directorate of National Examination and Assessment (DNEA). Table 1.1., below shows the examiners' comments on learners' performance as challenges in Algebra.

Table 1.1: Document analysis of the DNEA Examiners' Report

YEAR	PAPER	QUESTION	REPORT COMMENT
2013	3	5 (a) and (b)	5 (a) Learners could not write down the equation, and (b) many learners had no idea on how to solve a factored out quadratic equation.
2014	3	7 (b) (iv) 8 (c)	7 (b) (iv) Poorly answered 8 (c). Surprisingly, this part was fairly answered (changing the subject of the formula).

2015	3	10 (b) – (d)	Poorly answered, most learners couldn’t substitute correctly, change the subject of the formula, and could not factorize
2016	3	8	The question of algebra seemed very challenging to many learners. Learners struggled to collect like terms
2017	3	4 (b) – (c)	Poorly answered 4 (b) learners could not substitute properly and make N the subject of the formula; 4 (c) Learners could not remove the brackets correctly.

According to the above table (Table 1.1), questions on Algebra were been poorly answered and that was alarming. In addition, the researcher concurs with Chow (2011) in believing that “the challenge in education today is to effectively teach learners to learn mathematical terms with understanding and developing positive attitudes towards mathematics learning” (p. 4). The Grade 12 learners were been challenged with the mathematical terms and have a negative attitude towards Algebra. Therefore, effective teaching strategies are required to resolve the situation. This means the Grade 12 NSSCO learners are mostly lacking the right habits of mind, which assist in solving problems in Algebra. However, data from the National Assessment of Educational Progress [NAEP] indicates that many

Grade 12 learners can only solve the simple and routine Algebra tasks (Star & Johnson, 2009). This is also evident in Zambezi Region especially in Katima Mulilo Circuit.

It is most probably that learners' little knowledge of using the strategies to solve problems in Algebra and their poor attitudes towards Algebra results in the challenges faced as shown in Table 1.1. Furthermore, support material, showing poor performance in Algebra is the document analysis done with Algebra questions during the August 2018 end of term examination for Grade 12 learners in the Zambezi Region. The results showed that only 31% performed above average and 69 % underperformed. That was a trend not only common in Zambezi Region, where the study took place, but also prevalent in the Kavango Region as revealed by Sikukumwa (2017).

Mathematics is much relevant to a wide range of academic subjects; as a result, learner who poorly performs in Mathematics may struggle in science subjects. However, Geometry, Algebra and Calculus may assist learners to understand and solve problems in the sciences; Chemistry and Physics (Thompson, 2018). Many learners perceive Algebra to be a different language altogether. This is true to a certain extent; Algebra is a simple language used to solve problems that are not been solved with numbers alone. This means, Algebra models situations by using symbols like x, y, z to represent numbers and others. In Physics, linear Algebra is a requirement to do basic Physics. Mostly, the experimental observations of physical science are been summarized up in theories and laws, and these laws are expressed in mathematical language as equations. For example, Newton's law of Motion, F= mA, where F is force, an acceleration and m mass.

In addition, finding V in the equation for kinetic energy requires a learner to have an algebraic skill of changing the subject of the formula. Changing the subject of the formula is one of the challenges of Grade 12 learners as indicated in the problem statement, Table 1.1. See the manipulation in Table 1.2., on the next page

THE FORMULA AND THE MANIPULATION	
$KE=\frac{1}{2}mv^2$	
$2xKE=\frac{1}{2}mv^2x2$	[multiply by 2 both sides]
$2KE=mv^2$	[answer after multiplication]
	[Divide by m]
$\frac{2KE}{m} = v^2$	[answer of after division]
$\sqrt{\frac{2KE}{m}} = v$	, the value of KE and m are substituted to get the value of v

Table 1.2. The manipulation of the Kinetic Energy formula to get Velocity, V.

In Chemistry, Algebra is been mentioned frequently in a statement of Hess' Law of heat summation stating that regardless of the multiple stages or steps of a reaction, the total enthalpy change for the reaction is the sum of all changes. Hess's Law is been expressed as an algebraic sum of two or more reactions. Conclusively, the non-mastery of Algebra by learners may affect their performance in science subjects and some topics in Mathematics like Geometry, which require the knowledge of Algebra to do. Hence, the mentioned subjects, related concepts and topics become a challenge for the learners. It is against this background that the researcher prompted to conduct this research project. The background and the problem revealed led, to the research questions below.

1.4. Research questions

In order to investigate the strategies used by teachers to address the Grade 12 learners' challenges in Algebra, the following questions were been used to direct the study:

1. What strategies do teachers use in teaching Algebra in Katima Mulilo Circuit in Zambezi Region?

2. What challenges do teachers face in teaching Algebra in Katima Mulilo Circuit in Zambezi Region?

3. How effective are the strategies in addressing the challenges faced by learners in learning

Algebra at the sampled schools in Katima Mulilo Circuit in Zambezi Region?

4. What are the teaching strategies that are been used to improve learners' understanding of Algebra in Katima Mulilo Circuit in Zambezi Region?

The foregoing research questions guided the research project and the importance of this study project is been discussed below.

1.5. Significance of the study

The findings of the study will be significant to teachers, learners and the stakeholders in education. Education stakeholders are people who invest in the welfare and success of the school by ensuring quality education and its developer are in place. These educational stakeholders are learners, school administrators, teachers, parents, local business leaders, community members, state representatives (for example, councilors), school board members (Yaro, Arshad & Salleh, 2015). The outcome of the study will inform education stakeholders about learners' challenges in Algebra, in order for them to help in the education of their children. When learners perform well in school, there is assurance of community development. The school management and the senior education officers may use the findings of the study in workshops, to train and advise teachers on effective teaching strategies in Algebra in order to mitigate learners' challenges in learning Algebra. Thereafter, teachers may use the skills and knowledge from workshops to teach Grade 12 learners Algebra effectively. The limitations that influence the findings of the study are been discussed after this section.

1.6. Limitations of the study

The limitations of the study are the characteristics of the methodology that influenced the clarification of the results of the research study (James & Murnan, 2013). In this study, the limitations as constraints that influenced the findings of the study. That involved the researcher's presence in the classroom, which might have affected the observations. A questionnaire would have been better, where the participants answer questions independently without the researcher being present. Secondly, the study engaged three secondary schools in Katima Mulilo Circuit in Zambezi Region. That was because of limited time to reach all the schools in Zambezi Region and that became a limitation. In order to collect adequate data of the research study, time was been provided for its success. Thirdly, understanding the questions of the instruments of the study was a limitation to the participants because some questions were been misunderstood due to language barriers. In order to overcome that issue of misunderstanding the interview questions, the researcher piloted the instruments and went through the questions with the participants before the interviews. Despite, the limitations experienced, the boundaries that were set for this research study are been discussed after this section as delimitations.

1.7 Delimitations

Delimitations are the "characteristics that limit the scope and define the boundaries of the study" (Simon, 2011, p. 2). The researcher conducted the study at three secondary schools in Katima Mulilo Circuit, Zambezi Region. The study only involved a selected number of mathematics teachers at three secondary schools in Zambezi Region. In addition, the researcher based the study on teachers' strategies for addressing Grade 12 learners' challenges in Algebra. Some concepts related to delimitations associated with the challenges faced in teaching Algebra are been discussed in the theoretical framework and literature review after this section.

1.8 Definition of concepts

In this study, there are certain concepts that might hinder the researcher and readers from following well the research. These are been explained in the context of this study.

A teaching strategy is a method used to help learners learn the desired subject content and to be able to develop achievable goals in the future (Armstrong, 2013).

Habits of mind are been defined as mental traits that allow learners to develop repertoire of general heuristics and approaches that can be applied in many situations like the situation where Grade 12 learners have challenges in Algebra (Cuoco et al. 1996). Hence, in this study the concept of Mathematical habits of mind is the basis, mathematical habits of mind are the teaching strategies of approaching mathematical problems like learners' challenges in Algebra (Cuoco et al., 1996; Matsuura, Sword, Piecham, Stevens & Cuoco, 2013).

Algebra is a branch of Mathematics that deals with symbols and the rules for manipulating the symbols (Coolman, 2015).

Direct modelling is been defined as an approach to a problem solving by constructing a solution to a story problem by modelling the structure, in the absence of abstract mathematical knowledge (Carpenter, Fennema, Frankie, Levi & Empson, 1996).

Attitude is a mental state of readiness organized through the experience upon the individual's response to situations (Alhmali, 2007).

Negative attitude is a disposition or a feeling that is not constructive, cooperative (Cheprasov, 2017), while **positive attitude** is the strong belief of optimists that good things will occur in their future life (Mueller, 2017).

Symbolic notations refer to the algebraic mathematical symbols, which can be letters, signs, symbols and equal signs (Ebiendele & Olaoye, 2013).

Naturalistic observation involves observing behaviours in the natural environment (Mack, Macqueen, Guest & Namey, 2005).

Some of the definitions used in the literature given after the overview of the chapters.

1.9. The outline of chapters

According to this research study, the outline of the chapters of the study consists of five chapters. Chapter One gives the introduction. The introduction explains the topic of the study, provides the research's context as given in the background and the rationale or significance of the research work. It also discusses the research questions, which gives a direction to the research study.

Chapter Two is the literature review. A literature review provides the theoretical base of the research study and a detailed summary of previous research on the topic of the study.

Chapter Three gives the research methodology. The research methodology is been defined as a systematic way to solve a problem. In fact, in other words, it is a science of studying how research is been carried out and offers the techniques by which researchers go about their work of describing, explaining and forecasting phenomena just as in this research study. The methodology of the research study is specific procedures used to identify, select and analyze the data concerning the research topic.

Chapter Four reviews the data presentations, analysis and interpretation of findings. The presentation of the findings is been given according to the data collected; some information is presented in tables, some described and discussed.

Chapter Five reviews the discussion, conclusion and recommendation. The first part of the section discusses the findings of the study. The conclusion gives the overall summary of the research study and recommendations comprise the suggestions and issues to be followed pertaining future research studies.

1.10. Conclusion

In concluding the chapter, Chapter One presented the background of the study, the statement of the problem, research questions and the significance of the study. Furthermore, the limitations, delimitations, definition of concepts and the overview of the chapters are been discussed thereafter. All the outlined concepts above were been discussed according to the teachers' strategies for addressing Grade 12 learners' challenges in Algebra in Zambezi Region. Subsequently, the next chapter presents the literature review according to the research questions and the theoretical framework. The researcher has outlined the discussion of the Theoretical framework by using the Social-Constructivist learning theory as a lens, after this section. Furthermore, the teachers' strategies are been discussed in more detail in the literature review below:

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

The literature review is an overview of what one has knowledge of and the new ideas not yet known (Shunda, 2007). The purpose of this chapter will be to explore and discuss literature related to teachers' teaching strategies. The literature review for this research study is been presented in the following ways:

Firstly, definition of Algebra and its pedagogical development; challenges faced by teachers with regard to Algebra teaching; the teachers' strategies in teaching Algebra; the successfulness of the teachers' strategies used in teaching and understanding Algebra and lastly the theoretical framework (socio-constructivist learning theory) for understanding the phenomenon of learners' skills in solving algebraic problems. The concepts in the literature are been discussed as follows.

2.2. The definition of Algebra and its pedagogical development

The historical development of Algebra in this section will help to understand how Algebra developed to have its definition today. The definition is important because it gives a clear understanding of the topic. The definition and pedagogical development of Algebra cannot be discussed separately from each other, so it is discussed in detail in the below paragraphs.

Algebra is a branch of Mathematics that deals with symbolic notations and the rules for manipulating the symbols (Coolman, 2015). These operations and symbols were been written in Latin and Greek, as quantities without fixed values and are called variables in basic Algebra. In olden days, Algebra went through an extensive reform by Islamic scholars at their Golden Age. This was been inherited later by the Babylonians who did Algebra with procedural methods, solving by transforming a problem into standard form and working out the solution. For example, solving 3(x – 3) = - 6. Firstly, the brackets are removed to set it in standard form as 3x – 9 = -6 gives 3x = 3, then $\frac{3x}{3} = \frac{3}{3}$, finally x= 1. Now in modern times, a move from applying procedural methods were used first, in doing operations to each side of the equation. Nowadays, there are invented methods to deal with Algebra, if one engages with habits of mind. For instance, if one engages in visualization, he might interact with one of the two strands namely; mental visualization or analogy visualization (Cuoco et al., 1996). For example, if one decides to interact or use analogy visualization using a geometrical model, the Pythagoras Theorem can be visualized as area of the square on hypotenuse side is equal to the sum of area of squares on adjacent and opposite sides. Figure 2.1 below shows this visualization of the Pythagoras theorem;

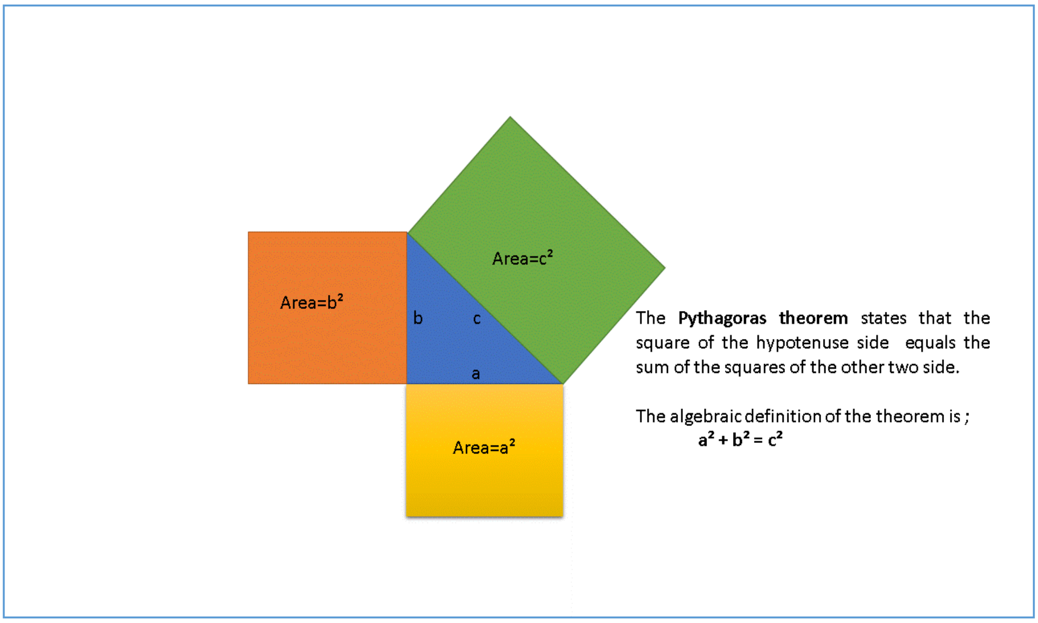


Figure 2.1: The Pythagoras theorem definition (Sparks, 2008).

Figure 2.1., shows the geometric model, used to demonstrate an algebraic thought, to define and prove the Pythagoras Theorem. In simple terms, the theorem entails that, the area of a square on the longest side is equal to the sum of the areas of squares placed on the other two sides, the adjacent and the opposite sides. This theorem can only be defined with an Algebraic expression as given above in Figure 2, as $c^2 = a^2 + b^2$. When Algebra is applied, then we may get side c may be got but Algebraic thought is needed in making c or b, as the subject of the formula as demonstrated in the following problems in **Figure 2.2.**, in the next page.

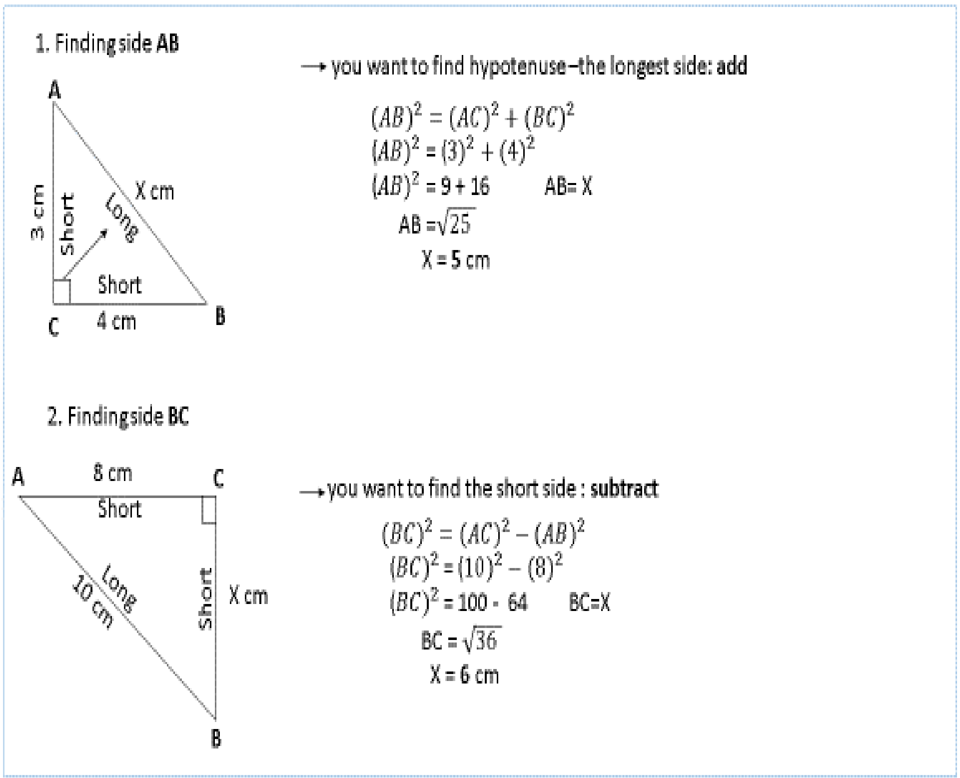


Figure 2.2: Finding the area of one side (D'Emiljo, 2010)

Moreover, the algebraic operations and symbolism were been seen in Geometry first, and it was argued that Algebra should be demonstrated by using Geometry for learners to understand the concepts (Katz & Barton, 2007). The invented methods which require one to use habits of minds proceeded from Algebra's historical stages of development, which involved; "rhetorical, the syncopated and symbolic" stages (Katz & Barton, 2007). We are now on the symbolic stage as outlined above and the meaning of Algebra was been taken from the symbolic stage, where algebra is defined as the representation of numbers by using symbols and letters. The variables used are x and y variables. The other four conceptual stages followed as stated by Katz and Barton (2007); are geometric stage, static – equation solving stage, dynamic function stage, and abstract stage '(Katz & Barton, 2007). Algebra is been defined fully at the conceptual stage. In the Namibian curriculum, at the symbolic stage, Algebra is been covered in the following topics;

(a) Algebraic expressions, where pupils simplify, expand and factorize the expressions

Involving symbolism. For example, Simplify $2x + 3y – 8x= 3y – 6x$

(b) Substitution of numbers into the expressions, such as find the value of $x^2 + 2$, if $x = - 2$,

$(- 2)^2 + 2 = 6$

(c) Changing the subject of the formula, such as make z the subject in $y = 2 + z$, $z = y – 2$.

(d) Equations, where learners solve equations (linear and quadratic). For instance, solve

(i) $6 = x + 2$

$x= 6 – 2$,

$x= 4$.

(ii) $y + x = 4$…………………1 [Using elimination]

$+\ y – x = 2$………………….2

$$\frac{2y}{2} = \frac{6}{2}$$

$y = 3$

$y + x = 4$ [Substitute the value of y in one of the equation to get the value of x]

$3 + x = 4$

$X = 4 - 3$

$x = 1$

(iii) The quadratic equation, $x^2 + 5x + 6 = 0$

Two factors of 6 are to be multiplied to give 6 and the same factors must added to give 5. These 2 factors are: 2 and 3, and since in $ax^2 + bx + c$, $a = 1$, 2 and 3 are written as the factors of the equation. Therefore,

$x^2 + 5x + 6 = 0$

$(x+2)(x+3) = 0$

$x + 2 = 0$ or $x + 3 = 0$

$x = -2$ or $x = -3$ as solutions of the equation

(e) Word problems, for example, "**The product of a number and 2 equals 8. What is the number?**" If a number is a, the equation will be $2\times a = 8$, $2a = 8$ then $a = 4$.

Sikukumwa (2017) argues that word problems are more challenging in Algebra than any other subtopic of what was been investigated. However, the researcher in this study believed that Algebra in general was a challenge to the learners, as discussed in the statement of the problem. In order to understand the learners' challenges, more literature in teaching Algebra is been discussed below.

2.3. The strategies teachers used in teaching Algebra

A teaching strategy is a method used to help learners learn the desired subject content and be able to develop achievable goals in the future (Armstrong, 2013). This study discusses the teachers' strategies that help Grade 12 learners solve problems in Algebra. Consequently, the researcher agrees with Sikukumwa (2017) that learners should be able to act on the operational stage in order to solve the problem by using the strategies, and decide on what to do and how to do it. The various strategies used in mitigating learners' problems in Algebra involved the innovative approach that focused on developing good habits of mind in solving algebraic problems as suggested by Cuoco et al. (1996). Cuoco et al. (1996) believed that visualizing problems, guessing, and pattern sniffing, experimenting, describing, inventing and conjecturing were important habits of mind as strategies useful for solving problems in Algebra. According to Cuoco et al. (1996), habits of mind are "mental skills that allow learners to develop a repertoire of general heuristics and method that can be applied in many different situations" (p. 378). In this study, habits of mind meant two aspects;

1. *The skills as the dispositions teachers develop in learners in their teaching strategies for addressing Grade 12 learners' challenges in Algebra*. This translates to the skills that need to be developed. in learners through a research experience.

2. *The teaching strategies used in Algebra in order to solve algebraic problems*.

For example, visualization is a skill and a strategy used to solve problems like, $x + 3 = 7$. A learner visualizes in making a mental picture of what the problem is in trying to solve it. Visualization is been aided by using concrete materials like counters. A problem can be described, as Maria has seven counters; she separates three counters from the seven. What has remained? It can also be in word (story) form. For example, *a number that can be added with three, the result is seven. What is that number?*

However, a curriculum organized around the habits of mind tries to close the gap between what the users and makers of Mathematics do and what they say. It develops learners to have the ability to be creators, inventors, visualizers, conjectures, pattern sniffers and experimenters; it lets them experience what goes on behind the study door before new results are polished and presented (Cuoco et al., 1996).

The problem-solving strategies that seem to be common in Algebra, especially when dealing with problem-solving, involve visualization, organizing data, finding a pattern, solving a simpler analogous problem, working backwards, adopting a different point of view, intelligent guessing and testing, logical reasoning, and considering extreme cases (Posamentier & Krulik, 1998). Other researchers (Puteh, 2002; Sikukumwa, 2017), review the strategies similar to the ones outlined above as habits of mind, but these researchers called some of the habits of mind (describing, and visualizing a problem) as teaching strategies. Puteh (2002) emphasizes on strategies to change learners' attitudes in Algebra. In addition, "teachers use learner-centered approach and on the other hand, diagnostic teaching to determine appropriate supplementary or remedial strategies" (Ministry Of Education, 2000, p. 125). However, the challenge is how to facilitate pattern sniffing, visualizing, describing, experimenting, inventing and conjecturing as suitable habits of mind. Furthermore, the innovative, approach of teaching focuses on problem solving with pictures and diagrams (Keierleber, 2015). This approach may be used in changing learners' attitude, with the other similar strategies, which are a combination of habits of mind. The effectiveness of these strategies was tested for further implementation, as given after the section below.

2.4. Challenges faced by teachers with regard to Algebra teaching

Koji, Mulenga and Mukuka (2016) concur with Sikukumwa (2017) that the problems teachers face in Algebra teaching are, background knowledge of Algebra by learners, little knowledge and skills in problem solving and lastly, inappropriate habits of mind to enforce better strategies in teaching Algebra by teachers. Apparently, the researcher consents with some authors (Koji et al., 2016; Sikukumwa, 2017) in that, learners had challenges regarding their background knowledge of Algebra. The background knowledge of Algebra among learners is required as prerequisites for the topic. For example, the learners should be able to construct and solve linear equations prior to solving simultaneous equations. Learners should be able to factorize before solving quadratic equations. Secondly, teachers also may have little knowledge of the habits of mind needed to come up with better strategies in teaching Algebra. It is quiet natural, that if a teacher cannot describe, visualize and do pattern sniffing, learners will not be taught to develop these important habits of mind. Therefore, the teaching strategies may not be developed in learners and as a result, learners struggle in Algebra. Furthermore, among all the other challenges, learners could be having the problems of attitude towards Algebra as suggested by Keierleber (2015), was investigated in this study. Attitude is a mental state of readiness organized through the experience upon the individual's response to situations (Alhmali, 2007). On the other hand, attitude is a mental position with regard to a fact or state, a feeling or emotion toward a fact or state (Webster, 2012). Whereas, learners' attitude may be positive or negative. Briefly, the two is defined as follows; *negative* attitude is a disposition, feeling, or manner that is not constructive, cooperative or optimistic (Cheprasov, 2017), whereas, *positive* attitude is the strong belief of optimists that good things will occur in their future life, such as it had happened in their past (Mueller, 2017). A Grade 12 learner may have either a positive or a negative attitude towards Algebra. There is no alarm for a positive attitude, according to the definition above but there is, with the negative attitude. The teachers' strategies, aim at mitigating the challenge of negative attitude amongst the Grade 12 learners in the research study.

Furthermore, the Namibian "Mathematics curriculum emphasizes that the learning of the subject involves conceptual structures and general strategies of problem solving and attitudes towards and appreciation of Mathematics" (Namibian

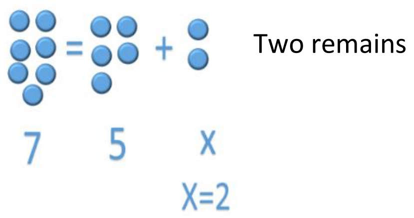
Ministry of Education, 2010, p. 2). It appears that, the rationale of the curriculum for Mathematics touches on general strategies for teaching problem solving and on attitude building for pupils to arrive at appreciating Mathematics in their academic setting. In addition, irrespective of how attitude is been defined, the most noticeable misconception with attitudes is the inconsistency between advocated and enacted attitudes. Thus, the difficulty of defining the concept arises because of attitudes are non-observable, and are been based on behavior (Chow, 2011). Despite that, Stoelinga and Lynn (2013) contend that "many Grade 8 and 9 learners who are supposed to take Algebra are not prepared and need more support to succeed because of weak foundations in prerequisite concepts" (p. 3). For this reason, more research is required in order to discover other strategies in preparing primary learners for Algebra at secondary level. Lastly, learners may be taught the strategies, as a result, of their negative attitude towards Algebra, success in Algebra is sometimes minimal.

2.5. The success of the teachers' strategies used in teaching Algebra

Successful teachers of Algebra visualize problems, encourage learners to guess and sniff patterns, experiment, describe and invent as part of the development of mind that is able to solve problems in Algebra. However, the ability to solve problems in Algebra depends on whether learners understand the vocabulary and the language in the problems for them to use the strategies appropriately. When, the more learners understand an algebraic problem, the more they will be able to use effective strategies to solve the problem. Some strategies are required for attitude change among Grade 12 learners in learning Algebra.

Puteh (2002) and Sikukumwa (2017) noted that acknowledging and influencing the attitudes of the learners is a critical part of teaching/learning process. Regardless of the thinking opportunities provided for the learner, if the attitude of the learner remains negative, it is unlikely that the learner will develop a mind that solves problems effectively. There is a difference between negative and positive attitude. Negative attitude is a disposition or feeling that is not productive and supportive (Cheprasov, 2017), whereas positive attitude is the strong belief of optimists that good things will occur in their future life (Mueller, 2017). In the case of positive attitude, the researcher used the definition written by Cheprasov (2017), which says, positive attitude is a feeling that is productive and supportive as opposed to a negative attitude. The innovative and spiral strategies (Keierleber, 2015) and the teaching strategies as habits of mind (Cuoco et al., 1996; Puteh, 2002; Sikukumwa, 2017) could be applied with the use of local concrete materials like bottles, stones, and so on, which help in changing learners' attitudes and challenges towards Algebra. For example, in solving the equation $x + 3 = 7$. The equation is been described in words and, then concrete materials are been used to attach meaning and then the equation is been solved in Table 2.1., as follows in the next page:

Table 2.1: The use of concrete material like counters in solving problems in Algebra

Equation	Story (word) form	Strategy: Use of concrete materials
x + 5 = 7	Nancy read some books and, said: “If I read five more, I will have read 7 books”. How many books has she read?	Nancy has 7 counters, separated five counters for books that She has to read and count how many remains as a number she has already read. What is the answer? 

As given in Table 2.1., the concrete materials boast learners’ interest as they learn by manipulating the real materials. Furthermore, Brown, McNeil & Glenberg (2009) argue that the use of local concrete materials is enough to help learners to succeed in a Mathematics class. The successful use of concrete materials can therefore, been aided by facilitating the habits of mind (Cuoco et al., 1996) and other strategies (Puteh, 2002;

Keierleber, 2015; Sikukumwa, 2017) with the three-part approach called Concrete-Representational–Abstract (CRA) approach. When the CRA approach is been used with the teachers’ strategies, it is believed to be effective in teaching (Garforth, 2014). The CRA approach involves physical manipulation of objects to solve Mathematical problems, where learners learn by touching, seeing and then use symbols (Brown et al., 2009).

The use of concrete materials with different strategies can help learners to understand algebraic concepts. For example, models are used to teach x + 6 = 10. These models can be geometric shapes or cubes. These models are there to represent the real or concrete learning materials that were been used to aid the learning of Algebra. These are just drawn or pictures and images used to represent the real materials. For example, drawing 10 triangles, separating 6 triangles from the ten and then drawing the remaining triangles for the answer. See the Box below.

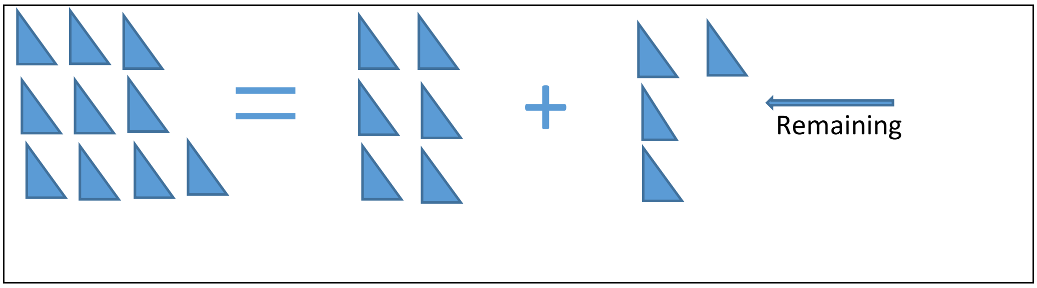


Figure 2.3: Box 1: Use of geometric in problem solving [i.e. x + 6 = 10]

This study supports the integration of the strategies reviewed by other researchers in order to test their constructiveness in mitigating the problems in algebraic problem solving.

2.6. Strategies that can be used by teachers to improve learners' understanding of Algebra

It is of importance to outline the strategies that can be used by teachers to improve Grade 12 learners' understanding of Algebra. Cuoco et al. (1996) believe that visualizing problems, guessing, and pattern sniffing, experimenting, describing, inventing and conjecturing are important habits of mind as strategies useful for understanding Algebra. The improvement of learners' learning is the primary goal of every Algebra teacher (Zbiek & Larson, 2015). Hence, Algebra teachers seek strategies to assist all their learners learn important Algebra content and develop proficient mathematical practices. The new Institute of Education Sciences (IES) practice guide make three recommendations. Whereas, Works Clearinghouse (WWC) developed the practice guide through its staff, in 2015. The guide was revised in 2019 by the given staff. The practice guide is titled, 'Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students'. It provides teachers with specific, evidence-based recommendations that address the challenges of teaching Algebra to secondary school learners as in this study (Star, Foegen, Larson, McCallum, Porath & Zbiek, 2019). It synthesizes the best available research, according to What Works Clearinghouse design standard. Accordingly, there are three recommendations discussed as strategies used by teachers to improve the understanding of Algebra (Zbiek & Larson, 2015; Star et al., 2019). The strategies are as follows;

1. The use of solved problems to engage students in analyzing algebraic reasoning and strategies,
2. Learners to use the structure of algebraic representations,
3. Teach learners to intentionally, choose from alternative algebraic strategies when solving

   problems (Star et al. 2015). For example, solve for x in:

$4x + 6 = 14$

$4x + 6 - 6 = 14 – 6$

$4x = 8$

$4x/4 = 8/4$

$x = 2$

The worked problem is analyzed to see the strategies been used, afterwards learners use its structure and steps in solving other problems. As the learners solve, they discuss the structure of the worked example and use it to solve the problem given. When the learners discuss and start following the steps of which the problem was been solved, they use teaching strategies reviewed by other researchers (Cuoco et al., 1996; Puteh, 2002; Sikukumwa, 2017). In this case, they use the strategies such as, to describe, choose an operation, and visualizing.

These three recommendations are been discussed with certain actions. The argument is that, for the strategies to serve their purpose, certain actions need to be taken on each recommended strategy. One example where the first strategy is to engage learners in analyzing algebraic reasoning and strategies. In order to put this into effect, learners are to discuss the solved problem structures and their solution to make connections with the strategies. Secondly, the selected solved problems should show the aim of the lesson. Lastly, the solved problems are been practiced in groups or individually. See **Table 2.2.** in the next page, for all the recommendations and actions to be taken:

Table 2.2: Recommendations and actions as strategies to improve learners' understanding of Algebra

Recommendation 1

Use solved problems to engage learners in analyzing algebraic reasoning and strategies.

Actions

1. Have learners discuss solved problem structures and solutions to make connections among strategies and reasoning.
2. Select solved problems that reflect the lesson's instructional aim, including problems that illustrate common errors.
3. Use whole-class discussions, small-group work, and independent practice activities to introduce, elaborate on, and practice working with solved problems.

Recommendation 2

Teach learners to use the structure of algebraic representations.

Actions

1. Promote the use of language that reflects mathematical structure.
2. Encourage learners to use reflective questioning to notice structure as they solve problems.
3. Teach learners that different algebraic representations can convey different information about an algebra problem.

Recommendation 3

Teach learners to intentionally choose from alternative algebraic strategies when solving problems.

Actions

1. Teach learners to recognize and generate strategies for solving problems.
2. Encourage learners to articulate the reasoning behind their choice of strategy and the mathematical validity of their strategy when solving problems.
3. Have learners evaluate and compare different strategies for solving problems.

The researcher concurs with Zbiek and Larson (2015) in arguing that the three recommendations are useful tools for Algebra teachers in order to refine their teaching strategies as given by other researchers (Cuoco et al., 1996; Puteh, 2002; Garforth, 2014; Keierleber, 2015; Sikukumwa, 2017). All these strategies, visualizing problems, guessing, and pattern sniffing, experimenting, describing, inventing and conjecturing, drawing pictures, choose operation and other approaches involve learners' work and examples, multiple representations and structure, and alternative solutions. However, the new teaching strategies such as those suggested by these recommendations are been often met with resistance (Zbiek & Larson, 2015). This is probably because some of these strategies may be quick and easy to implement, but some may be completely the opposite. Furthermore, these recommendations may come up with some challenges, because teaching multiple strategies for solving a problem can be too much for the learner and even confuse some. Learners may find it hard to learn a certain strategy, because it is not easy for them to master one strategy for solving Algebra problems, so what about when the strategies are many (Star et al., 2019)? However, the goal of teaching alternative strategies is not for mastery of all strategies by all learners, but the individual learner's mastery of the strategies that he or she chooses to use. Algebra teachers, therefore, should be careful in using these mitigation strategies aimed at improving learners' understanding of Algebra, and not confusing learners but improve their understanding. Lastly, in order to guide the learning of Algebra to Grade 12 learners, the theoretical framework using the social - constructivist theory of learning, which is been discussed next.

2.7. Theoretical framework

Vygotsky's Socio-Constructivist Theory (SCT) informs the theoretical framework. According to Vygotsky (1978), individual knowledge is been constructed through social interaction with others, rather than being received. According to social-constructivists, the assumption is that knowledge does not exist in a book, but rather it is been constructed by the learner in the process of interacting with other learners (Lowenthal & Muth, 2008). The theory examines the knowledge and understanding of the world that are been jointly developed by individual learners. However, making sense of other peers and construct knowledge on a social level allows the learners to relate themselves to circumstances.

The focus of social constructivist theory is the role played by social interaction in creating knowledge. Vygotsky believes that learning could not be separated from the social context. Vygotsky (1978) argues that all cognitive functions are been ignited as products of social interactions. This means constructivist theory largely influences the way in which people learn. The most important learning method according to constructivism is problem solving (Petraglia, 1998). Pagan (2006) maintains that effective constructivist provides real life problems that learners must deal with and problems are been solved better than, through social cognition rather than solving the problems alone. The teacher's main task in this model of learning is to translate the learning content into the format suited to the learners' state of understanding

.

The study, therefore, focused on the concept of Zone of Proximal Development (ZPD). The ZPD is been defined as the gap between the time that the child may be able to solve a problem with the help of a teacher, and the time that the child can solve the same problem alone (Vygotsky, 1978). However, since the study concentrated on teachers, the focus of the study based on the potential developmental level. At that level, learners solved problems without the help of a teacher in other topics, which were prerequisites to Algebra, but in Algebra and at a stage where they were been challenged, the teacher had to come in and help. The teachers' strategies as the required habits of mind were been used in teaching Algebra to help the learners to solve algebraic problems. The teachers mostly facilitated the development of habits of mind as strategies to solve problems in Algebra. For example, visualizing the equation $2x + 1 = 7$. In the words (story form)**, the number is doubled and 1 added to give 7.** In that way, learners understand the given equation and work out the problem using solving skills in Algebra.

In addition, Vygotsky (1978) believes that teaching strategies using social constructivism as a lens include teaching in the context that has personal meaning to learners. Therefore, teachers used different categories of strategies in teaching learners how to solve problems in Algebra.

Furthermore, learners were to have the right attitude in order to learn the strategies used to solve algebraic problems. For coming up with a solution, the study focused on the methodology below to answer the research questions stated.

2.8. Conclusion

This chapter presented the literature review, involving the subtopics; definition of Algebra and its pedagogical development, the strategies teachers use in teaching Algebra, challenges faced by teachers in teaching Algebra. Furthermore, it discussed the effectiveness of these outlined strategies with the strategies that can be used by teachers to improve Grade 12 learners' understanding of Algebra. Lastly, the chapter presented the theoretical framework, using the Social-Constructivist Learning Theory as a lens. The next chapter will present the methodology of the study, outlining the type of research, how the data was collected, who participated and reasons of the choices made by the participants.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter outlines different research methodological aspects, which the researcher used to collect, organize and analyze the data for this specific study. The subsections that were used in this chapter were the research design, population under study, sampling procedure and the method that was used to collect the data. The reliability and validity of the instruments been addressed. The ethical considerations pertaining to the research study discussed.

3.2. Research design

This research study was descriptive in nature. Descriptive research is the research design, which gives a picture of a situation in its natural settings (Burns & Grove, 2007). Similarly, when the research is descriptive, the researcher pursues to describe, observe, and document an occurrence of the phenomenon in its natural way (Polit, Beck & Hungler, 2001). Burns and Grove (2003), make it clear that a descriptive research design describes, in giving more details about the phenomenon of the study and it is descriptive of the way it is happening.

The study used a descriptive qualitative research design in observing and describing everyday practices of specific events of Mathematics teachers' strategies in teaching Algebra (Allwright & Hanks, 2009; Lambert & Lambert, 2012). In addition, the research design was used to expose the existence and the extent of Grade 12 learners' challenges in Algebra that triggered this study in order to get new educational teaching and learning ideas in Algebra problem solving (Sikukumwa, 2017).

Furthermore, there is a difference between the two types of research methods, quantitative and qualitative research strategies. The qualitative research method is been chosen in order to explore the issue at hand in more detail than when it is a quantitative research method (Setia, 2017). The qualitative research study is the study that happens in its natural sceneries where the researcher interprets the occurrences in order to make meaning, which the people bring (Ospina, 2004). On the other hand, qualitative research is been purposed in constructing detailed descriptions of the social realities of the participants (DeVos, Strydom, Founche & Delport, 2011). This study adopted qualitative study since more details were been needed, as it describes teachers' strategies for addressing Grade 12 learners' challenges in Algebra, at the selected three secondary schools in Zambezi Region. The phenomena is been described and explained as the researcher naturally observed it. For the purpose of this study, the descriptive research design was been used to obtain details of the effective teachers' strategies used to address the Grade 12 learners' challenges in Algebra.

3.3. Population

According to Burns and Grove (2007) population under study are all the elements that are included in the study by some certain criteria. However, according to the other researchers, a population is an entire group of people from which some information is required to be ascertained (Banerjee & Chaudhury, 2010). The researcher agrees with the given definitions, especially the first one that clearly discusses population as all elements of the targeted group and the choice is been based on certain requirements. Therefore, all elements had to do with mathematics teachers in secondary schools. For this study, the population of the study was the 12 secondary school mathematics teachers in Zambezi Region. The criteria for the inclusion in the study were:

1. Mathematics teachers who were currently working in secondary schools
2. Mathematics teachers who were currently teaching Algebra.

3.4. Sample and sampling procedure

A sample is been defined as a group of people taken from the large population for measurement (Mujere, 2016). At the time of data collection, Zambezi Region consisted of twelve secondary schools offering Grade 12, and possibly twelve mathematics Grade 12 teachers as outlined in the population before this section. The Katima Mulilo Circuit had nine secondary schools, but only three schools were offering Grade 12. However, three mathematics teachers were been sampled from the population of 12 mathematics teachers teaching Mathematics in three sampled secondary schools in Katima Mulilo Circuit, Zambezi Region. The requirements reached to select these schools were that the schools had Grade 12 classes and they were located in the Katima Mulilo Circuit, hence only three schools had Grade 12 in the circuit. The Mathematics teachers were been sampled for this study as follows; one Grade 12 teacher from each secondary school in Katima Mulilo Circuit, Zambezi Region. These three schools were as follows: schools 1, 2 and 3 respectively in the circuit. From each school, one Grade 12 mathematics teacher was been selected to take part in the study. Moreover, this sample was been used to discover the effective teaching strategies used by mathematics teachers in sampled schools. Hence, the problem of Algebra was been noticed mostly, in the secondary phase, especially at Grade 12.

There are fundamentally two types of sampling strategies. According to Setia (2016), there is probability sampling, based on chance events, and non-probability sampling strategy, based on the researcher’s choice, population that is accessible and available. Therefore, the study employed a non- probability sampling strategy. Amongst all the types of non-probability sampling strategies, the two broader categories of non-probability are purposive and convenient sampling techniques (Alvi, 2016). Purposive sampling is a sampling strategy where a sample is approached having a purpose in mind, while on the other-hand convenient sampling is where a researcher includes the participants who are easy to find and easy to approach .

Consequently, convenient sampling strategy was been used in the research study. Convenient sampling is the sampling method, which relies on the data collection from population elements that are conveniently available to take part in the research study (Dudovskiy, 2018; Farrokhi, 2012). This sampling method was been used to sample the Grade 12 mathematics teachers by considering the accessibility and availability of the mathematics teachers in the Katima Mulilo Circuit of the Zambezi Region. Sampling is the process of selecting a suitable part of a population in order to determine the characteristics of a whole population (Mugo, 2002). The available mathematics teachers in Grade 12 were been used. This was for a reason that there were few mathematics teachers that were been allocated in secondary schools teaching Mathematics. For instance, at one secondary school, one teacher handled grade 12A – 12E, so the probability of not having an option was almost 100%. The mathematics teachers were been selected for observation in class and for an interview.

3.5. Research instruments

The interview schedule, observational schedule, audio-visual recorder and document analysis guide were the instruments used to collect data. Hence, the interview, observation, audio-visual and document analysis were methods used to generate the data. The researcher used the above-mentioned instruments for the reasons that are been discussed below as advantages.

3.5.1. The interview schedule

The interview schedule was been used to answer the five research questions, 1 - 5. The researcher acknowledged that the interview had some advantages and disadvantages. However, the advantages of an interview in research included, the prospect to generate data directly, access to written and verbal information, and to a certain extent confidential information is been obtained (Trigueros, 2017). In spite of this, the researcher acknowledged that interview as a method of generating data had some disadvantages. One of the disadvantages was that the interview needed a skillful interviewer to obtain the information required and since it is face –to-face, the interviewee may be afraid to face the interviewer. To limit such challenges that came with interviews, observational schedules were been engaged. The observational schedule is been discussed below.

3.5.2. Observational schedule

The researcher used observational schedule as naturalistic observations in identifying the teaching strategies that teachers used to teach Algebra. The observation also helped to fill the gap in generating information, which did not come out with the interview. This was an advantage because, it gathered information about the physical environment and general behavior of the participants, the data generated is rich and detailed (Holmes & Bloxham, 2007).

The researcher as the observer had no effect on the validity of the data. In explaining more, the discussion of the audio-visual device is after this section.

3.5.3. The audio-visual device

To capture the conversations, the audio-visual device was been used. This instrument also filled the gap left by the observation schedule. The researcher found time to listen to the conversations again from the device and wrote down the information as to answer the research questions.

3.5.4. Document analysis

On the other-hand, document analysis was used to establish Grade 12 learners' performance in given tests and examinations on Algebra. Document analysis was a qualitative research instrument that was used in interpreting the documents in order to give meaning to what was assessed, it included coding content into themes (Bowen, 2009). Though the document analysis was advantageously used in interpreting and analyzing the document in order to make sense of the data, the researcher acknowledged that it had a disadvantage. The document was not made with a research agenda so skills were needed for its use and it might not give all the information the researcher desired to obtain. According to Bowen (2009), some information may not be available for analysis and for the use of the research study. For the reasons that some documents, question papers for examinations and tests and examiners' reports were to be analyzed for the purpose of this research study, the document analysis was used in order to interpret the data. The procedures taken in generating the data are discussed below.

3.6. Pilot study

A pilot study is a small-scale study, which precedes the main research study in order to analyze its validity, it can be externally or internally independent, but the researcher uses a small sample of the population of interest having similar characteristics of the sample that is to be involved in the main study (Patton, 1990; Between, 2017).

The researcher carried out a pilot study in order to find out whether the research instruments used were credible and trustworthy and to provide appropriate information to the research questions. The questions were revised on the basis of the responses obtained from the pilot, study. The supervisors of the study checked the interview questions, the observation guide and the document analysis prior to their use in the research study. The pilot study was conducted in one secondary school with one Mathematics teacher in Zambezi Region, Bukalo Circuit. The circuit is next to the Katima Mulilo Circuit in Zambezi Region. Subsequently, the interview was conducted after the observations were done, and the observations were done while the teacher taught Algebra in class for the duration of 40 minutes. The school used in the pilot study was not included in the actual sample of the study, in order to avoid bias in the findings.

3.7. Data generation procedures

Data generation is an important aspect of a research study and the following steps were taken into consideration in generating data. Firstly, a letter of ethical clearance was obtained from the University Of Namibia Research Ethics Committee (UREC) (Appendix 9). Secondly, the researcher wrote a letter to the Permanent Secretary of Education (Appendix 4) and the Director of Education of Zambezi Region

(Appendix 3), to seek permission to carry out the research study in the region. Thirdly, after the Permanent Secretary of Education and the Regional Director of Zambezi Education Region granted the permission, the researcher wrote other letters to the principals of the three selected schools to ask for permission to carry out the study at their schools (Appendix 5). Fourthly, the researcher visited the three selected schools, and liaised with the school principals in order to make appointments with the potential participants and invite them to take part in the study. The purpose was for the researcher to establish good relationship with the participants. The participants were given the study's information letter (Appendix 1) in order to inform them of what was required of them and to assure them of the confidentiality, and that the identities of the schools and teachers were protected by the use of pseudonyms. Before participation in the study, participants were given a consent form (Appendix 6), to complete and sign, to obtain their written consents.

The data were generated from Grade 12 Mathematics teachers by using the interview schedule and the observation guide. Each interview lasted approximately 30 minutes and each lesson observation lasted for 40 minutes. The document analysis was done in the afternoon after the interview and the observation sessions.

3.8. Data analysis

Qualitative data on Mathematics teachers' strategies for addressing Grade 12 learners' challenges in Algebra were analyzed using semantic coding and themes. The data collected from the three interviews, document analysis and observation were first transcribed and then analyzed using discourse analysis. Additionally, the development of topological themes emerged. Furthermore, the researcher acknowledged that discourse analysis had advantages and disadvantages. One of the advantages of discourse analysis, which attracted the researcher was that, “it is qualitative and researchers use it to develop theoretical conclusions and models in the research study” (Hormuth, 2009). It also reveals the challenges and strategies, participants use to cope with the situation at hand (Hormuth, 2009). A discourse analysis was used in data analysis as a guide (Roger, et al., 2005). The researcher analyzed the data and then put it into categories of the teachers’ strategies used to curb problems in Algebra (Harding, 2013). The researcher observed teachers while they were teaching how to solve problems in Algebra, then identified all the teachers’ strategies as the habits of mind, that the Grade 12 teachers used to answer questions and recorded them on a pre-designed checklist (see Appendix 7). These teaching strategies were the habits of mind that were needed in learners to be able to solve problems in Algebra. Teachers in this study were observed to have the habits of mind of being creative, pattern sniffers, describers, guessers, and inventors. The observation was not limited to the above, but other teaching strategies like *choosing an operation, identifying key words, step procedures, work backward*s were observed. In addition, the non- verbal and verbal behaviour that learners demonstrated while teachers were teaching Algebra were noted.

The coding process was done with the researcher’s free reading of the data and used identification of units of meaning where he designed the data into the proper categories of the teaching strategies and also modified to have categories of learners’ challenges. Then the coded information was compared with the data analyzed. The coding resulted in different categories as mentioned. However, the data not categorized was recommended as new ideas for further research. From these categories, the principles of this study emerged.

3.9. Data verification and trustworthiness

The biggest question was that could the findings of this research study be trusted? In order to answer this question, data verification and trustworthiness is discussed as the answer to the given question. Generally, in qualitative research, data verification refers to the mechanisms used during the process of research to incrementally contribute, ensuring reliability and validity (Strauss & Corbin, 2014). Therefore, data is systematically checked, the focus is sustained, the suitability of the data, the theoretical work of analysis and clarifications are monitored and confirmed constantly (Bernard, 2015). Trustworthiness is defined as the way in which qualitative researchers make sure that credibility, transferability, dependability, and conformability are evident in the research study. It is through trustworthiness that confidence can be placed in the truthfulness of the research findings and provide rigor to the study. The aim of trustworthiness in a qualitative research study is to support the argument that the research study's findings are worth paying attention to (Lincoln & Guba, 2015). The following section discusses the aspects in detail

3.9.1 Truth-value

Truth-value refers to the fact that the data is rich and reflects participants' knowledge (Mayburgh & Poggenpoel, 2007). The researcher used credibility to provide truth-value of the research study. Furthermore, the researcher personally engaged himself in the field, involved with the participants in collecting the data, where the researcher used a reflective journal in order to avoid influencing the research process. Triangulation was also used and some masters students were also involved the research study. Triangulation is the use of different types of instruments and methods in order to obtain corroborating evidence (Myburgh &

Poggenpoel, 2007). After data was analyzed, the researcher went back to the participants just to go do member checking in ensuring whether the results reflected the information obtained from the participants. Truth-value is an idea associated with credibility, transferability, dependability and confirmability.

3.9.2. Credibility

The first aspect of truth-value and the criterion for trustworthiness is credibility. Therefore, the researcher used credibility to validate the research findings. The researcher made sure that the findings represented plausible information collected originally from the participants and that the findings were the correct interpretation of the original views of the participants. Credibility is defined as the establishment of the research findings that represent plausible information drawn from the participants' original data and are a correct interpretation of the participants' original views (Vicent, 2014; Moser & Korstjens, 2018).

3.9.3 Transferability

The second aspect of truth-value is transferability. Transferability is the degree to which the results of qualitative research can be transferred to other contexts with the other respondents, it is the interpretive equivalent of generalizability (Moser & Korstjens, 2018). The researcher facilitates the transferability judgement by a potential user through thick description. The study also used transferability as a technique, strategy for credibility and trustworthiness of a study findings. During the study, the researcher provided a detailed description of the enquiry and participants were selected conveniently. Similarly, the researcher provided a thick description of all the research process, from data collection, context of the study and the production of the final report (Sikukumwa, 2017). Vincent (2014) discusses that thick description helps other researchers to replicate the study with similar conditions in other settings and facilitates the transferability of the inquiry.

3.9.4 Dependability

The third aspect of truth-value is dependability. Dependability is defined as the stability of findings over time, where the researcher evaluates the findings, interpretation and recommendations of the study so that all are supported by the data as received from the participants (Vincent, 2014; Moser & Korstjens, 2018). During the research process the researcher looked for support from professionals who provide scholarly guidance. The supervisors and the research committees at the University of Namibia supported the researcher in giving feedback on the findings of the study, hence, improved the quality of the research study.

3.9.5 Confirmability

The fourth aspect of truth-values is confirmability. The researcher used this criterion, confirmability in order to confirm that the findings were evident in the data collected. Furthermore, other researchers were used in this research to confirm the findings. Confirmability is defined as the degree to which, the findings of the study could be confirmed by other researchers, there were clearly from the data generated (Moser & Korstjens, 2018). The researcher used confirmability as a technique to validate the finding. Confirmability of qualitative study is been achieved through an audit trial, reflexive journal and triangulation (Bowen, 2009; Vicent, 2014). According to Bowen (2009), an "audit trail offers visible evidence from process and product that the researcher did not simply find what he or she set out to find" (p. 307). The researcher used triangulation technique to reduce bias from the findings. The researcher triangulated the data, findings by cross-examining the truthfulness of participants' responses from the three secondary schools. The researcher also used different sources of data, such as an interviews and participant observations, and document analysis, in order to enhance the quality of the data.

3.9.6 Peer examination

Peer examination is the credibility strategy where the researcher discusses the research process and findings with neutral colleagues (Vincent, 2014). Therefore, in this research, the researcher's colleagues, who are Master of Education students, were used in discussing this research process and its findings in two sessions; during the student seminar attended by Masters Students, at the University of Namibia and, also at a session for masters students gathered one afternoon to discuss about their research studies.

3.9.7 Applicability

Applicability is the researchers' responsibility of providing a thick description of the participants and the research process, to enable the reader to assess whether the findings are transferable to participants' own setting (Moser & Korstjens, 2018). According to Myburgh and Poggenpoel (2007), applicability is the ability to use the results of the research in similar contexts with similar participants. Hence, the researcher used the results of the study by providing clear descriptions of the demographics of the participants.

3.9.8 Consistency

The researcher used consistency in this research as a criterion for the trustworthiness of the data. Consistency involves checking whether the analysis process is in line with the accepted standards for a particular design, by following the research methodology of the original research to make same conclusions (Myburgh & Poggenpoel, 2007; Moser & Korstjens, 2018). In doing this, the researcher used a thick description in providing understanding to generate the hypotheses. The researcher made sure that a sufficient and all-embracive set of details concerning methodology and context is been provided in the research report. Thick description is the ethnographic method in which researchers write as they immerse themselves within the context of a certain culture, detailed references about social actions and behaviours of the participants (Clark & Chevrette, 2017).

3.9.9 Self -reflexivity

The researcher used self- reflexivity in the study, that is a process of self-reflection or self-check on how the researcher related to the research. Self- reflexivity is the process of critical self-reflection about oneself as a researcher and the research relationship (Moser & Korstjens, 2018). The researcher contemplates on how his background, values, beliefs and attitudes play a role in the research. Therefore, the researcher considered critique and critical reflection of biases. Hence, the researcher examined and consciously acknowledged the assumptions and the preconceptions that were been brought in this research study.

3.9.10 Neutrality

The sixth trustworthiness criterion is neutrality. The researcher used neutrality to free bias from the research by basing the interpretation of the research findings on the data itself, but not own viewpoints. Neutrality is ensuring the inter-subjectivity of the data, where the interpretation of the findings, is not based on the researcher's particular preferences and viewpoints, but grounded in the data (Moser & Korstjens, 2018). According to Myburgh and Poggenpoel (2007), neutrality is the situation where the research is free from bias, confirmability was, therefore implemented in order to provide rigor.

3.10. Ethical considerations

Prior to the start of the study, the researcher prepared an informed consent form and participants were given the consent form (see Appendix 6) which they read and completed. In addition to that, they were also given the information letter (see Appendix 1) concerning the study to assure them about confidentiality, in which the researcher clearly indicated to the participants that the information collected would be kept confidential. In the same letter, the researcher specified how the participants were chosen. The purpose and nature of the study were also explained verbally and in writing, discussing with the participants the benefits of participating in the study. Furthermore, the participants' identities were protected by using pseudonyms (Allen & Wiles, 2016) throughout the research study instead of using their real names. This was to ensure anonymity. The researcher further informed the participants that their participation was voluntary and that they were free to withdraw from the study, should they not wish to continue taking part at any stage. Thereafter, the researcher stored the raw data in a safe that was accessible to the researcher alone. The data would be kept for a period of 5 years after the completion of the study. Furthermore, the researcher would destroy all the raw data and the soft copies of the collected data will be deleted from all devices used. Lastly, the information gathered was for the purpose of the thesis and other publications without exposing the schools and the Mathematics teachers who participated in the research study.

3.11. Conclusion

The foregoing chapter presented the research design, population, sample with the sampling procedures, research instruments, pilot study outline, data collection procedures, data analysis, data verification and lastly the ethical considerations. The next chapter presents and discusses the findings of the research study.

CHAPTER 4

DATA PRESENTATIONS, ANALYSIS AND INTERPRETATION

4.1. Introduction

This chapter presents, analyses, and interprets the data that the researcher generated through interviews, observations and document analysis in order to address and answer the research questions of the study. The research study investigated mathematics teachers' strategies for addressing Grade 12 learners' challenges in Algebra in Katima Mulilo Circuit, Zambezi Region of Namibia. The study used a qualitative approach in order to provide complex textual descriptions of teachers' experiences in the above-mentioned research study. Qualitative research helps to interpret and aid a better understanding of the complex realities of a given situation and complex understanding of a specific social context.

Furthermore, the data that came out from the interviews, observations and the document analysis were been presented under five subheadings. The subheadings were: 1) Demographic information of the participants; 2) The teaching strategies used by teachers in teaching Algebra; 3) The challenges experienced by teachers in teaching Algebra to Grade 12 learners; 4) The teaching strategies used by teachers to make learners understand Algebra; 5) The effectiveness of the teaching strategies in teaching Algebra to Grade 12 learners. The results were been presented, analyzed and interpreted according to the research questions.

4.2. Demographic information of the participants

This section presents the demographic information of the participants to provide the reader with a better understanding of the study participants as shown in Table

4.1. The participants were teachers who were teaching Grade 12 Mathematics in Katima Mulilo Circuit in Zambezi Region. Three Mathematics teachers participated in this research study. The researcher used convenience-sampling technique in order to sample out the Mathematics teachers at the three secondary schools.

Table 4.1: Demographic information of the participants

School	Participant	Age	Gender	Professional Qualifications	Marital status
1	A	37	M	Diploma In Education	Married
2	B	28	F	BEd, BSc	Single
3	C	34	M	BETD, ACE	Married

4.2.1 Age

The participants were aged from 26 years to 37 years. The two male participates are in their 30s and started teaching in their 20s. One female participant is in her 20s and started teaching five years ago. From the ages of the participants, there has a clear indication that they had the required experience in teaching and no one had started teaching at the age below 23 years.

4.2.2 Gender

Two participants were male and one female. The two males had more experience in teaching Mathematics at Grade 12 than the one female who was only five years in the profession.

4.2.3. Professional qualifications

All the three participants, the mathematics secondary school teachers at the three sampled schools indicated that they had teaching qualifications. That meant that these participants went through secondary and tertiary education successfully. Equally important, the information showed that these teachers were professionally qualified to teach the grades they were teaching at the sampled schools of the

Katima Mulilo Circuit in Zambezi Region. These teaching qualifications ranged from the Advanced Certificate of Education to a degree in education specializing in Mathematics and Science Education.

4.2.4 Marital status

Two of the participants were married and one was single. The two were married males and one unmarried female. The young lady was engaged to get married. The participants were all mature and responsible, as they had shown during observations and interviews.

4.3 The Algebra test results and April examination on Algebra questions

Table 4.2, 4.3, 4.4., and Figure 4.1, 4.2., and 4.3 below show the results of Algebra tests written by Grade 12 learners at schools 1, 2, 3 and the results of April examinations from a document analysis of questions on Algebra. The Mathematics teachers taught using the teaching strategies that were at their disposal and learners got results as given in the tables and presented in figures (Figure 4.1, 4.2 and 4.3). The information on learners was collected in order for the researcher to have a better understanding of how good or poor these learners were, in using the strategies they were taught at solving algebraic problems.

Table 4.2: Algebra test and April exam results for school 1

Learner	April exam marks [out of 9]	%	Algebra test marks [out of 39]	%	Sex
A1	2	22	11	28	M
B1	0	0	13	33	M
C1	6	67	0	0	M
D1	5	56	30	77	M
E1	4	44	21	54	M
F1	2	22	6	15	F
G1	3	33	9	23	F

H1	2	22	15	38	F
I1	2	22	8	21	F
J1	7	78	14	36	F

The information displayed on Table 4.2. above is interpreted in the bar graph on the below.

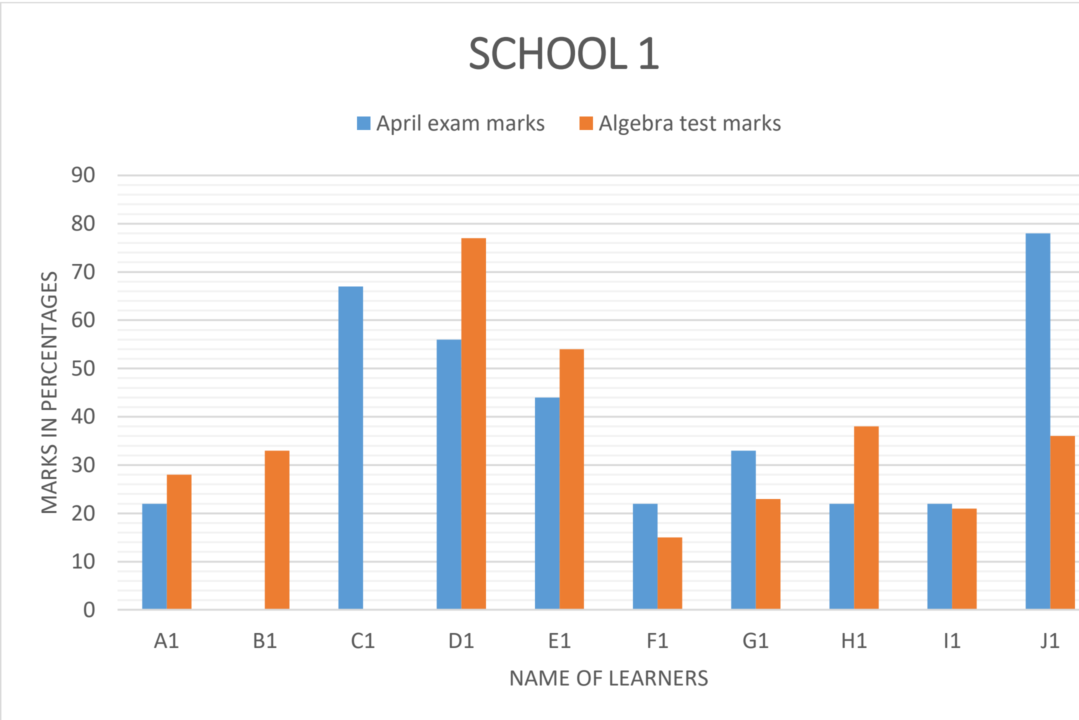


Figure 4.1: Algebra test and April examination results for school 1

Figure 4.1 and Table 4.2 shows the results for School 1. Firstly, the results show that 70% of the learners taught at this school got below 50% in April examination in 2019, on Algebra questions and only 30% got above average. The learners who performed above average were learners C1, D1 and J1 who got 67%, 56% and 78% respectively. The learners who performed better than others were two boys and one girl. Secondly, 80% of the learners got below average in the Algebra test and 20% got above average. These were learners D1 (77%) and learner E1 (54%) and these were all boys.

Table 4.3: Algebra test and April exam results for school 2

Learner	April exam marks [out of 17]	%	Algebra test marks [out of 25]	%	Sex
A2	9	53	5	20	M
B2	10	59	10	40	M
C2	11	64	13	52	M
D2	14	82	16	64	M
E2	9	53	12	48	M
F2	10	59	14	56	F
G2	9	53	9	36	F
H2	11	64	10	40	F
I2	12	71	11	44	F
J2	10	59	9	36	F

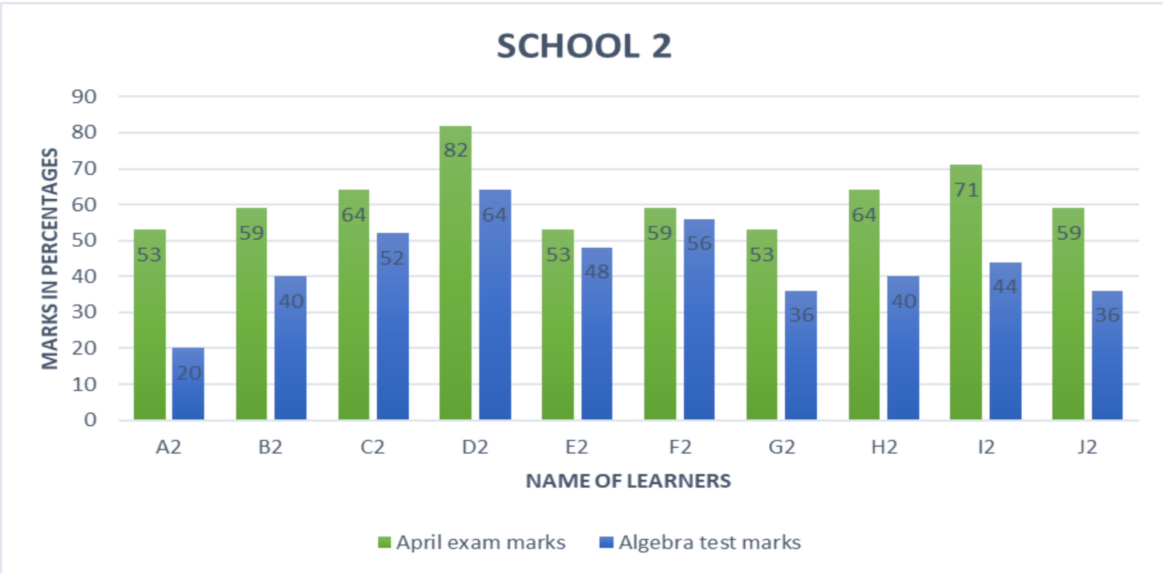


Figure 4.2: Algebra test and April exam results for School 2

Figure 4.2 and Table 4.3 above show the results for School 2. Firstly, the results show that all the sampled learners taught at this school got above 50 % in the April examination in 2019, on the Algebra questions that were out of 17. Whereas, 60% of these learners performed between 50% and 60% and were both boys (3) and girls (3), while 40% achieved between 60% and 83%, 2 boys and 2 girls. Secondly, 70% of the learners got below average in the algebra test and 30% got above average.

The learners who achieved better than others were learners C2 (52%), D2 (64%) and learner F2 (56%). These learners were two boys and one girl.

Table 4.4: Algebra test and April exam results for school 3

Learner	**April exam marks [out of 10]**	**%**	**Algebra test marks [out of 30]**	**%**	**Sex**
AA	5	50	0	0	M
AB	4	40	5	17	M
AC	1	10	17	57	M
AD	3	20	8	27	M
AE	4	40	14	47	M
AF	2	20	15	30	F
AG	5	50	13	43	F
AH	1	10	21	70	F
AI	3	30	10	33	F
AJ	4	40	9	30	F

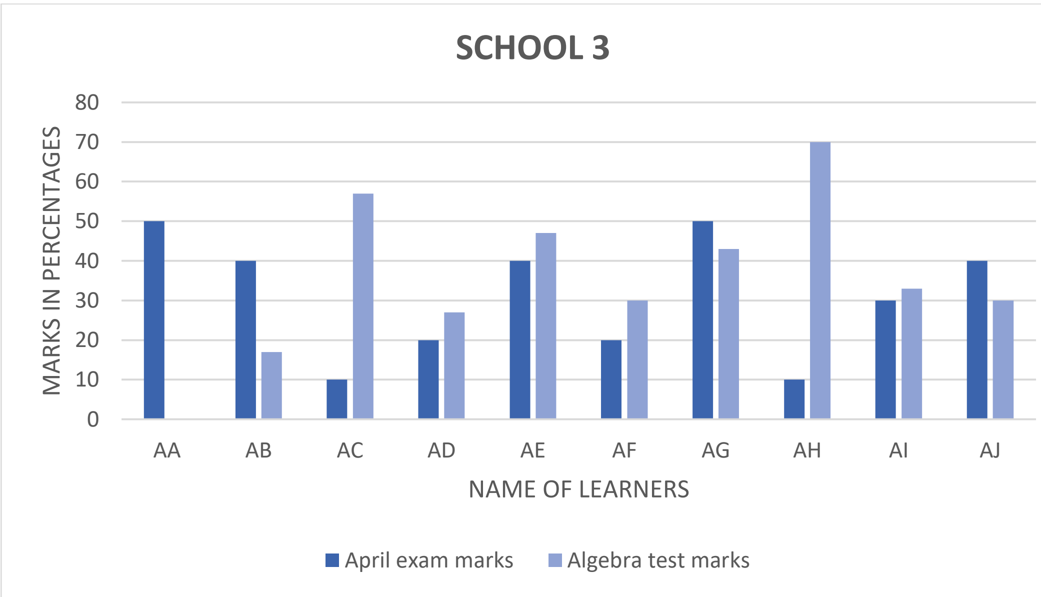


Figure 4.3: Algebra test and April exam results for School 3

Figure 4.3 and Table 4.4 above show the results for School 3. Firstly, the results show that 80% of the learners taught at this school got below 50 % in the April examination in 2019, on Algebra questions and 20% got above average. One girl and one boy achieved, on average. The learners who performed above average were learners AA (50%) and AG (50%). Secondly, 80% of the learners got below average in the algebra test and 20% got above average. These were learners' AC (57%) and learner AH (70%), one boy and one girl.

Conclusively, among the three schools, School 2 was the school that performed best in the April Mathematics examination. The results still show that fact. The document analysis on the April examination Algebra questions still shows that School 2 was the best when compared to schools 1 and 3 in the April examination. At School 2, all the learners achieved above average in April examination on Algebra questions when compared to other schools. However, School 3 achieved the poorest in the April examination Algebra questions (31%) and School 1 in the Algebra test (32, 5%). The average achievement of schools 1, 2 and 3 were as follows:

Table 4.5: Average (%) marks of April exam and Algebra test summary

SCHOOL	APRIL EXAMINATION ALGEBRA QUESTIONS	ALGEBRA TEST
1	36.6%	32,5%
2	61,7%	43,6%
3	31%	35,4%

When learners were solving the algebraic problems, the researcher observed that learners were unable to apply appropriate strategies to solve the problems. Many of the questions asked assessed the '*choose an operation'* teaching strategy.

However, the teaching strategy, choose an operation, mentioned by teacher A as a '*golden rule'*.

Figure 4.4- 4.8 presents the samples of the answer sheets given by some of the learners in school 1 of this study:

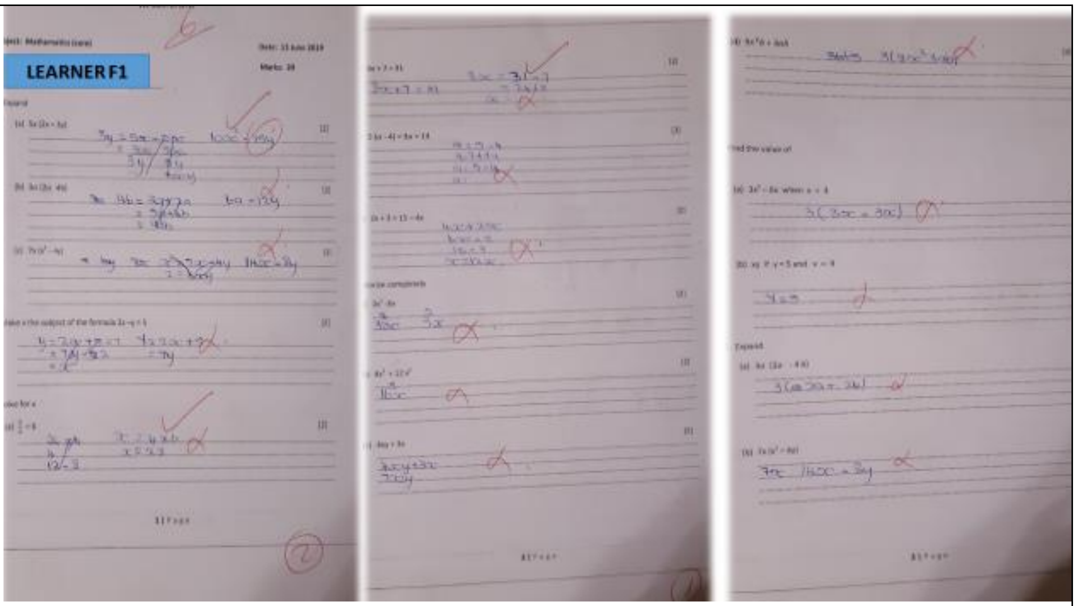


Figure 4.4: Learner F1's results in the Algebra test at School 1

Learner F1 in Figure 4.4 was the lowest achiever in this Algebra test written. The learner had difficulties with the appropriate use of the teaching strategies taught by Teacher A. The learner demonstrated poor habits of mind in Algebra by only getting an achievement of 6 out of 39, which is 15% in the Algebra test.

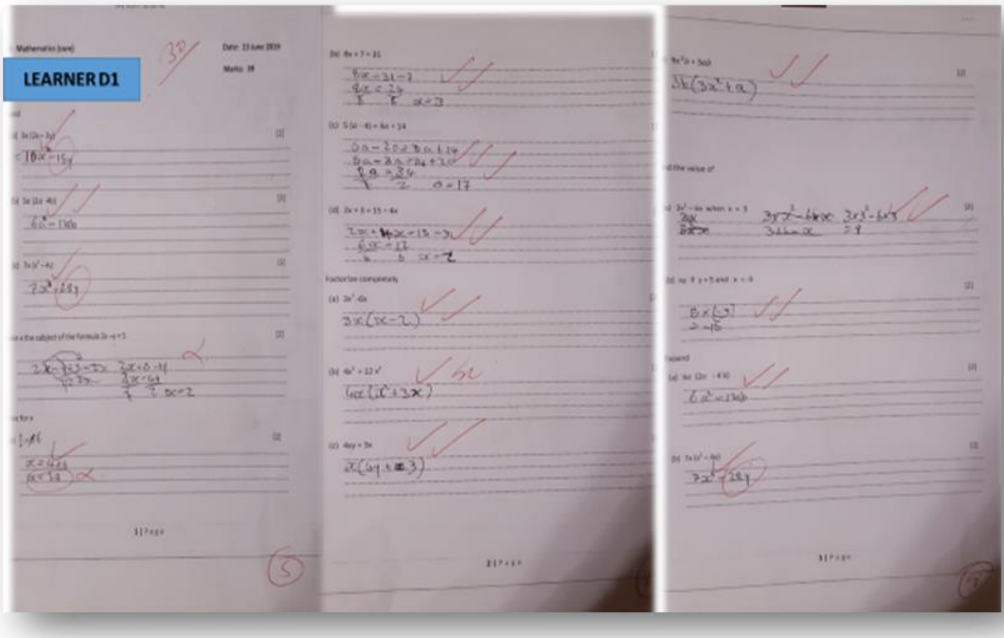


Figure 4.5: Learner D1's results Algebra test at School 1

Figure 4.5., shows Learner D1, the best achiever in this Algebra test written at School 1. The learner had minimum difficulties with learning under the teaching strategies taught by Teacher A. The learner demonstrated good habits of mind in Algebra, especially describing and visualization. Furthermore, the learner demonstrated his knowledge of the teaching strategies by getting 30 out of 39, which gives 77% achievement in the Algebra test.

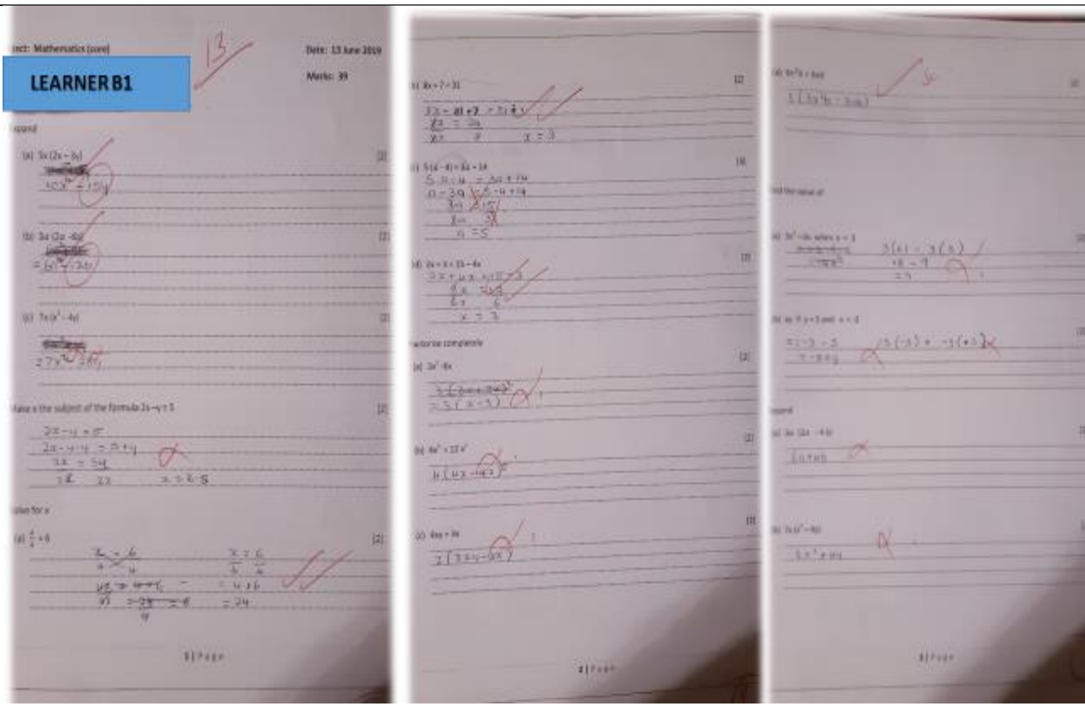
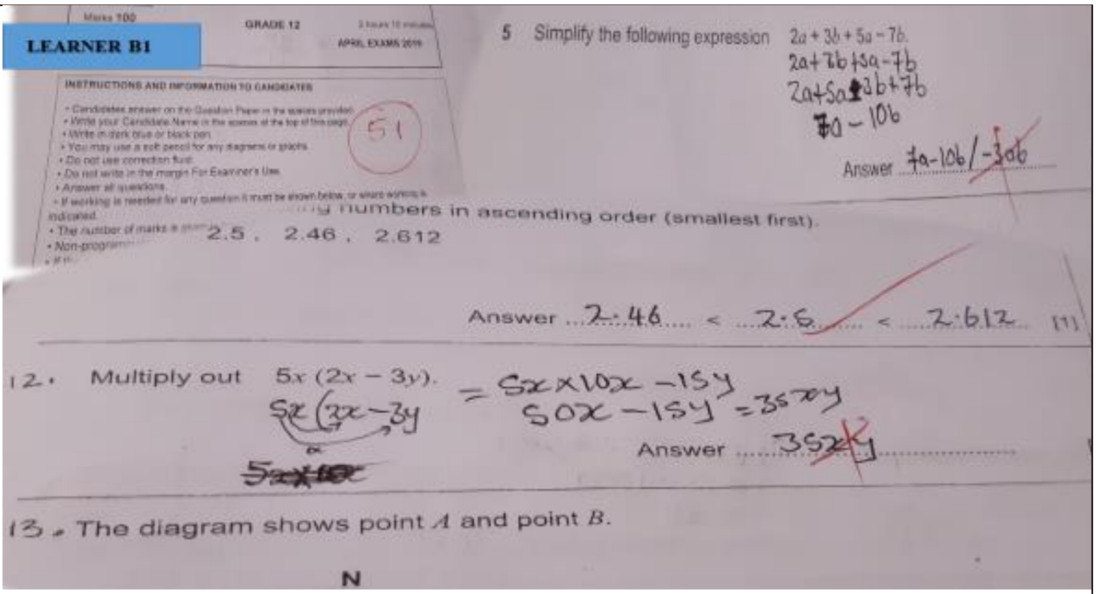


Figure 4.6: Learner B1's results of the algebra test at School 1

Learner B1 in Figure 4.6 was one of the underachievers in this Algebra test written. The learner had difficulties in the appropriate use of the teaching strategies taught by Teacher A in School 1. The learner demonstrated poor habits of mind in Algebra by only getting 13 out of 39, which was 33% achieved in the Algebra test.



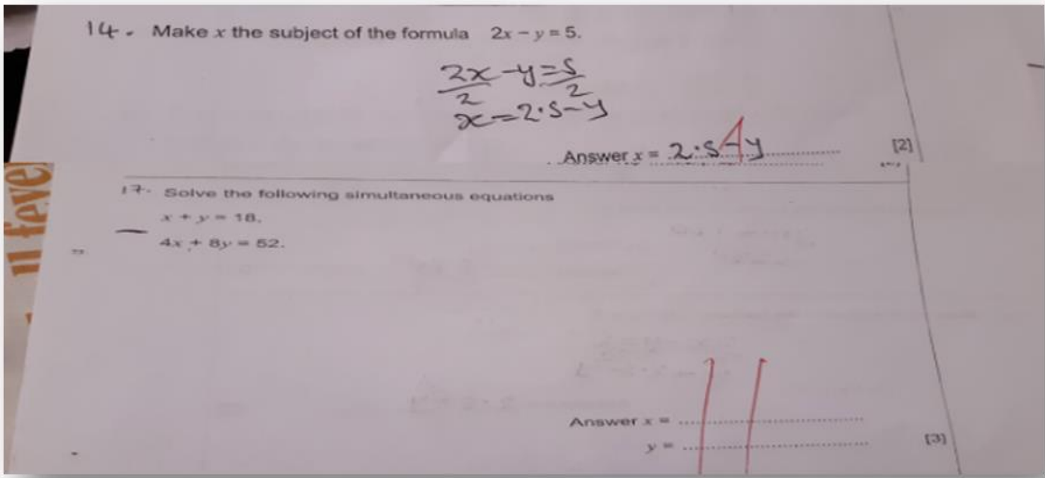


Figure 4.7: Learner B1's answers in the April examination Algebra questions at School 1

Learner B1 above was the poorest achiever in the April examinations on Algebra questions (question 5, 12, 14 and 17). The learner failed to answer any of the questions correctly (0%). Furthermore, Learner B1 did not have good habits of mind (describing, pattern sniffing, visualizing a problem) as suggested by (Cuoco et al., 1996). That learner did not master the good habits of mind that teachers facilitated in teaching Algebra. The other learner sampled, learner J1, was the best achiever as shown on the next page.

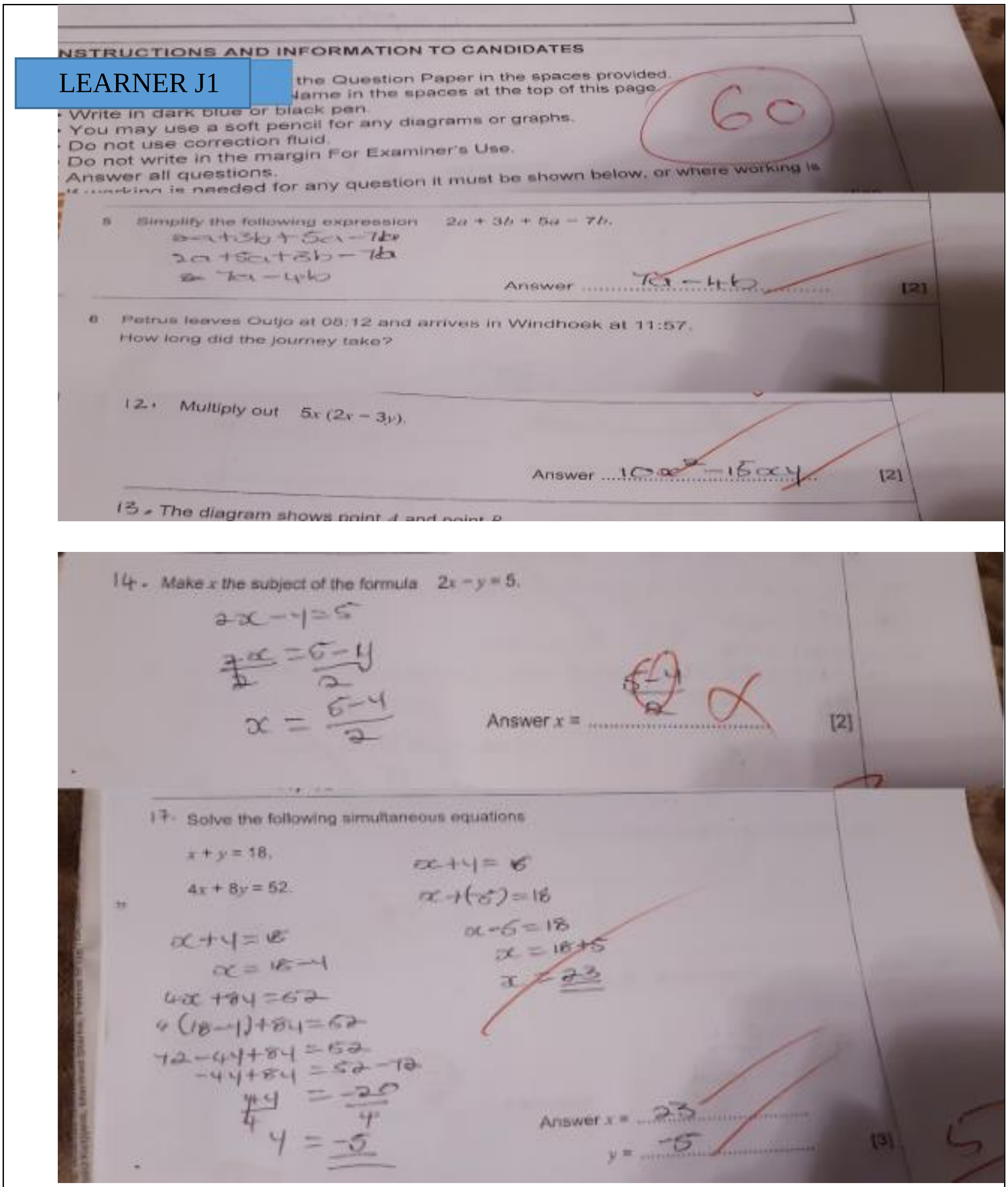


Figure 4.8: Learner J1's answers to April examination Algebra questions at School 1

Learner J1 was the best achiever in the April examination Algebra questions based at School 1. The questions were out of 9 and got 7 out of 9 which gave 78% in the Algebra questions. The learner used different strategies (*choose an operation, step-by-step procedure, describing, visualizing the problem*) to answer the questions.

Figure 4.9-4.12, presents samples of the test answer sheets for learners at Schools 2:

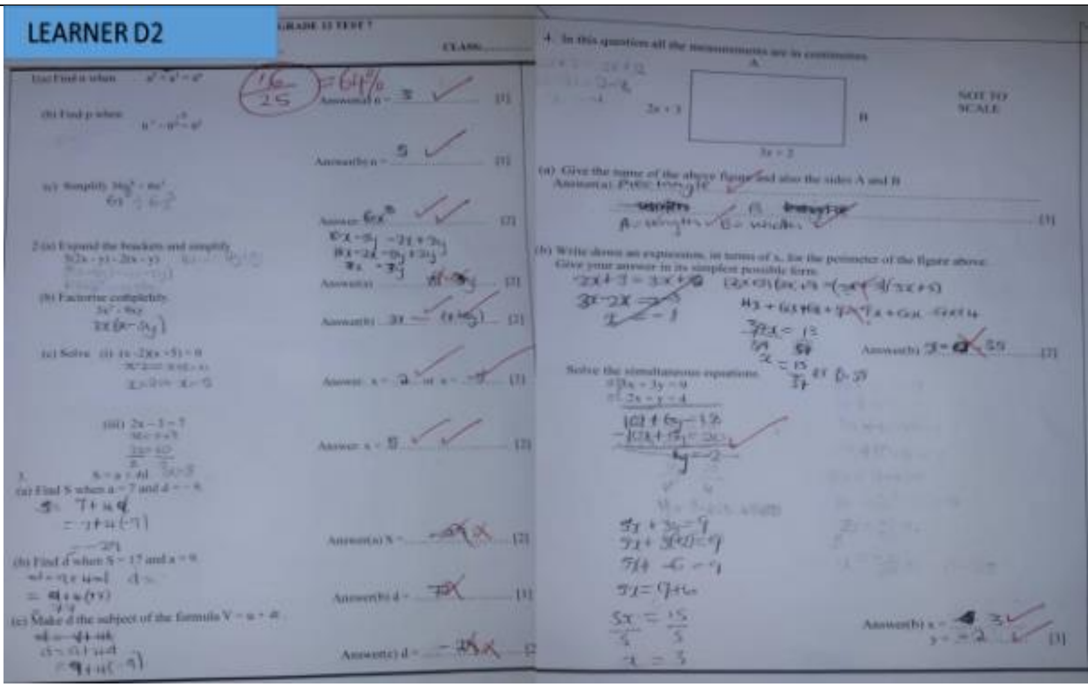


Figure 4.9: Learner D2's answer sheet of Algebra test at School 2

Learner D2 in Figure 4.9 was the best achiever at school 2 at the Algebra test by achieving 16 out of 25, which was 64%. The learner demonstrated reasonable habits of mind. The learner was able to *choose an operation, identify the key words,* do the *step-by-step procedure,* and *visualize the problems.* The learner had difficulty with questions 3 and 4 (b). In other words, the learner was able to apply most of the strategies in solving algebraic problems. Amongst the questions answered, word problems were a challenge to the learner hence he failed to apply the appropriate and suitable strategy in answering the questions. Learner D2 was supposed to decide on what operation to use in the word problem (addition, subtraction, division or multiplication). This is given in figure 13 question 4 (b), which is about finding the perimeter of the rectangle with width 2x + 3 and length 3x + 2. The operation which was supposed to be chosen was the addition because perimeter is the distance around the shape, so it is given by P = 2x + 3 + 3x + 2, P = 5x +5 written in terms of x.

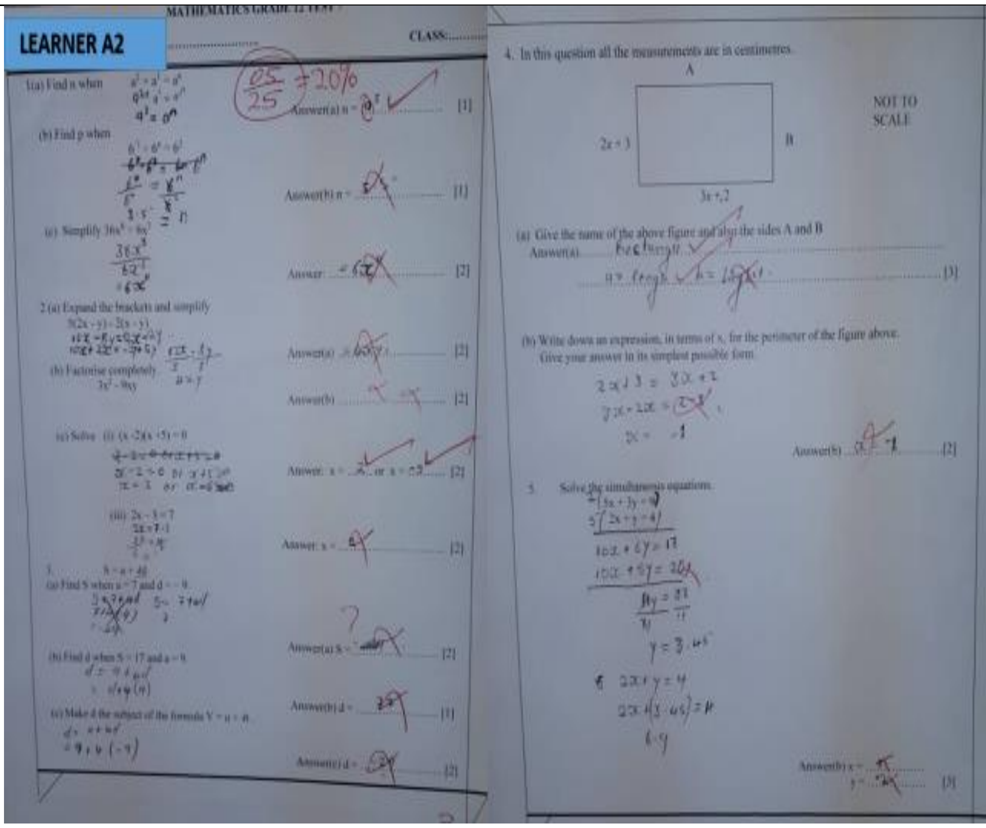


Figure 4.10: Learner A2 ‘s answer sheet of the Algebra test at School 2

Learner A2 in Figure 4.10 was the lowest achiever at School 2, by achieving 5 out of 25, which was 20% in the application of the strategies used to solve problems in Algebra teaching. The learner just answered questions 1 (a), 2 (c) and 4 (a) respectively. Therefore, the rest of the questions (80%) were a challenge. The questions answered correctly by the learner were where the teaching strategy ‘choose an operation’ was been applied.

Figure 4.11: on the next page presents Learner D2’s answers of the April examination Algebra questions from School 2:

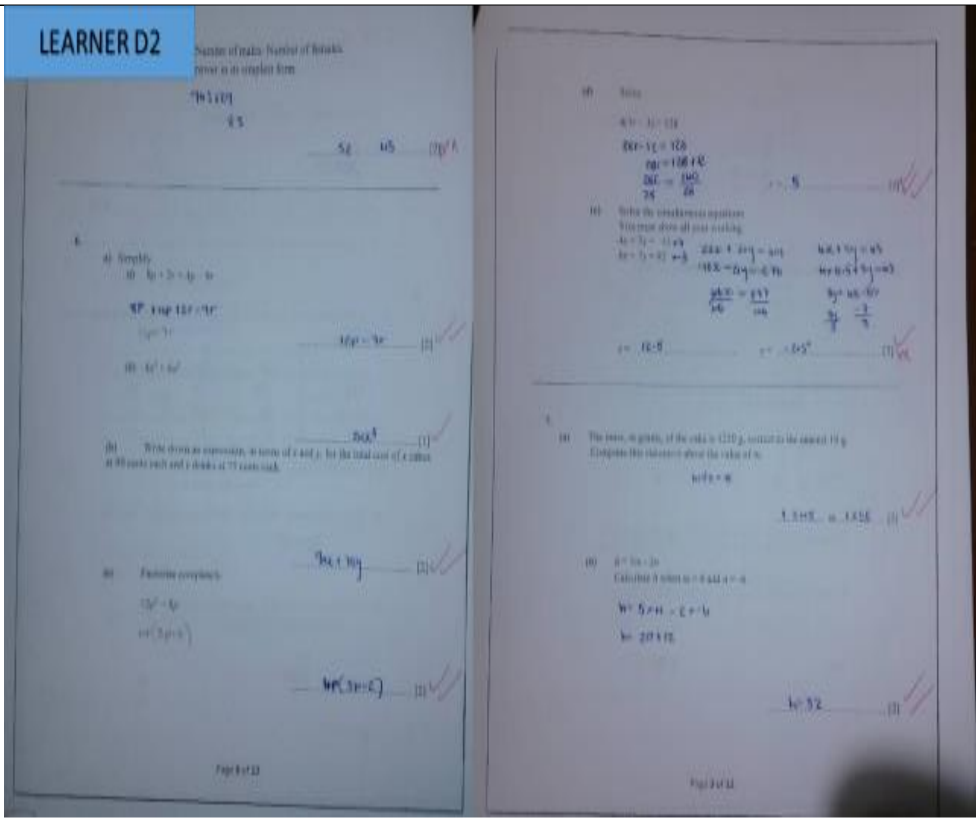


Figure 4.11: Learner D2's answers to April examination Algebra questions at School 2

Learner D2 in Figure 4.12 above was the best achiever in the April examination at large, and also the best according to the document analysis of April examination Algebra questions (questions 6 and 7) as well as the Algebra test, 16 out of 25 , which is 64% recorded. The learner achieved, 14 out of 17, which is 82% on the Algebra questions. This means that the learner optimally applied the strategies for solving problems in Algebra. The learner mostly used Choose an operation strategy in solving algebraic problems in the April examination.

Figure 4.12., on the next page presents Learner F2's answer sheet of the April examination Algebra questions from school 2:

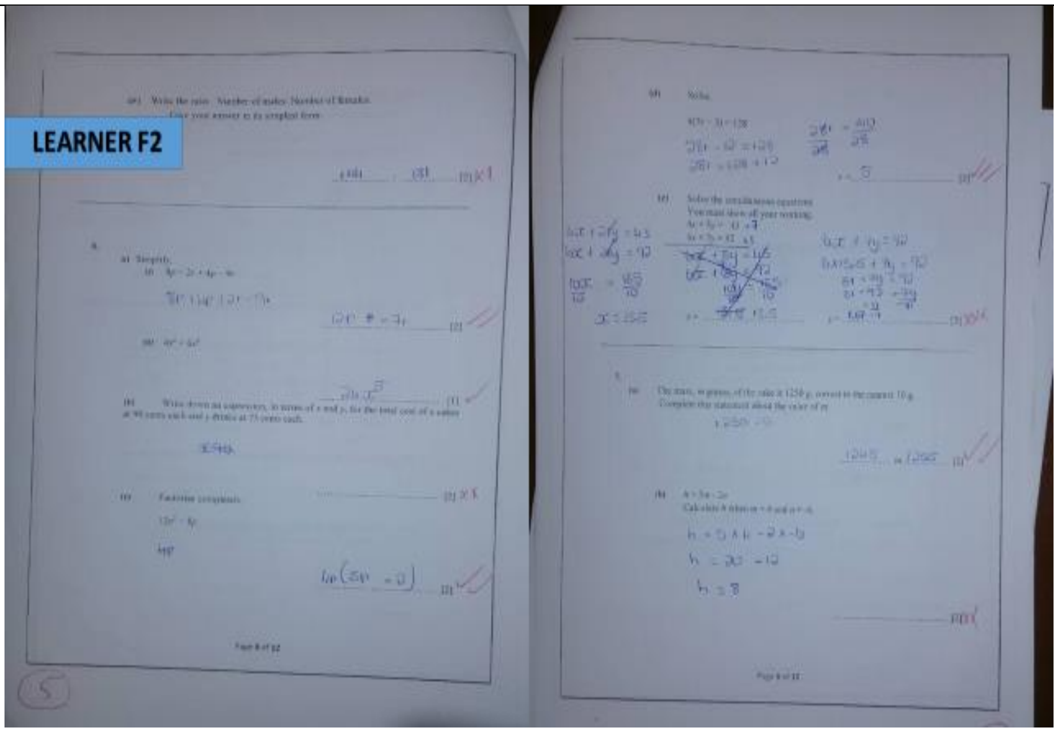


Figure 4.12: Learner F2's answer sheet of the April examination Algebra questions at School 2

Learner F2 in Figure 4.12 achieved on average of 10 out of 17, which is 59 % in the Algebra questions of the April examination paper for 2019. Most of the learners achieved below average in the examination. The learner was able to *choose an operation* and do *step-by-step procedure* on the questions answered.

Figure 4.13 –4.16 present, the samples of the answer sheets given by some of the learners at Schools 3 of the study, in the next pages:

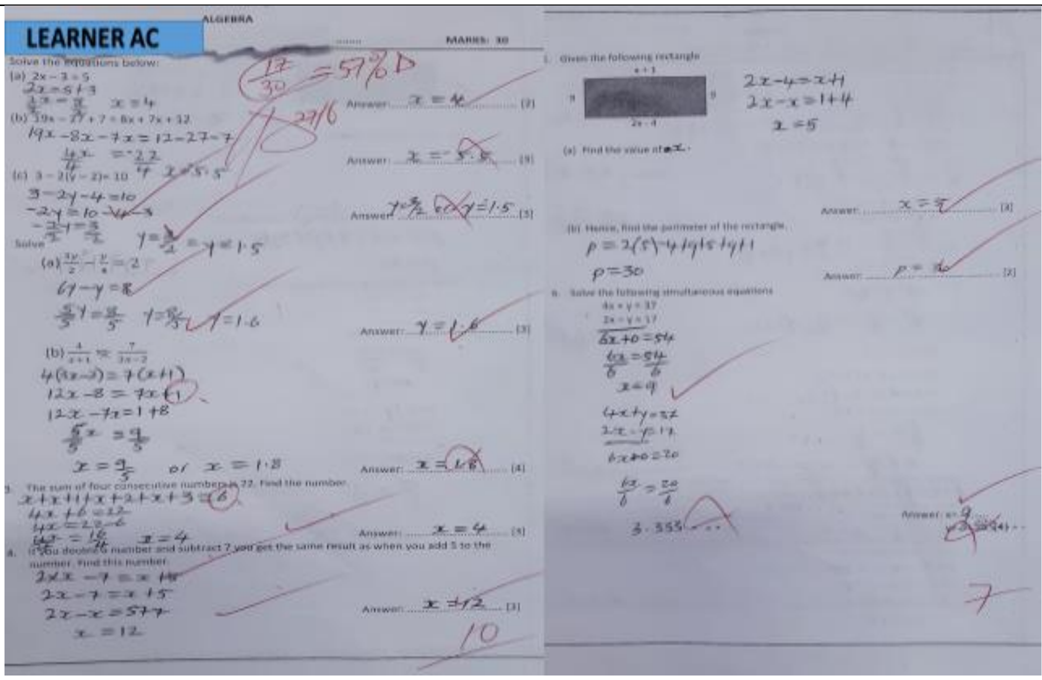


Figure 4.13: Learner AC's answer sheet in the Algebra test at School 3

Learner AC as shown in Figure 4.13 above was the best achiever (57%) in the Algebra test at School 3. At least the learner showed the minimal use of the strategies taught by the teacher. The learner was able to use strategies like *choose an operation* in most of the questions. For example, in question 3, which said, "the sum of the four consecutive numbers is 22. Find the numbers". In solving the word problem, the learner was supposed to choose the addition sign because of the word '*sum*'. Then, underlining key words in the word problems (e.g. sum/four/consecutive), *visualizing the problem* (making a mental picture of the consecutive four numbers, step-by-step procedure and describing in order to solve problems in Algebra in question 3, 4, 5 and 6 respectively. The result of learner AC is presented in comparison with the result for learner AA who could not answer any of the questions correctly (0%). The result of learner AA is given below in Figure 4.14.

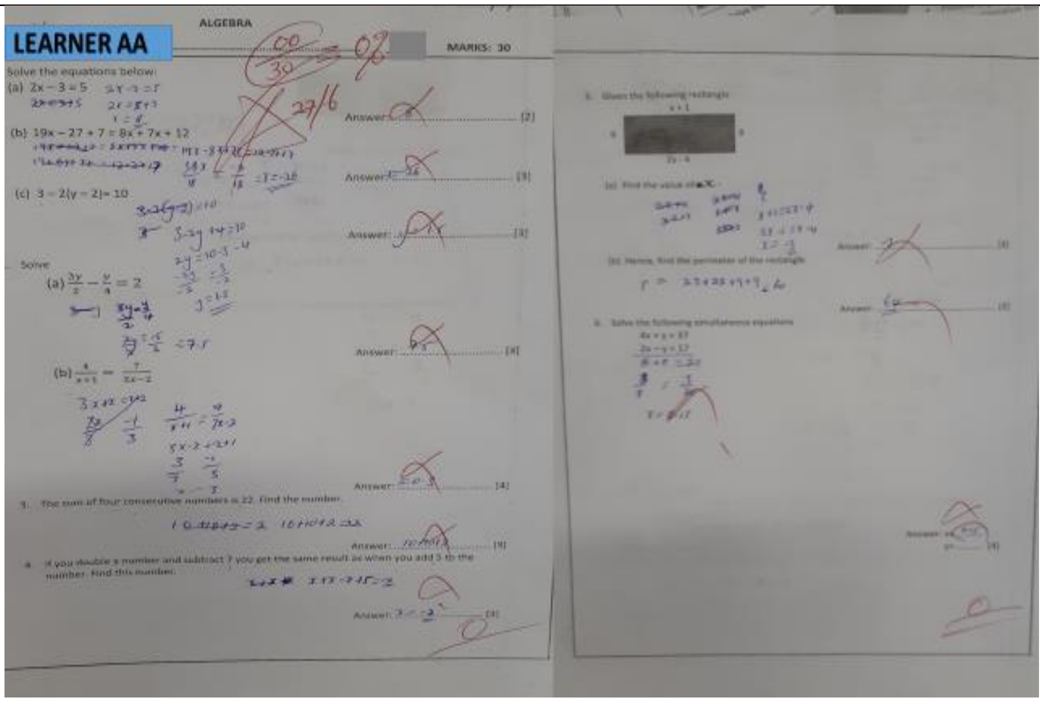
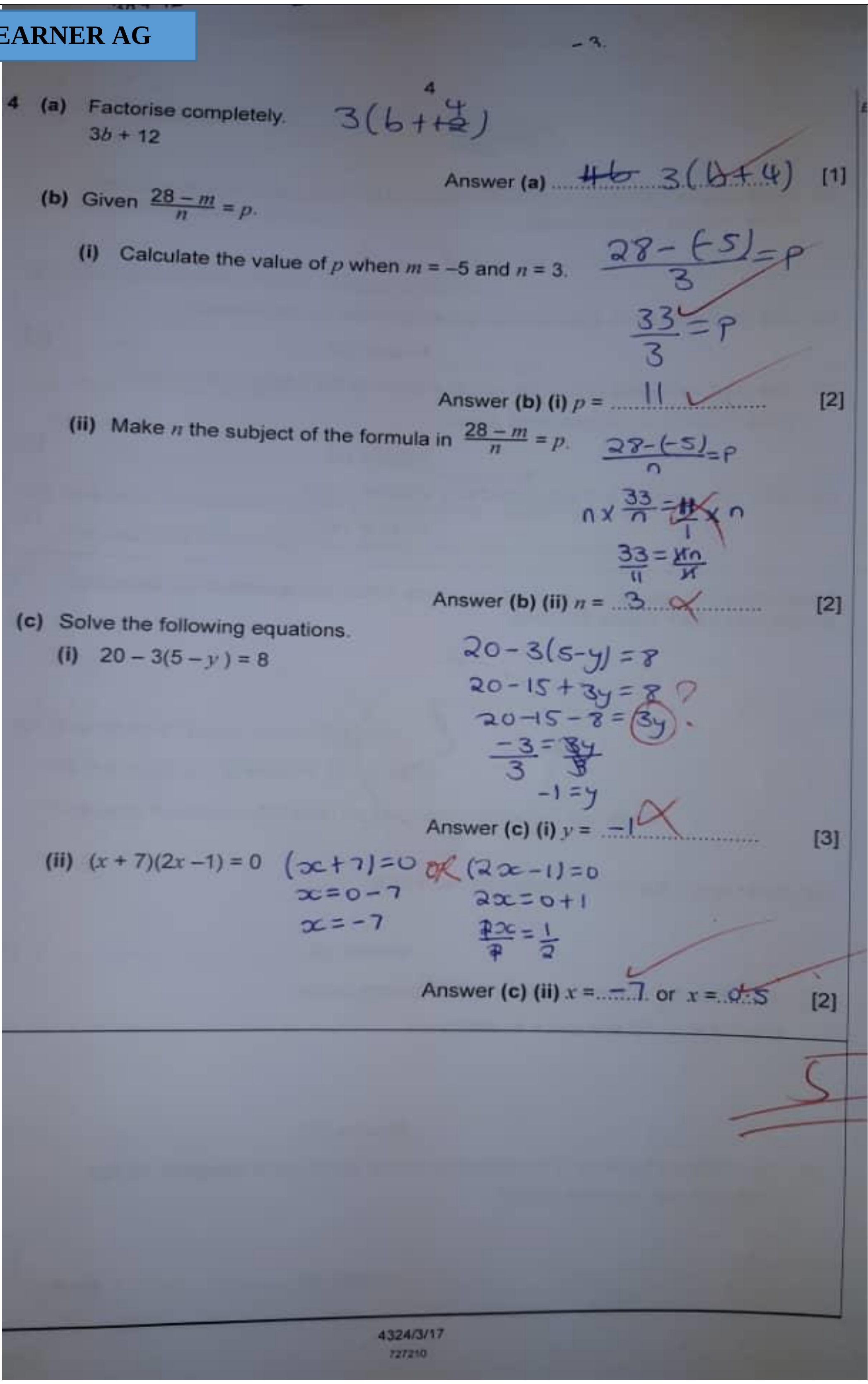


Figure 4.14: Learner AA's answer sheet in the Algebra test written from school 3

Learner AA as shown in Figure 4.14 above was the lowest performer in the April examination in School 3 and he did not manage to answer even one question on Algebra, so he got a result of zero. The researcher observed that, amongst the teaching strategies used in solving algebraic problems, *choose operation* was been mostly used. If the learner could had mastered this strategy, he could not have zero result. For example, in question 1, the problem given is to solve 2x – 3 = 5. The learner could have used *choose operation*, where the teacher mentioned that: 'the number changes the sign when it crosses over the equal sign. For example, when -3 crosses it becomes + 3, so 3 adds to 5 to give 8 on the right, 2x = 8. x= 4. The question follows some steps the *step-by-step procedure* is used, then *guess and check* can be applied for the value of x.

LEARNER AG



4 (a) Factorise completely.

$3b + 12$

$3(b + \cancel{12}^{4})$

Answer (a) ~~4b~~ $3(b+4)$ [1]

(b) Given $\frac{28 - m}{n} = p$.

(i) Calculate the value of p when $m = -5$ and $n = 3$.

$\frac{28-(-5)}{3} = p$

$\frac{33}{3} = p$

Answer (b) (i) $p =$ 11 [2]

(ii) Make n the subject of the formula in $\frac{28 - m}{n} = p$.

$\frac{28-(-5)}{n} = p$

$n \times \frac{33}{n} = \frac{11}{1} \times n$

$\frac{33}{11} = \frac{11n}{11}$

Answer (b) (ii) $n =$ 3 [2]

(c) Solve the following equations.

(i) $20 - 3(5 - y) = 8$

$20 - 3(5 - y) = 8$

$20 - 15 + 3y = 8$?

$20 - 15 - 8 = 3y$

$\frac{-3}{3} = \frac{3y}{3}$

$-1 = y$

Answer (c) (i) $y =$ -1 [3]

(ii) $(x + 7)(2x - 1) = 0$

$(x+7) = 0$ or $(2x-1) = 0$

$x = 0 - 7$ $\quad$ $2x = 0 + 1$

$x = -7$ $\quad$ $\frac{2x}{2} = \frac{1}{2}$

Answer (c) (ii) $x =$ -7 or $x =$ 0.5 [2]

5

4324/3/17

727210

Figure 4.15: Learner AG's answer sheet of the April examination Algebra question at School 3

Learner AG as shown in Figure 4.15 answered question 4 on average, getting 5 marks out of the total of 10 (50%). There were just two learners, who managed to get the average on the April examination at School 3. The rest of the learners got below average. Learner AG was able to apply some strategies used to solve algebraic problems *like choose an operation, step procedure, pattern sniffing due to formulae and visualizing the problem*. *Visualizing the problem* has to do with changing the algebraic problem to be in words or story form. Therefore, concrete materials were used to make the problem easier. That examination had only one question, that was question 4(a) – (c). The appropriate application of the strategies aided performance in solving algebraic problems.

LEARNER AH

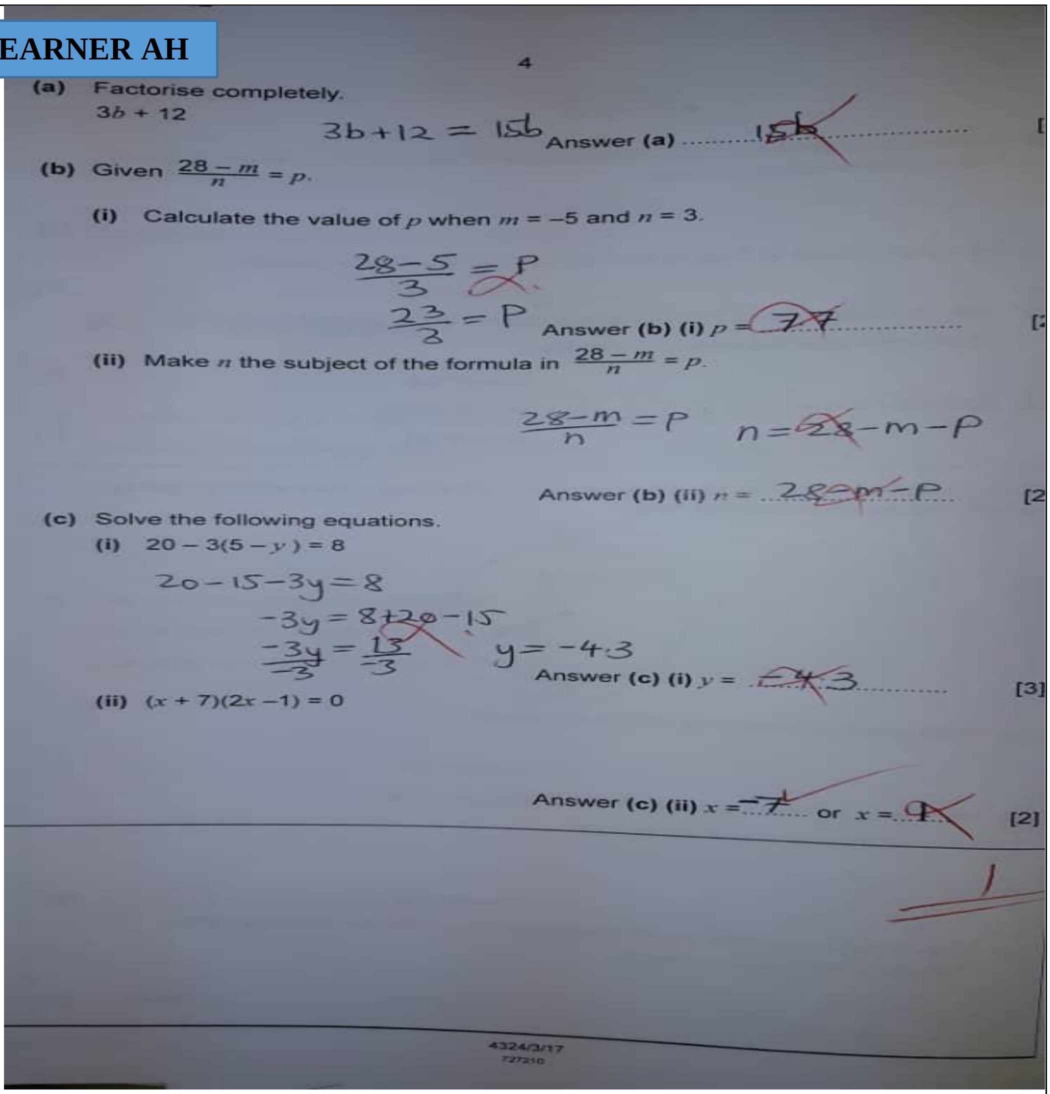


Figure 4.16: Learner AH's answer sheet for April examinations Algebra questions at School 3

Learner AH in Figure 4.16 answered the questions poorly (achieved 10%). The only thing the learner could do was to *choose operation* as they were taught to change the sign of a number as it crossed the equal sign. As was given in the question paper, (x + 7) (2x – 1) = 0, *step by step procedure, choose operation* is applied here. Therefore, the result was to be as follows,

$(x + 7)(2x - 1) = 0,$

$x + 7 = 0$ or $2x - 1 = 0$

$x = -7$ or $2x = 1$

$x = 0.5.$

In Figure 4.16, Learner AH only gave the answer x = - 7 correctly and missed the other part x = 0.5. The learner had a challenge in applying *choose an operation strategy.*

Figure 4.17 below presents the learner applying the strategies in solving the simultaneous equations:

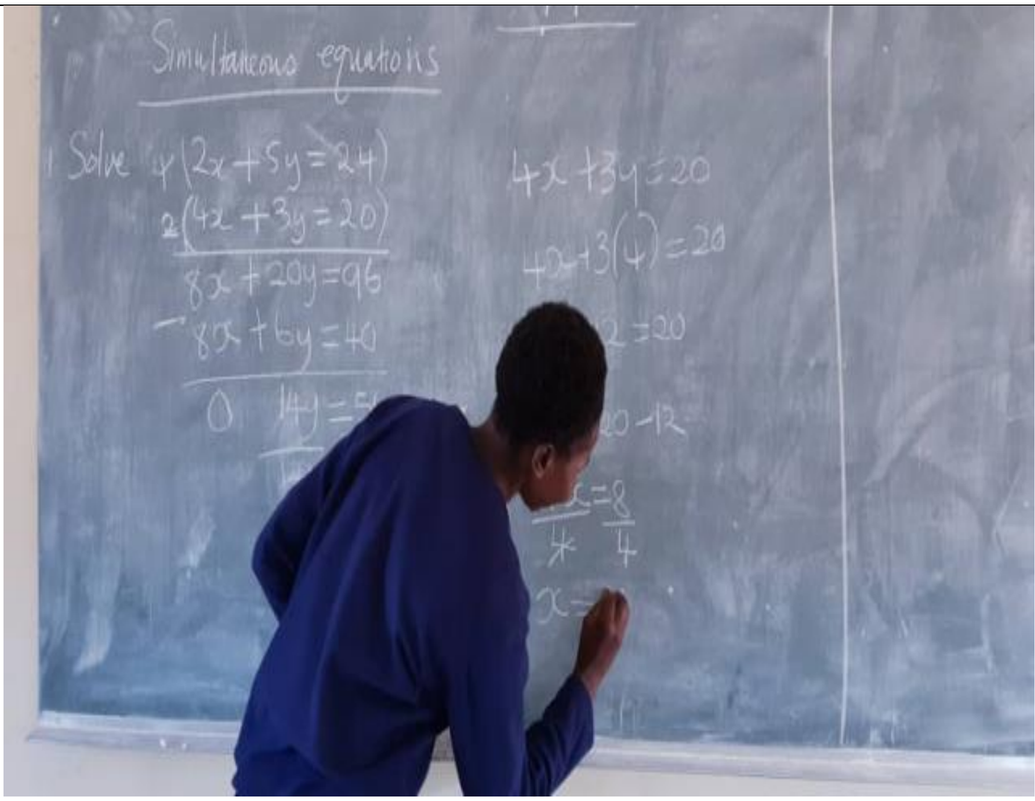


Figure 4.17: A learner solving the algebraic simultaneous equations at School 1

The learner in Figure 4.17 used some strategies such as; *choose an operation, step procedure, guess & checking and visualization* in solving the equations. Solving simultaneous equations was one of the algebraic concepts, which was a problem at the three sampled schools.

The strategies, which emerged from the study that teachers used, were; *choosing an operation, identifying key words, re-reading the words, visualizing problems, guessing and checking, step procedures, and looking for patterns.*

The April examination and the Algebra test written by the learners in all the sample schools varied from one school to the other. Thus, it could not be fair to make conclusions on the best overall learner amongst all the learners at all the three sample schools. The best learners were defined in the study according to the same paper written and these were written at each school. Many of the learners from the three sampled schools applied the strategies inappropriately in the April examination Algebra questions and Algebra tests. The strategies that were reflected in the document analysis of both the April examination Algebra questions and the Algebra tests were as follows: *choose-an-operation, identifying-key-words, step-by-step procedure (describing), and visualizing the problem.* The researcher observed the strategies in the answers of different learners.

4.4 The teaching strategies used by teachers in teaching Algebra

The study showed that the teachers at the three schools used some teaching strategies as reviewed in the literature of the research study. Teachers facilitated the teaching strategies involving the good habits of mind and this was been observed in classes taught by Grade 12 Mathematics teachers. During the analysis of the learners' solutions to the algebraic problems in their April examination, and the tests, the researcher identified the teaching strategies as outlined in the previous section. Furthermore, during the class observations, the researcher observed seven emerging categories or themes of teaching strategies used by teachers to teach Algebra, namely *identifying key words, choose an operation, re-reading the words, visualizing problems, guessing and checking, describing (step procedures) and looking for patterns. The table below shows the summary of the teaching strategies used by teachers (Teachers A, B and C) in the three sample schools (School 1, 2 and 3).*

Table 4.6: Categories of strategies used by teachers from sample schools

		Questions	Strategies used by teachers
SCHOOL 1	TEACHER A	1.Simplify $3a(2a - 3) - a(2 - 5a)$ $= 6a^2 - 9a - 2a + 5a^2$ $= 11a^2 - 11a$	choose an operation, step procedure
		2.Solve for a $1 + 2a = 13$ $2a = 13 - 1$ $2a = 12$, $a = 6$	choose an operation, step procedure, guess and checking
		3.Add 3 to a number. If the result of multiplying this total by 7 is 63. Find the number. Let the number be x.$7(x + 3) = 63$ $7x + 21 = 63$ $7x = 63 - 21$ $7x \div 7 = 42 \div 7$, $x = 6$	Identifying key words, choose an operation, step procedure, visualize the problem
		4.Solve $2x + 3y = 0$ $2x + 3(0.5) = 0$ $-$ $\underline{2x - 5y = -4}$ $2x + 1.5 = 0$ $0 + 8y = 4$ $2x \div 2 = -1.5 \div 2$ $y = 0.5$ $x = -0.75$	choose an operation, step procedure
SCHOOL 2	TEACHER B	1.Simplify $5y = 4y + 17$ $5y - 4y = 17$ $y = 17$	choose an operation, step procedure
		2.Solve for x $2x - 7 = x + 5$ $2x - x = 5 + 7$ $x = 12$	choose an operation, step procedure, visualizing the problem, guess and checking
		3. If I multiply a number by 4 and then add 5, the answer is 8. Find the number. Let the number be x Then, $4x + 5 = 8$ $4x = 8 - 5$ $4x \div 4 = 3 \div 4$ $x = 3/4$	Identifying key words, choose an operation, step procedure, visualize the problem
		4.Solve $(x - 3)(x - 1) = 0$ $x - 3 = 0$ or $x - 1 = 0$ $x = 3$ or $x = 1$	choose an operation, step procedure
SCHOOL 3	TEACHER C	1.Solve $(2x + 5y = 24)\,4$ $4x + 3y = 20$ $-$ $\underline{(4x + 3y = 20)\,2}$ $4x + 3(4) = 20$ $8x + 20y = 96$ $4x + 12 = 20$ $\underline{8x + 6y = 40}$ $4x = 20 - 12$ $0 + 14y = 56$ $4x \div 4 = 8 \div 4$ $y = 4$ $x = 2$	choose an operation, step procedure, guess and checking
		2.A rugby book costs N$x and a football book costs N$y. (a)Find an expression in terms of x and y, for the total cost of 5 rugby books and 7 football books (b)The total cost of 5 rugby books and 7 football books is N$107. Write down the equation , in terms of x and y. (c)The total cost of 3 rugby books and 14 football books is N$172. Write down the equation, in terms of x and y. (d)Solve the simultaneous equation from part (b) and part(c) to find the cost of one rugby book and one football book. Solution: (a)$5x + 7y$ (b)$5x + 7y = 107$ (c)$3x + 14y = 172$ (d) $-2(5x + 7y = 107)$…. $-10x - 14y = -214$ $3x + 14y = 172$ …….. $\underline{3x + 14y = 172}$ $-7x = -42$ $x = 6$ $5x + 7y = 107$ $5(6) + 7y = 107$ $7y = 107 - 30$ $7y = 77$ $y = 11$ One rugby book=N$6:00 One football book=N$11:00	identifying key words, choose an operation, visualizing the problem, guessing and checking, looking for patterns in the problem, step procedure
		3.Solve $2x(x - 7) = 0$ $2x = 0$ or $x - 7 = 0$ $x = 0$ or $x = 7$	choose an operation, step procedure

		4.Make x the subject of the formula in $y = x + 3$ $y - 3 = x$ $x = y - 3$	choose an operation, re-reading the words, identifying the key words

Table 4.6 shows that the mathematics teachers (Teachers A, B and C) from the three sampled schools used *choose an operation*, and *step-by-step procedure* more than other strategies. The teachers taught learners to identify key words before setting up the equations in word problems. At times, those teachers taught learners to use strategies of re-reading the words first and visualizing the questions and putting the questions in story form before they attempted to solve the problem. For example, the algebraic equation, $x + 3 = 5$ given in Table 4.6., where visualization was applied. Teacher A taught learners to visualize the equation and change it in story form and say, '*what is the number that you can add to 3 for you to get 5?*'

In summary, the strategies in Table 4.6 are in seven categories; *choose an operation, identifying key words, step procedure (describing), visualizing the problem, pattern sniffing, re-reading the words, and lastly is guessing and checking*. These themes emerged from the study as categories of teaching strategies in the study. The researcher observed that the strategies were been used silently in teaching Algebra, and teachers had knowledge of some of the strategies in calculations but not in concept. That meant, teachers used the strategies without actually naming the teaching strategies. The strategies, which came out as the teachers taught Algebra in class were as follows: *identifying key words, re-reading the question*, and to a lesser extent *visualizing the problem*.

During the interviews, the researcher asked participants to share their opinion on strategies that learners could use to get answers to algebraic problems. The strategies could hardly come out until when examples of the problem were been given for them to model how a learner could solve the problem. When that was been done, themes such as follows: *"step procedure, identifying key words, visualizing the problem, guessing and checking, and choosing the operation (change the sign as the number crosses the equal sign)"* emerged during the discussions.

When teachers solved the algebraic problems during the class observation by the researcher, it was observed that learners were challenged in applying the strategies taught by their teachers appropriately, to solve the problems. However, that was because many of the

strategies were silent, so learners remained without the knowledge of the strategies by concept. Hence, learners could not mention the strategies by their names. From the researcher's observation and interviews, it was also clear that, the lack of relevant vocabulary had a negative effect on learners' understanding and the ability to solve algebraic problems as discussed by Sikukumwa (2017). Therefore, that related to the lack of habit of the mind to describe. Many of the learners at the three-sampled schools had problems in dealing with simultaneous equations whether in word problems or just in words.

4.5. The challenges experienced by teachers in teaching Algebra to Grade 12 learners

In this study, the findings revealed that Algebra was difficult to the Grade 12 learners, especially in Katima Mulilo Circuit, Zambezi Region. Many of the Grade 12 learners from the three sampled schools scored low marks in both the Algebra test and the April 2019 examination Algebra questions.

The document analysis of the results from the algebraic problems in all the figures shown before revealed that solving algebraic problems is difficult for Grade 12 learners. That was confirmed, also evidenced by teachers at Schools 1 and 3 who said the following:

"It is challenging, the performance is really bad, and learners normally complain about Algebra."(Teacher A)

"Algebra is challenging to learners because they perform poorly in tests and activities, only a handful pass tests."(Teacher C).

The analysis done on the results for Algebra test and the April examination showed that the Grade 12 learners were been challenged when it came to Algebra in relation to other topics. The performance of learners showed that Algebra was hard and it needed the facilitation of the good habits of mind to better the situation. Furthermore, it was observed that, when the teaching strategies were used appropriately, Algebra questions could be solved correctly.

The other challenge, according to the study was the learners' attitude towards Algebra was negative. The researcher observed that Grade 12 learners in Katima Mulilo Circuit, Zambezi Region did not like the topic Algebra. All the three teachers who were interviewed and observed, agreed with the issue of negative attitude:

"The learners do not like the topic, because they believe it has nothing to do with life."(Teacher C)

The learners do not like Algebra; they always make mistakes and claim it is complicated."(Teacher A).

Learners do not like Algebra because of the letters and symbols they don't understand."(Teacher B).

Furthermore, the researcher observed that the Grade 12 learners were been challenged by the appropriate use of the strategies, because sometimes the learners used the wrong strategy for a different question. Teacher A said:

"We don't normally mention the strategies as we teach Algebra, but just explain how the learners can solve the algebraic problems. These strategies are not given in the syllabus and textbooks, as the strategies, we must use to solve algebraic problems."

The Grade 12 learners lacked the background knowledge of Algebra, therefore, the issue of letters and symbols became a problem to them. The participants alluded to the issue of poor background knowledge of learners in Algebra. Teachers might have caused the poor background of learners at Algebra from the lower grades. These challenges were been reflected in the NSSCO final examination for Mathematics 2018, also. See Table 1.11., below:

Table 4.7: Document analysis of Grade 12 NSSCO examiner's report for 2018

YEAR	PAPER	QUESTION	REPORT COMMENT
2018	1	14	This question was very poorly answered. Candidates could not differentiate between the algebraic expression and an equation. Algebraic expressions cannot be written with equal sign. Some few candidates use other variables other than x, which was provided. $30x$
		16	Factorization seems to be a problem to many candidates. Majority of the candidates failed to determine the highest common factor. Most candidates factorized the given expression partially. $3ab(3a + 1)$
		21	This question was poorly answered as majority of candidates prove not to know what to do. Some candidates wrote $3x$ instead of 3. Part **(b)** was very poorly answered as candidates

			failed to rearrange the terms. Subject of the formula need to be emphasized to the learners.
		24(c)	(c)was very poorly answered as majority of the candidates failed to solve a quadratic equation graphically. Majority of the candidates were solving the equation using wrong methods although the instruction is saying use the graph to solve.
	3		This question on algebra was fairly to moderately answered. Most candidates spoilt their answer for **5(b)**, $7x^3 - 28xy$ to $-21x^3y$. This showed that some candidates did not know that the answer comprised of 2 unlike terms. **(a)** Moderately answered. **(b)** Fairly answered. Most candidates struggled to expand the brackets correctly and those who managed went further to spoil their answer. **(c)** Moderately answered. **(d)** Well answered.

Table 4.7., shows that Grade 12 learners generally have challenges with regard to the application of the strategies in solving algebraic problems. In the NSSCO Mathematics Grade 12 examination paper 1, questions 14, 16, 21 and 24 were on Algebra. The examiners' comment on the questions was that 'the questions were very poorly answered'. For instance, the Grade 12 learners could not differentiate between the algebraic expression and an equation and wrote the algebraic expressions with equal signs. Different variables were used instead of the one

given. Factorization of expressions and solving the equations were a challenge, according to the examiners' report, "*Majority of the candidates were solving the equation using wrong methods, although the instruction is saying use the graph to solve*." This was a clear case of inappropriate use of the strategies because the learners lacked the solving skills of Algebra, lack of good habits of mind.

In paper 3, question 5 was on Algebra. The examiners said, "*This question on Algebra was fairly to moderately answered, as outlined the examiners. Most candidates spoiled their answer for* ***5(b)***, $7x^3 - 28xy$ *to* $-21x^3y$. *This showed that some candidates did not know that the answer comprised of 2 unlike terms*" (MOE, 2018). The learners could not apply the strategies appropriately because they have a lacked of knowledge of the basics of Algebra as with like and unlike terms. The strategies, such as *choose an operation, visualization, step procedure and guessing-checking*, were to be used in answering the questions. When the strategy of 'choosing an operation' is fully mastered, Mathematics learners should be solve many problems in Algebra successfully, especially problems with symbolic notations.

In conclusion, during the data analysis process, the researcher identified categories that emerged from the three sampled schools. The themes/categories of challenges hindering the teaching and learning of Algebra were as follows: *background knowledge of Algebra by learners, negative attitude of learners towards Algebra, inappropriate use of the teaching strategies in solving algebraic problems, and lack of understanding of Algebra due to language barriers*. Amongst all the questions answered in the tests and exams analyzed, the word problems and the simultaneous equation were the most challenging. Many of the learners lacked the correct application of the strategies to solve the algebraic problems.

4.6. The teaching strategies used by teachers to make learners understand Algebra

The study showed that Mathematics teachers at the sampled schools used the teaching strategies for making learners understand Algebra inappropriately. These strategies should be integrated with the strategies for solving algebraic problems, as these were the good habits of mind needed to effectively learn Algebra. Mathematics teachers used some of the strategies, to teach Algebra. It was either, one teacher used strategy 1 (use solved problems to engage students in analyzing algebraic reasoning and strategies) minus the other two strategies. All the teachers used the first strategy, by using examples for the learners to use and solve given algebraic problems. Teacher C used strategy 1 (use solved problems to engage students in analyzing algebraic reasoning and strategies) and strategy 2 (learners to use the structure of algebraic representations), where learners were given examples for them to use and work out algebraic problems, but basing on the language of Algebra. The researcher acknowledged that the lack of strong relationships between learners' understanding of algebraic representations and the teaching strategies taught by teachers in the sampled schools were evident. However, the weak relationship to be addressed in teaching of Algebra should therefore be centered on the structure of problems (Seifi, et al. 2012), as emphasized in Strategy 2. The other two teachers (Teachers A and B) only based their teaching on Strategy 1. The study became a revelation to the teachers at the three sampled schools when the strategies were discussed during the interview. The researcher observed that, the teaching strategies for understanding Algebra were inseparable from the teaching strategies used to teach Algebra. Hence, the teaching strategies for understanding Algebra gave the correct application of the teaching strategies listed in this study. The third strategy (teach learners to intentionally choose from alternative algebraic strategies when solving problems) was minimally used.

Learners were been taught in groups, but given minimal time in order for them to choose alternative strategies in solving problems. The teachers used the third strategy minimally and that was observed during class observations with Teacher C at School 3.

4.7. The effectiveness of the teaching strategies in teaching Algebra to Grade 12 learners

In the study, the effectiveness of the teaching strategies used in teaching Algebra was discussed. The effectiveness of these strategies depended on the appropriate use of the teaching strategies to the Grade 12 learners learning Algebra. However, the ability to solve problems in Algebra depended on whether learners understood the vocabulary and the language in the problems for them to use the strategies appropriately. Amongst the Grade 12 learners who used to achieve well in Algebra, Teacher C said:

"The learners are self-motivated and like the subject. They always share their knowledge in group discussion which improves motivation, do peer teaching which improves understanding."

At the sampled schools, learners were been given examples to discuss and use to work out other algebraic problems. Learners of mixed abilities were grouped and the teachers coached the learners who were able to teach those who were struggling. The learner-centered approach (LCA) was optimally used, but the CRA was not observed in teaching Algebra at the three sampled schools. Cooperative learning was used as defined in integration with LCA, but without the use of teaching strategies with concrete materials. The use of teaching strategies with

CRA was observed in the study's literature as the effective ways of teaching Algebra successfully (Garforth, 2014).

In conclusion, the inappropriate use of the teaching strategies for solving problems in Algebra, the inappropriate use of strategies for understanding Algebra by the teachers and the none use of the CRA in the teaching of Algebra was observed at the three sampled schools (Schools 1, 2 and 3) and Teachers A, B and C.

4.8. Conclusion

This chapter presented the data, data analysis and interpretations of it. These has been done in the following subtopics: the demographic information about the participants, the teaching strategies used by teachers in teaching Algebra, the challenges experienced by teachers in teaching Algebra to Grade 12 learners, the teaching strategies used by teachers to make learners understand Algebra and the effectiveness of the teaching strategies in teaching Algebra to Grade 12 learners. The next chapter presents the discussion of the findings, conclusion and recommendations of the research study.

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

This chapter presents the discussion, conclusion and recommendation of the research study. The chapter is the last of the research study. It discusses the findings of the research study, gives a summary (conclusion) of the study and lastly, the recommendations for future research involving the strategies for teaching Algebra.

5.2. Discussions

5.2.1. Strategies used to teach Grade 12 learners Algebra

The findings in the study showed that teachers at the selected schools used some strategies in teaching Algebra to their Grade 12 learners. However, these strategies were used inappropriately (see table 4.5) in the previous chapter. Although it was possible to teach Algebra using the problem-solving strategies in Algebra classrooms so that the Grade 12 learners would learn about strategies without missing out the concepts and procedures for understanding the algebraic representations and concepts, both teachers and learners were observed to have limited knowledge of such strategies. At School 1, Learners A1, B1, E1, F1, G1, H1 and I1 performed below average in the April examination on Algebra questions and Learners A1, B1, C1, E1, F1, G1, H1, I1 and J1 performed below average on the Algebra test. The learners lacked the skills and the strategies for solving algebraic problems. Learner B1 (see Figure 11) got zero in the April examination on Algebra questions. He failed to apply any strategy to answer the questions in the study Algebra test. Learner J1 applied the strategies well in the April examination but poorly in the Algebra test. The test was written before the April examination, when the learner was corrected on the test in preparing for the examination. At School 2, learners applied the strategies well in the April examination Algebra questions compared to the Algebra questions. At School 3, learners applied the strategies at the same level as the learners at School 1. During the observation, interviews and the document analysis of the April examination papers and Algebra tests, the researcher identified teaching strategies used by Grade 12 learners to answer the questions in Algebra.

The learner in Figure 4.17 used some strategies such as; *choose an operation, step procedure, guess & checking and visualization* in solving the equations. Solving simultaneous equations was one of the algebraic concepts, which was a problem at the three sampled schools.

The researcher might have relatively expected the result of the study because the Grade 12 learners were not given enough time to use all the strategies in the activities given in class. The April examination answers and the Algebra test showed that the learners focused on various standard procedures. On average, learners who used the strategies such *as choose an operation, identifying key words, and visualizing problems* showed to have the understanding of critical aspects of the strategies, namely that the same strategy could be used in different contexts or in the same context but in tasks with different characters (Sikukumwa, 2017). However, many Grade 12 learners showed that they had a lack of knowledge of the strategies used to solve algebraic problems. That was been expected because the teachers at the sampled three schools were unable to identify and use all the teaching strategies since they experienced some challenges too.

5.2.2. Challenges faced by teachers in teaching Algebra

In the study, the researcher observed that teachers teaching Algebra at the three sampled schools in Katima Mulilo Circuit in Zambezi Region were faced with different challenges in teaching Algebra. Infact, algebraic word problems were observed to be more challenging than other symbolic algebraic problems in Algebra as noted by Sikukumwa (2017). In addition, Grade 12 learners were been challenged because of poor background knowledge of Algebra from the previous grades. The issue of Algebra only came in the primary phase, Grade 7 in 2017 for the first time in Namibia as claimed by teachers at the three schools. On the other hand, language was also a barrier, hence, learners could not relate Algebra to the real life, and were not good at describing as a good habit of mind in Algebra. Algebra has its own language so learners missed the language of Algebra. Therefore, understanding algebraic questions became a problem. The other challenge was the inappropriate use of the strategies by the learners and teachers, this made many of the Grade 12 learners to perform poorly in Algebra tests and the April examinations. For example, solving a question like, $2x - 3 = 5$, a learner was challenged if the strategy '*choose-an-operation*' was not mastered. However, with the word problems like "*The sum of three consecutive numbers is 22, find the number?*" Grade 12 learners used strategies like *'identify key words', 'choose an operation', 'visualize the problem' and 'guess-checking'* as well as '*step procedure'* (descriptor). Since the strategies were not well mastered, grade 12 learners poorly answered Algebra questions at the end of the year during the NSSCO examinations in 2018 (see Table 4.6). Many of the Grade 12 learners poorly answered Algebra questions in the April Examinations 2019 and the Algebra tests presented in Tables 1.1, 1.2, 1.3 and Figures 5, 6 and 7.

The study showed that 70% of the learners taught at School 1 got below average in the April Examination in 2019, on Algebra questions and only 30% got above average. On the other hand, 80% of them got below average in the Algebra test and 20% got above average. At School 2, all the ten sampled Grade 12 learners achieved above average in the April examination Algebra questions and 70% got below average on the Algebra test analyzed. At School 3, 80% of the Grade 12 learners achieved below average in the April examination on the Algebra questions and the same percentage in the Algebra test.

Most probably, the findings discussed above showed that the Grade 12 learners at the three sampled schools had some challenges. However, the categories of challenges that emerged in the study were been identified as *lack of background knowledge of Algebra by learners, negative attitude of learners towards Algebra, as perceived by teachers at the three schools, inappropriate use of the teaching strategies in solving algebraic problems, and lack of understanding of Algebra due to language barriers*. These were teachers' perceptions as shown in the interview schedule, and observed in class activities, Algebra tests, April examination answers for Grade 12 learners and confirmed in the interviews with the teachers. Therefore, the results in this paper demonstrated how ineffective teaching strategies influence and change the focus of learners' learning abilities to solve algebraic word problems.

5.2.3. Strategies used to make Grade12 learners understand Algebra

The study showed that Mathematics teachers used the teaching strategies to make learners understand Algebra inappropriately. These strategies were supposed to be used in integration with the strategies for solving algebraic problems, as these were the good habits of mind needed to deal with Algebra. The strategies that emerged from the study, which were used to teach Grade 12 learners at the three sampled schools were, namely:

Using examples to engage learners in analyzing algebraic reasoning and strategies (strategy 1), learners using the structure of algebraic representations (strategy 2), *and teaching learners to purposely choose from substitute algebraic strategies when solving problems (strategy 3).*

The teachers used some but not all of these strategies to teach Algebra. However, these strategies were not given in the Mathematics syllabuses or the textbooks, but they are methods used to teach Algebra in order for Grade 12 learners to understand how to deal with algebraic problem solving. As observed the teachers at the sampled schools, either, one teacher used Strategy 1 not the other two strategies. Infact, all the teachers used the first strategy. The teachers used the worked examples for the learners to apply and solve given algebraic problems. For example, worked examples as follows:

1. $x + 3 = 7$	2. $6x - 9 = 3$	3. $5y - 8=4y + 2$
$x = 7 - 3$	$6x = 3 + 9$	$5y - 4y =2+8$
$x = 4$	$6x = 12$,	$y =10$
	$x = 2$	

Below are some of the problems that Grade 12 learners were asked to solve:

Solve 1. $x – 4 = 12$ 3. $3x – 5 = 2x + 7$

2. $2x – 2= 8$ 4. $3x = 9$

Teacher C used Strategy 1 and Strategy 2, where learners were given examples to use and work out the above algebraic problems, but basing on the language of Algebra. The researcher acknowledged that the lack of strong relationships between learners' understanding of algebraic representations and the taught algebraic teaching strategies was evident. Therefore, for one to address the weak relationship, the teaching of Algebra should be centered on the structure of problems (Seifi, *et al*, 2012), as emphasized in Strategy 2. The other two teachers (Teachers A and B) only based teaching on Strategy 1. The study became an eye opener for the teachers at the three sampled schools when the strategies were discussed during the interview. The researcher observed that the teaching strategies for understanding Algebra were inseparable from the teaching strategies used to teach Algebra. The third strategy was minimally used. Learners were taught in groups, but given minimal time for them to choose alternative strategies in solving problems being in their groups. The teachers, as observed in Teacher C at School 3 minimally used Strategy 3. The effectiveness of the strategies is discussed in the following section.

5.2.4. The effectiveness of the teaching strategies used to teach Algebra

In this chapter, the effectiveness of the teaching strategies used to teach Algebra is discussed. The effectiveness of these strategies depended on the appropriate use of the teaching strategies to the Grade 12 learners learning Algebra. However, the ability to solve problems in Algebra depended on whether learners understood the vocabulary and the language in the problems for them to use the strategies appropriately. Teacher A said:

"*Learners do not know the concepts such as like and unlike terms, adding, subtracting, multiplying and dividing algebraic expressions*."

Amongst the Grade 12 learners who achieved well in Algebra, Teacher C said:

"The learners are self-motivated and like the subject. They always share their knowledge in group discussions which improves motivation, do peer teaching which improves understanding."

When using the strategies, the Grade 12 learners were given examples to discuss and to work out other algebraic problems. This relates to Vygotsky's Social constructivist theory, which says that learners are social beings and learn effectively from one another. Furthermore, Vygotsky states the concept of ZPD, which is defined as the time that the child may be able to solve a problem with the help of a teacher, and the time that the child can solve the same problem alone (Vygotsky, 1978). Many, learners were unable to solve the algebraic problems alone but needed the assistance of the teacher. As a result, teachers were seen helping learners who needed help. Thus, learners of mixed abilities were grouped and the teachers coached the learners who were better than others to teach those who were struggling. Teacher A supported the above strategy in:

"*The learners should use peer teaching for them to use the strategies in solving given algebraic problems*".

The teachers used the Learner-Centered Approach (LCA) optimally at the three sampled schools, while the CRA was not observed, in teaching Algebra at the three sampled schools in Katima Mulilo Circuit in Zambezi Region. Cooperative learning was used in conjunction the LCA. However, the teaching strategies where concrete materials were used, were not used. The use of teaching strategies with CRA was reported in the study's literature as the effective way of teaching Algebra successfully (Garforth, 2014).

In conclusion, the inappropriate use of the teaching strategies to solve algebraic problems, the inappropriate use of strategies for understanding Algebra by the teachers and the none use of the CRA in the teaching of Algebra was observed at the three sampled schools (Schools 1, 2 and 3) by Teachers A, B and C. The issues discussed led to the failure of Grade 12 learners in Algebra tests and examinations.

5.3. Conclusion

Conclusively, the researcher investigated Mathematics teachers' teaching strategies used to address the Grade 12 learners challenges in Algebra in Katima Mulilo Circuit in Zambezi Region, Namibia. The algebraic problem solving teaching and learning strategies were analyzed at the three sampled schools in Zambezi Region, Katima Mulilo Circuit.

Furthermore, the researcher studied different ways the teachers and learners, used as strategies to solve problems in Algebra. The strategies studied were observed to be the solutions for the challenges that were faced in algebraic problem solving.

The research study synthesized the teaching strategies of Algebra that Mathematics teachers used in Katima Mulilo Circuit in Zambezi Region. That was an overview perception of Grade 12 teachers' abilities in the Zambezi Region on how they taught Algebra using the strategies in order to address the Grade 12 learners' challenges in Algebra. During the study, teachers were observed in class while teaching Algebra, and were interviewed to ascertain the strategies they used to teach Algebra and the challenges they faced in teaching Algebra. The observation provided an opportunity for the researcher to identify and see the use of the teaching strategies in Algebra and come up with a list of strategies used to teach Algebra and strategies used to make learners understand Algebra. The aim was to get the strategies that the Mathematics teachers could use to improve the performance of learners in Algebra. Algebra was a core topic in relation to other topics, so the understanding of Algebra opened doors to the understanding of other topics like Geometry and other science subjects like Physics. The researcher was unable to collect all the needed data on the strategies from the interviews and the observations, so a document analysis of the Grade 12 April examination answer sheets and their Algebra test answer sheets was done in order to analyze the strategies that learners used to solve algebraic problems.

The findings of the study showed that teachers at the three sampled schools used some strategies in teaching algebra to their Grade 12 learners, although these strategies were used inappropriately. Therefore, it was observed that it was possible to teach Algebra using the problem-solving strategies in Algebra classrooms so that the Grade 12 learners could learn about strategies without missing out the concepts and procedures for understanding the algebraic representations and concepts. During the observations, interviews and the document analysis of the April examination papers and Algebra tests, the researcher identified strategies used by Grade 12 learners to answer the questions in Algebra, which were the teaching strategies taught by teachers in Algebra. The strategies which emerged from the study that were used were; *choose an operation, identifying key words, re-reading the words, visualizing problems, guessing and checking, step procedures, and looking for patterns.*

The researcher might have expected the result of the study, relatively because the Grade 12 learners were not given enough time to use all the strategies in the activities given in class. The April examination answers and the Algebra test showed that the learners focused on various standard procedures. Learners who used the strategies such as *choose an operation, identifying key words, and visualizing problems* showed an understanding of critical aspects of the strategies as discussed above, namely that the same strategy could be used in different contexts or in the same context but in tasks with different characters (Sikukumwa, 2017). However, many Grade 12 learners showed in the analysis that they had a lack of knowledge of the strategies used to solve algebraic problems. The was expected because the teachers in the sampled three schools were unable to identify and use all the teaching strategies too.

Furthermore, teachers teaching Algebra at the three sampled schools were faced with different challenges in teaching Algebra. The algebraic word problems were observed to be more challenging than other symbolic algebraic problems in

Algebra as also noted by Sikukumwa (2017). Secondly, Grade 12 learners were challenged because of the poor background knowledge of Algebra from the previous grades. On the other hand, language was also a barrier; hence learners could not relate Algebra to the real life or describe (Sikukumwa, 2017). Algebra has its own language so learners missed the language of Algebra. Therefore, understanding algebraic questions became a problem. The other challenge was the inappropriate use of the strategies by the learners and teachers that made most of the Grade 12 learners to perform poorly in Algebra tests and April examinations. The categories of challenges that emerged in the study were identified as *background knowledge of Algebra by learners, negative attitude of learners towards Algebra, inappropriate use of the teaching strategies in solving algebraic problems, and lack of understanding of Algebra due to language barriers*. These were observed in class activities done, Algebra tests, April examination answers for Grade 12 learners and confirmed in the interviews done with teachers. Therefore, the results in this paper demonstrated how ineffective teaching of strategies influence and change the focus of learners' learning abilities to solve algebraic word problems.

Finally, the study made some recommendations to the various stakeholders in the Ministry of Education. Mathematics teachers were recommended to give more algebraic problems to the Grade 12 learners to allow them to practise in order to help the learners to become more efficient in solving problems. The senior education officers were recommended to have workshops where they train teachers on teaching strategies of Algebra. On the other hand, further research was recommended to be done in all the phases of school (Primary, junior secondary, and senior secondary phases). These recommendations are discussed after this section.

5.4. Recommendations

In this study, the recommendations go to the following stakeholders who aid the teaching and learning of Mathematics in Grade 12 in Katima Mulilo Circuit, in order to enhance effective teaching strategies of Algebra:

5.4.1. Teachers

(a) Grade 12 Mathematics teachers

- Should expose learners to various strategies of teaching Algebra and apply the strategies used for learners to understand Algebra. The habits of mind as strategies should be facilitated in Mathematics Algebra lessons and be done step by step using worked examples. Learners should be allowed to identify the strategies to solve algebraic problems.
- Should give more algebraic problems to the learners to allow them to practise in order to help them become more efficient in solving such problems (Sikukumwa, 2017). Enough time should be given to Grade 12 learners for group discussions and peer teaching as this supports LCA in classrooms.
- Should motivate Grade 12 learners and invite other people to come motivate learners at the school concerning Mathematics especially Algebra which seems difficult. When learners are motivated, they will have a positive attitude towards Algebra and Mathematics at large.
- Should be careful in choosing the examples and class exercises that are to be used in the classroom situation, because unfamiliar contents and language barriers in the algebraic problems make learners to be unable to

recognize the problem and understand. Clear language and instruction should be considered.

- Should also design, teaching and learning aids from the local materials that their learners are familiar and that could aid effective strategies for solving problems in Algebra, in the Mathematics classrooms.
- Should also make use of various strategies, which this study revealed, which were not observed at all the three sampled schools. These strategies include, *Organizing Data, Solving a Simpler Analogous Problem, Working Backwards, Adopting a different point of view, Intelligent Guessing and Testing, Logical reasoning, and considering extreme cases* (Posamentier & Krulik, 1998).

(b) **Other teachers**

Teachers not teaching Mathematics should encourage Grade 12 learners to perform well in Mathematics since there are some teachers who normally discourage learners saying that learners cannot pass Mathematics because it is difficult. These teachers encourage learners to concentrate on other subjects except Mathematics, especially Algebra.

5.4.2 Senior education officers (SEO) of the Ministry of Education

- The senior education officers (SEO) for Mathematics Grade 12 of the Ministry of Education should support the Mathematics teachers by visiting the schools regularly and offer help.
- The SEO should provide and avail the teaching and learning materials to schools like graph-boards, Mathematics textbooks, and other materials relevant to Algebra. They should also organize workshops where teachers

discuss the strategies used to teach Algebra and how to motivate learners in order to reduce the negative attitude towards Algebra and Mathematics as a subject.

- Curriculum developers from the Ministry of Education should include the types of strategies used to teach the given specific competencies outlined in the syllabus. These should be indicated with some examples of algebraic problem solving. Teachers currently teaching the subjects should be involved in the development of the curriculum in order to learn more about the coverage of the topics and their levels. That should be done in order to fill the gaps, which the researcher observed in Algebra between the grades.

5.5 Further research

1. More research studies on the teaching strategies of Algebra should be done in order to aid the effective teaching and learning of Algebra. An intervention research study should be done, as this would help Mathematics teachers with the teaching strategies of learning Algebra, for the teachers to have more knowledge of the teaching strategies.
2. The research should be done in all the phases: Primary schools, junior secondary schools and senior secondary schools to investigate the cohesion in the contents of Algebra. When a research is done that the gaps that exist in the learning of Algebra would be identified. Once the gaps are identified, the researcher believes that can harmonize the development of the strategies of algebraic problem solving through the teaching and learning of Mathematics in the country. The research study should be carried out in all the other education, regions not only Zambezi Region.

5.6 Conclusion

This chapter presented the summary of the chapters in the study, followed by a summary of the main findings emanating from the study. It also presented recommendations and areas for further research.

A qualitative –descriptive approach was used to answer the research questions of the study, thereby attaining the research objectives of the study. The findings of the study gave insight into the Mathematics teachers' strategies for addressing Grade12 learners' challenges in Algebra in Katima Mulilo in Zambezi Region of Namibia. This chapter of the study provided a summary and the conclusions of the preceding chapters, from the introduction, theoretical framework, literature review, methodology and the presentation of the research findings.

A number of recommendations are been made to the teachers and the supervisors who can train teachers in applying these teaching strategies. The recommendations made in the study were based on the results of the study. Lastly, the researcher made suggestions for future research.

6. REFERENCES

Alhmali, R. J. (2007). Student attitudes in the context of the Curriculum in Libyan Education in Middle and High Schools, PhD thesis, University of Glasgow, Glasgow.

Allen, R. E., & Wiles, J. L. (2016). A rose by any other name: Participants choosing research pseudonyms. *Qualitative Research in Psychology, 13*(2), 149 – 165.

Allwright, D. & Hanks, J. (2009). T*he development language learner: An introduction to exploratory practice* (1st. ed.). Hampshire: Palgrave Macmillan.

Alvi, M. H. (2016). *A manual for selecting sampling techniques in research*. Pakistan, Karachi: University of Karachi.

Armstrong, S. (2013). *The 10 most important teaching strategies*. Retrieved from https://www.innovatemyschool.com

Baker, C. R. (2013). *New research says the push to have students take algebra by 8th grade has hurt, not help, students*. Retrieved from https://www.deseretnews.com

Banerjee, A., & Chaudhury, S. (2010). Statistics without tears: populations and samples. *Industrial Psychiatry Journal*, 19(1), 60 – 65.

Bernard, H. R. (2015). *Analyzing Qualitative Data: Systematic Approaches, Thousand Oak.* California: Sage.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9* (2), 27 – 40.

Brown, C. M., McNeil, N.M., & Glenberg, A.M. (2009). Using concreteness in education: Real problems, potential solutions. *Child Development Perspectives, 3*(3), 160 - 164

Burns, N. & Grove, S.K. (2007). *Understanding nursing research* (4th ed). Philadelphia: Saunders Company.

Cankoy, O., & Darbaz, S. (2010). Effect of a problem posing based problem solving instruction on understanding problem. *Journal of Education, 38*, 11-24.

Carpenter, T.P., Fennema, E., Frankie, M.L, Levi, L., Jacobs, V.R., & Empson, S.B. (1996). A longitudinal study of learning to use children's thinking in Mathematics instruction. *Journal for Research in Mathematics Education*, 27(4), 403 – 434.

Cheprasov, A. (2017). Negative attitude: *definition and examples*. Retrieved from https://study.com

Chow, T. C. F. (2011). Students' difficulties, conceptions and attitudes towards learning algebra: *an intervention study to improve teaching and learning*. Retrieved from https://escape.curtin.edu.au>handle

Clark, L., & Chevrette, R. (2017). *Thick description*. Retrieved from https://onlinelibrary.wiley.com

Coolman, R. (2015). What is Algebra? History of Algebra. Retrieved from https://www.google.co... om /50258-algebra.html

Cuoco, A., Goldenberg, E. P., & Mark, J. (1996). Habits of mind: An organizing principle for Mathematics curricula. *Journal of Mathematical Behaviour, 15*, 375 – 402.

D'Emilio, K. (2010). *Y=mx + c for success. Ordinary level grade 11- 12*. Windhoek: John Meinert Printing.

De Vos, A.S., Strydom, H., Founche, C.B., & Delport, C. S. L. (2011). *Research at grass roots*. Pretoria: Van Schaik Publishers.

DNEA. (2013). *Examiner report for Namibia senior secondary certificate [Mathematics]*. Windhoek: Directorate National Examination and Assessment

DNEA. (2014). *Examiner report for Namibia senior secondary certificate [Mathematics]*. Windhoek: Directorate National Examination and Assessment

DNEA. (2015). *Examiner report for Namibia senior secondary certificate [Mathematics]*. Windhoek: Directorate National Examination and Assessment

DNEA. (2016). *Examiner report for Namibia senior secondary certificate [Mathematics]*. Windhoek: Directorate National Examination and Assessment

DNEA. (2017). *Examiner report for Namibia senior secondary certificate [Mathematics]*. Windhoek: Directorate National Examination and Assessment

DNEA. (2018). *Examiner report for Namibia senior secondary certificate [Mathematics]*. Windhoek: Directorate National Examination and Assessment

Dudovskiy, J. (2018). *The ultimate guide to writing a dissertation in business studies: A step-by step assistance*. USA: Pittsburgh.

Ebiendele, P. & Olaoye, A.A. (2013). Enhancing Quality of Mathematics offered in the Nigerian School System; through effective Mathematics Professional Development. *International Journal of Academic Research in Education and Review*, 2(4). 64 – 71.

Farrokhi, F. (2012). Re-thinking convenience sampling: Defining quality criteria. *Theory and Practice in Language Studies, 4*(2), 784-792.

Garforth, K. (2014). *Concrete-Representational-Abstract: An instructional Strategy for Math*. Retrieved from https://www.Idaschool.ca

Harding, J. (2013). *Qualitative data analysis from start to finish***.** London: SAGE Publication.

Hormuth, J. (2009). The benefits of Discourse Analysis for Human Resource Management. *German Journal of Research in Human Resource Management, 35,* 418 – 441.

In, J. (2017). Introduction of a pilot study. *Korean Journal Anesthesiol*, *70*(6), 601 – 605.

James, H., & Murnan, J. (2013). Research Limitations and the necessity of reporting them. *American Journal of Healthy Education*, 35(2), 66 – 67.

Katz, D. (1960). *The Functional approach to the study of attitudes*. Retrieved from https://academic.oup.com

Katz, V.J., & Barton, B. (2007). Stages in the History of Algebra with Implications for Teaching. *Educational Studies in Mathematics, 66, 185 – 201.*

Katz, V.J., & Parshall, K.H. (2014). *Taming the unknown: A History of Algebra from Antiquity to the Early Twentieth Century*. Princeton: Princeton University Press.

Keierleber, M. (2015). Six reasons why Singapore math might just be better way. *News article.* Retrieved from https://www.the74million.org

Koji, S., Mulenga, H. M., & Mukuka, A. (2016). An investigation into challenges faced by secondary school teachers and pupils in algebraic linear equations. *Journal of Education Practice, 25*(7), 99 – 106.

Kriek, J., & Basson, I. (2013). Implementation of a new FET Physical Science Curriculum: Teachers' perspectives. *Original articles*, *12*(1), 63 – 75.

Lambert, V. A., & Lambert, C. E. (2012). Qualitative descriptive research: An acceptable design. *Pacific Rim International Journal of Nursing Research, 16(4)*, 255–256.

Langat, C. A. (2015). *Students' attitudes and their effects on learning and achievement in Mathematics.* Retrieved from https://ir-library.ku.ac.ke.

Lincoln, Y., & Guba, E. (2015). *Naturalistic inquiry.* Beverly Hills: Sage Publications.

Lowenthal, P., & Muth, R. (2008). In E. F. Provenzo, Jr. (Ed.), *Encyclopaedia of the social*

Mack, N., Macqueen, C.W.K., Guest, G., & Namey, E. (2005). *Qualitative Research Methods: A data collector's field guide*. North Carolina, USA: Family Health International.

Matsuura, R., Sword, S., Piecham, M.B., Stevens, G., & Cuoco, A. (2013). Mathematical habits of mind for teaching: Using language in Algebra classrooms. *The Mathematics Enthusiast*, 10(3), 735 – 776.

Meriam-Webster' s collegiate dictionary. (2012). Springfield, MA: Meriam-Webster Incorporated.

Ministry of Education and culture. (2000). *Towards education for all: A development brief for education, culture and training.* Windhoek: Gamsberg Macmillan.

Ministry of Education. (2010). *Terms of reference for the consultancy project in mathematics.* Windhoek: Programmes and Quality Assurance.

Moser, A., & Korstjens, I. (2018). Series: practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, *24*(1), 120 – 124.

Mueller, S. (2017). *How to develop a positive attitude?* Retrieved from http://www. planetofsuccess.com

Mugo, F. W. (2002). *Sampling in research*. Retrieved from http://trochim.human.cornell.edu /tutorial/mugo/tutorial.htm

Mujere, N. (2016). *Sampling in research*. Retrieved from https://www.researchgate.net

Myburgh, C., & Poggenpoel, M. (2007). *Qualitative methods: a research approach worth considering*. Retrieved from https://www.ajol.inf

Ospina, S. M, (2004). *Qualitative research: Encyclopedia of Leadership*. New York: SAGE Publications Ltd.

Pagan, B. (2006). Positive contributions of constructivism to education design. *Europe's journal of psychology, 2(1), 1 – 6.*

Patton, M. Q. (1990). *Qualitative research and evaluation methods* (2nd Ed.). Newbury Park, CA: Sage

Petraglia, J. (1998). The Real World on a Short Leash: The (Mis) Application of Constructivism to the Design of Educational Technology. *Educational Technology research and Development, 46(3), 53- 65.*

Polit, D. F., Beck, C. T., & Hungler, B. P. (2001). *Essentials of nursing research: Methods, Appraisal, and utilization (5th ed.)*. Philadelphia: Lippincott.

Posamentier, A.S., & Krulik, S. (1998) *Problem-solving strategies for efficient and elegant solution.* Thousand Oaks, CA: Corwin Press.

Price, J.H., & Murnan, J. (2004). Research limitations and the necessity of reporting them. *American journal of Health Education*, 35(2), 66 – 67.

Puteh, M. (2002). Techniques for developing positive attitude towards mathematics. Retrieved from https://www..researchgate.net

Rogers, R., Malancharuvil-Berkes, E., Mosley, M., Hui, D., & Joseph, G. O. (2005). Critical discourse analysis in education: a review of the literature. *Review of Educational Research. 75*(3), 365-416.

Saunders, M., Lewis, P. & Thornhill, A. (2012) Research methods for business students. 6th edition. New York: Pearson.

Seifi, M., Haghverdi, M., & Azizmohamadi, F. (2012). Recognition of students' difficulties in solving mathematical word problem from the viewpoint of teachers. *Journal of Basic and Applied Scientific Research*, *2*(3), 2923-2928.

Setia, M. S. (2016). Methodology series module 5: Sampling strategies. *Indian Journal Dermatology*, *61*(5), 505- 509.

Setia, M. S. (2017). Methodology series module 10: Qualitative health research. *Indian Journal Dermatology, 62*(4), 367- 370.

Shunda, N. (2007). What is a Literature review? Retrieved from https://web2.uconn.edu

Sikukumwa, E. (2017). *Types of strategies used to solve algebraic word problems by grade 12 ordinary level mathematics learners of Kavango East region of Namibia.* Retrieved from: repository.unam.na

Simon, M.K. (2011). *Dissertation and scholarly research: Recipes for success*. Retrieved from https://www.dissertationrecipes.com

Sparks, J. C. (2008). The Pythagoras Theorem: Crown Jewel of Mathematics. Bloomington, Indiana: Author House.

Star, J. R., & Johnson, B. R. (2009). Making algebra work: Instructional strategies that deepen student understanding, within and between representations. *ERS Spectrum*, *27*(2), 11-18.

Star, J. R., Caronongan, P., Foegen, A., Furgeson, J., Keating, B., Larson, M. R., … Zbiek, R. M. (2019). *Teaching strategies for improving algebra knowledge in middle and high school students*. Retrieved from https://whatworks.ed.gov.

Stoelinga, T., & Lynn, J. (2013). Algebra and the Underprepared learner. UIC research on Urban Education Policy Initiative, 2(3), 1 – 17.

Strauss, A., & Corbin, J. (2014). *Basics of qualitative research: Grounded theory procedures and* techniques. Newbury Park, CA: Sage Publications.

Thompson, V. (2018). *How is Mathematics used in other subjects?* Retrieved from https://www. Sciencing.com

Trigueros, R. (2017). *Qualitative and quantitative research instruments, research tools*. Retrieved from https://www.researchgate.net/puplication

Vicent, N. A. (2014). Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of emerging trends in educational research and policy studies*, *5*(2), 272- 281.

Vygotsky, L.S. (1978). *Mind in society.* London: Harvard University Press.

Yaro, I., Arshad, R.., & Salleh, D. (2015). Education stakeholder's constraints in policy decisions for effective policy implementation in Nigeria. *British Journal of education, society & Behavioural science, 14*(1), 1 – 12.

Zbiek, R. M., & Larson, M. R. (2015). Teaching strategies to improve Algebra learning. *Mathematics teacher, 108* (9), 696- 699.

APPENDIX 1: INFORMATION LETTER FOR PARTICIPATION IN RESEARCH PROJECT

I hereby write to request you to participate in the University of Namibia research study to be conducted by me. I am, **Martin Musokotwani Sezuni**, a Master of Education student in Mathematics Education. The title of my research study is; "*Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges in Algebra In Katima Mulilo circuit In Zambezi Region, Namibia"*. This study will be conducted at your school in the morning (lesson observations) and sometimes, afternoon sessions (interviews) for at least two days. The researcher is conducting this study to learn about teachers' strategies in teaching algebra. To ascertain the issue of challenges among learners in algebra and in order to explore the effective strategies used by teachers to minimize those challenges in algebra. As a researcher, understanding is required and finding out how teachers might adapt their teaching strategies to aid the effective teaching and learning of algebra starting from simplifying algebraic expressions to the learning of mathematical word problems in secondary where learners do NSSC and also the use of algebraic problem solving concepts.

In addition, you may withdraw at any time during the study without any punishment. To withdraw just indicate as such to the researcher and no questions can be asked. The responses will be considered confidential and individual's names will be anonymous. You are assured of this research study, as it has been reviewed and approved by the research ethics and review committee of the University of Namibia. The permanent secretary for Ministry of education, the principal of the school and the director of education in Zambezi region are aware of the study. I would be very happy if you decide to participate in this research study because it is aimed at furthering our understanding, knowledge and skills in Mathematics, especially in algebra. The decision is yours as mentioned already but you are requested to complete the consent form attached and submit it back to me.

If you have any questions or you need more information concerning this study, you are free to contact me, (Martin Musokotwani Sezuni) at 0814160475 email: msezuni@yahoo.com or my supervisors; (Dr. Mukwambo) at 0812876624 email: mmukwambo@unam.na and (Dr. Chirimbana) at 065 223 2289 email: mchirimbana@unam.na.

Sincerely,

………………………

Signature

Martin M. Sezuni (Department of Mathematics and Science) student no: 201027968

APPENDIX 2: TEACHER'S INTERVIEW GUIDE (SEMI-STRUCTURED QUESTIONS)

Date:……………………………

Participant: …………………………………..

1. Introduction

My dear participant, how are you today? Thank you for accepting to participate in this study. My name is **Martin Musokotwani Sezuni**, as part of the requirements for a Master's Degree in Education; I am conducting a study on "*Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges In Algebra In Katima Mulilo circuit In Zambezi Region, Namibia".* You are kindly requested to spare some of time to answer few questions, which I have for you. Our discussion will be audiotaped.

2. Ethical considerations

Your participation in this study is voluntary and your responses will strictly be confidential. Pseudonyms will be used in ensuring your identity and that of your school confidential. Also, you have the right to withdraw from participating in this research study at any point in time during this interview. Please respond the questions I will ask with all honesty.

[Open-ended questions]

3. Personal information

Name of your school?

Gender:

Marital status:

Age:

What is the grade you teach?

What is your qualification?

What is your teaching experience?

4. Interview questions

a) Are you comfortable to teach all the topics in Mathematics syllabus at the level you teach?

If No' which topics are you not comfortable to teach and why?

b) Do you normally use LCA (**Learner-centred Approach**) in your teaching of algebra?

Give reasons for your answer.

c) Do learners like the topic, Algebra in Mathematics, explain?

d) Do you think Algebra is challenging for learners and if so, comment on how they perform in algebra activities?

e) What are the challenges that you face in teaching algebra at your school?

f) What teaching strategies do you normally use in teaching Algebra to your grade 12 learners?

g) How effective are the teaching strategies you use in addressing the challenges faced in Algebra at your school?

h) What are the teaching strategies that are used to improve learners' understanding of Algebra?

APPENDIX 3: REQUEST TO CONDUCT EDUCATIONAL RESEARCH STUDY IN SCHOOLS (TO THE REGIONAL DIRECTOR)

Sezuni Martin M

Box 2366

Ngweze

Date:………………

The Director of Education, Zambezi Region

Private Bag 1096

Katima Mulilo

Dear Sir/madam

REQUEST TO CONDUCT EDUCATIONAL RESEARCH STUDY IN YOUR SCHOOLS

My name is **Martin Musokotwani Sezuni**, student no:201027968, as part of the requirements for a Master's Degree in Education(Mathematics Education) at the University of Namibia; I am conducting a study on " *Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges In Algebra In Katima Mulilo circuit In Zambezi Region, Namibia".* I write to seek permission to conduct a study in your schools, especially at senior secondary schools in Zambezi Region. The study will mainly involve interviews, and observing the mathematics teachers in classes.

I promise the confidentiality and anonymity of the schools and participants in the study. The study requires that I collect data for at least three weeks and I would like to begin collecting data in a week's time.

Please let me know if you would like to see the instruments or hold a discussion with me about my study.

Yours sincerely,

……………………………………

MM Sezuni Department of Mathematics and Science Contact: 0814160475

APPENDIX 4: REQUEST TO CONDUCT EDUCATIONAL RESEARCH STUDY IN SCHOOLS (TO THE PERMANENT SECRETARY OF EDUCATION)

Sezuni Martin M

Box 2366

Ngweze

Date:…………….

The permanent secretary

Ministry of education, sports and culture

Private Bag 5006

Windhoek

Dear Sir

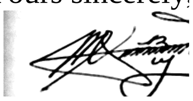
REQUEST TO CONDUCT EDUCATIONAL RESEARCH STUDY IN YOUR SCHOOLS

My name is **Martin Musokotwani Sezuni**, student no:201027968, as part of the requirements for a Master's Degree in Education (Mathematics Education) at the University of Namibia; I am conducting a study on "*Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges In Algebra In Katima Mulilo circuit In Zambezi Region, Namibia".* I write to seek permission to conduct a study in your schools, especially at senior secondary schools in Zambezi Region. The study will mainly involve interviews, and observing the mathematics teachers in classes.

I promise the confidentiality and anonymity of the schools and participants in the study. The study requires that I collect data for at least three weeks and I would like to begin collecting data in a week's time.

Please let me know if you would like to see the instruments or hold a discussion with me about my study.

Yours sincerely,



……………………………………

MM Sezuni Department of Mathematics Contact: 0814160475

APPENDIX 5: REQUEST TO CONDUCT EDUCATIONAL RESEARCH STUDY IN YOUR SCHOOLS (TO THE SCHOOL PRINCIPALS)

Sezuni Martin M

Box 2366

Ngweze

Date:

The school principal

Ministry of education, sports and culture

Private Bag 5006

Katima Mulilo

Dear Sir/madam

REQUEST TO CONDUCT EDUCATIONAL RESEARCH STUDY IN YOUR SCHOOLS

My name is **Martin Musokotwani Sezuni**, student no:201027968, as part of the requirements for a Master's Degree in Education (Mathematics Education) at the University of Namibia; I am conducting a study on "*Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges In Algebra In Katima Mulilo circuit In Zambezi Region, Namibia".* I write to seek permission to conduct a study at your school. The study will mainly involve interviews, and observing the mathematics teachers in classes.

I promise the confidentiality and anonymity of the schools and participants in the study. The study requires that I collect data for at least three weeks and I would like to begin collecting data in a week's time. However, I would be grateful if allowed to collect the data in grade 9, 11 and 12 by using the instruments immediately.

Please let me know if you would like to see the instruments or hold a discussion with me about my study.

Yours sincerely,

……………………………

MM Sezuni Department of Mathematics Contact: 0814160475

APPENDIX 6: CONSENT FORM FOR RESEARCH PARTICIPANTS

Name of Researcher: Martin Musokotwani Sezuni

Title of study: "*Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges In Algebra In Katima Mulilo circuit In Zambezi Region, Namibia"*.

Please read and complete this form carefully. Tick the appropriate response, YES or NO. At the end of this consent form write your names in full, sign and write the date. Ask where you do not understand. Write clearly and legibly.

	YES	NO
I pledge to take part in the research study , the procedures were clearly explained to me both verbally and in written form by the researcher.		
I do understand that my participation is voluntary and I am not forced to participate in this research study.		
I also understand that I may withdraw from this study at any time without any punishment. This will not affect me in anyway.		
I understand that all information about me will be treated in strict confidence and that my name will not be written on publishable documents arising from this study.		
I understand that any audiotape/recording material will be used solely for the purpose of this research and it shall be deleted after the completion of this research		
The researcher will be discussing the matters and progress of this research study with the supervisor and co-supervisor of the University of Namibia		

I,…………………………………………… voluntarily give my consent to be involved in this research study and have been given a copy of an information letter for my own information.

Signature of Participant: ………………………………………… School:………………

Date: ……………………………………………………………………

APPENDIX 7: OBSERVATION SCHEDULE

SCHOOL:…………………………… DATE:……………...

Research topic: ***"Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges In Algebra In Katima Mulilo circuit In Zambezi Region, Namibia".***

Researcher observation check-list		
Questions	**Teachers' strategies used in answering each questions**	**Categories of strategies**
		Identify key words Draw pictures Reword/ re-read Step procedures Making a table Work backward Choose operation Guess and check Counting techniques Inverse operation Looking for patterns visualizing problems, guessing, experimenting, describing, inventing and conjecturing

APPENDIX 8: DOCUMENT ANALYSIS GUIDE

NAME OF THE SCHOOL:…………………………………………………………

Research topic: "Investigating Mathematics teachers' strategies for addressing grade 12 learners' challenges In Algebra In Katima Mulilo circuit In Zambezi Region, Namibia".

The purpose of this data analysis guide is for investigating grade 12 learners' performance in Algebra tests and examinations at the sampled schools.

Table X: Algebra test Marks Grade 12

Name of learner	Test marks	Marks in Percentage

Table Y: April examination marks on Algebra questions for 2019

Name of learner	November exam marks on Algebra questions [Grade 12 for 2019]	Marks in percentage

Table Z: Examiners' report for 2018 NSSCO Mathematics examinations

Year	Question on Algebra	Examiners' comments on Algebra
2018		

APPENDIX 9: ETHICAL CLEARANCE CERTIFICATE

UNAM
UNIVERSITY OF NAMIBIA

ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: FOE /543/2019 **Date: 25 November, 2019**

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

Title of Project: Investigating Mathematics Teachers' Strategies For Addressing Grade 12 Learners' Challenges In Algebra In Zambezi Region

Researcher: SEZUNI MARTIN MUSOKOTWANI

Student Number: 201027968

Supervisor(s): : *Dr. M. Mukwambo (Main) Dr. M. Chirimbana (Co)*

Take note of the following:

(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.
(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.
(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.
(d) The UREC retains the right to:
(i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,
(ii) Request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Dr. E. de Villiers: HREC Chairperson

pp

Ms. P. Claassen: HREC Secretary