BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

BACHELOR OF SCIENCE EDUCATION HONOURS
DEGREE IN MATHEMATICS

INVESTIGATING PROBLEMS FACED BY FORM THREE LEARNERS WHEN SOLVING
QUADRATIC EQUATIONS AT GLENVIEW 2 HIGH SCHOOL.

BY

CHINYANI GILLIAN

REG NO. B224895B

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

JUNE 2024

Title of the dissertation: Investigating why learners struggle to solve quadratic equations at Glenview 2 High School in Glenview/Mufakose District of Harare Metropolitan Province.

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

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

    _____   _____

    (Signature of student)   (Date)

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

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

    Mutambara

                                                                                16/10/24

    _____   _____

    (Signature of Supervisor)   (Date)

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

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

(Signature of the chairman)   16/10/24   (Date)

APPROVAL FORM

Name of the student: CHINYANI GILLIAN

Registration Number: B224895B

Dissertation Title: Investigating why learners struggle to solve quadratic equations in Glenview/Mufakose District

Degree Title: Bachelor of Science Honours Degree in Mathematics Education.

Year of completion: 2024

Signed……………………   Date ……/………. /…………

Permanent Address

8676 24ᵗʰ Street

Glenview 8

Harare

ACKNOWLEDGEMENTS

DEDICATION

This study is dedicated to my children who encouraged me through all circumstances. I am so thankful.

ABREVIATIONS/ACCRONYMS

HBSCED-   Honours Bachelors Science Education Degree

ABSTRACT

This study aimed to investigate the underlying factors contributing to the learners' struggle with quadratic equations at Glenview 2 High School District in Glenview \Mufakose district of Harare province. Prior research has indicated that secondary school learners face challenges with solving quadratic equations .

A sample of thirty participants was drawn from a population of all form three learners.Stratified random sampling procedure was undertaken whereby the population was divided into subgroups basing on mathematics achievement levels of advanced, average and struggling. Random sampling of thirty participants was done .

The study employed a mixed-methods approach, incorporating both quantitative analysis of student test scores and qualitative interviews with students and teachers. Potential contributing factors which were explored include common misconception and errors made by leaners technology integration in learning of quadratic equations, teaching strategies and methods and impact of cognitive abilities and mathematical background of secondary school leaners on ability to solve quadratic equations

Based on the findings, the research also identified and evaluated potential interventions to address the identified causes of learners' struggle with quadratic equations. Strategies which were considered included differentiated instruction, hands- on activities, peer tutoring, technology integration, parent involvement and self-regulation skills.

The results of this study were expected to provide important insights to educators, policymakers, and local stakeholders seeking to enhance mathematics learning outcomes and expand educational and career opportunities for secondary school learners.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

1.0   INTRODUCTION

This is a case study investigating learners' mathematical difficulties with quadratic equations at form three level. The main purpose of this study is to explore the learners' difficulties while learning quadratic equations. This chapter discusses the background of the study, statement of the problem, significance of the study, statement of the problem, research questions and assumptions of the study.

1.1   BACKGROUND

Quadratic equations are a fundamental topic in mathematics that students typically encounter during their secondary school education. These equations play a crucial role in various fields such as physics, engineering, computer science, and economics, making it essential for students to grasp this concept early on. However, research suggests that many secondary school learners struggle to effectively solve quadratic equations, leading to poor performance in mathematics overall.

One of the branches of mathematics is algebra. Chazan (1996) asserts that algebra is an important part of mathematics and a subject to be understood. Algebra is concerned about solving equations, finding unknowns and using symbols. Quadratic equations fall under Algebra. According to Erbas and Essay (2009) cited in Joshi (2019), learning of quadratic equations is important for students because algebra connects subdomains of mathematics and other branches of science.

According to O'Connor and Norton (2022), difficulties with quadratic equations in junior secondary years may lead to students to not commence the study of further abstract algebra that is included in Advanced level syllabus, such as Calculus. Calculus includes as necessary

prerequisites studies of algebra. It can be argued therefore that ability to solve quadratic equations is a fundamental skill that forms the bases for more advanced mathematical concepts.

According to Hattie (2019) understanding quadratic equations helps students develop problem solving skills, such as critical thinking. When solving quadratic equations, students need to carefully analyze the problem, identify the given information and apply appropriate techniques to find the solution. this process requires critical thinking skills and the ability to evaluate different approaches. By understanding how to factor, complete the square, or use the quadratic formular or students learn how to decompose and tackle each component separately before putting it all together. Problem solving skills are essential for success in mathematics and other disciplines. By mustering the techniques and strategies' for solving quadratic equations, students build a strong foundation for approaching complex problems and developing effective problem-solving.

O'Connor (2022) asserts that one of the possible reasons why students have challenges with solving quadratic equations is lack of understanding of the concept. Quadratic equations involve variables raised to power of two, which can be challenging for students who have not grasped the fundamentals of algebra. Difficulty in factoring is another challenge faced by learners. Solving quadratic equations often requires factoring, which can be a complex and time-consuming process for students. Factoring involves breaking down a quadratic equation into its factors, which requires a strong grasp of algebraic manipulation skills.

Many students have a fear or aversion to mathematics, which can affect their confidence and motivation to tackle quadratic equations. According to Garcia and Lee (2016) this fear can lead to a lack of engagement with the material and a reluctance to seek help when facing difficulties. Understanding the attitudes, beliefs and experiences of students towards quadratic equations, and mathematics in general can provide insight into why the learners may struggle with these concepts.

Another factor which contributes to learners' challenges with quadratic equations is lack of practice. Mastery of quadratic equations requires regular practice and reinforcement of skills. Students who do not practice face challenges with quadratic equations as they may forget important skills or procedures.

Smith and Johnson (2015) propound that the way quadratic equations are taught in schools can also contribute to students' challenges. If teachers do not provide clear explanations, examples and practice opportunities, students may struggle to grasp the concepts effectively. It is crucial therefore to investigate teaching strategies, approaches and training of mathematics educators to see how they may impact students' ability to solve quadratic equations. Technology integration in teaching and learning of quadratic equations is also a factor to be considered. Exploring the role of technology in teaching quadratic equations and whether digital tools or educational apps can help students overcome challenges in understanding and solving these equations.

Quadratic equations are essential in mathematics as they play a crucial role in various real-life applications. Additionally, the ability to solve quadratic equations is a fundamental skill for more advanced mathematical concepts. However, many secondary school learners face challenges with solving quadratic equations, leading to educational researchers studying the reasons behind this challenge.

1.2   STATEMENTS OF THE PROBLEM

The study aims to investigate the reasons why secondary school learners often struggle to successfully solve quadratic equations. Factors such as inadequate understanding of the underlying concepts, lack of problem-solving skills, ineffective teaching methods, and math anxiety may contribute to the difficulties experienced by students in solving quadratic equations. By identifying

and examining these factors, the study seeks to provide insights and recommendations for improving the teaching and learning of quadratic equations in secondary schools.

1.3   MAIN RESEARCH QUESTIONS

Why do secondary school learners struggle to solve quadratic equations?

1.4   SUB RESEARCH QUESTIONS

The research seeks to answer the following questions

1. What are the common misconceptions and errors made by secondary school learners when solving quadratic equations?

2. How do the cognitive abilities and mathematical background of secondary school learners impact their ability to solve quadratic equations?

3. What teaching strategies or methods are most effective in helping secondary school learners understand and solve quadratic equations.

1.5   IMPORTANCE OF THE STUDY

The study of why secondary school pupils fails to solve quadratic equations is important for several reasons. Understanding the reasons behind this difficulty can help educators design more effective teaching strategies to support students in mastering this fundamental concept in mathematics. By identifying common challenges and misconceptions that students face, interventions can be developed to address these issues and improve learning outcomes.

Additionally, studying why students struggle with quadratic equations can inform curriculum development and assessment practices. By identifying areas of weakness or misunderstanding,

educators can revise instructional materials and assessments to better align with student needs and promote a deeper understanding of the topic.

Furthermore, understanding the reasons behind student difficulties with quadratic equations can help identify patterns or trends that may be indicative of broader issues within the educational system. For example, if certain demographic groups consistently struggle with this concept, it may signal a need for targeted support or interventions to address inequities in access to quality education.

Thus, studying why secondary school pupils fail to solve quadratic equations is essential for improving teaching and learning practices, enhancing student outcomes, and promoting equity in education.

1.6 LIMITATIONS

The limitations of a study investigating challenges faced by form three learners when solving quadratic equations include same size, generalization, data collection methods, incomplete assessment of variables, measurement tools, external factors and time constraints. It is essential to acknowledge and address these limitations in order to ensure the credibility and validity of the study's findings and interpretation of the results.

One of the primary limitations in studying secondary school learners face challenges with solving quadratic equations is a small sample size of participants in research studies. Researchers' often have limited resources and access to schools to conduct large-scale studies. As a result, the findings from such studies may not be generalizable to a wider population of students. Small sample sizes can also limit the statistical power of the study, making it difficult to draw definitive conclusions about the factors contributing to students' difficulties with quadratic equations. Small Sample sizes

only include students from a specific geographic area or demographic group hence lack of diversity.

Another limitation in studying this issue is the lack of longitudinal data tracking students' progress in quadratic equation solving over time. Understanding the developmental trajectory of students' mathematical skills is crucial for identifying the specific points at which students begin to struggle with quadratic equations. However, many studies are cross-sectional in nature, focusing on a single point in time and offering limited insights into how students' abilities evolve over time.

Studying why secondary school learners struggle to solve quadratic equations requires an investigation of various factors that may influence students' mathematical abilities. These factors could include pedagogical practices, teacher quality, students' prior knowledge, motivation and cognitive abilities. However, research studies may not always capture the complexity of these variables comprehensively. For instance, studies may focus on a limited set of factors or fail to account for the interaction between different variables, leading to an incomplete understanding of students' difficulties.

Data collection methods is another limitation to the study. The study may rely on self-reporting or subjective assessments, which could introduce biases or inaccuracies in the data collected. Subjective assessments include essays, portfolios or oral presentations. These assessments are typically graded based on the quality of the students 'work, rather than on specific correct answers. Subjective assessments means making assumptions, making interpretations based on personal opinions without any verifiable facts.

Furthermore, measurement tools are another limitation to the study. The tools used to measure the students' ability to solve quadratic equations may not be standardized or validated, leading to

potential inconsistencies in the results. Measurement tools are instruments used by researchers to measure or collect data on a variety of variables. Interviews, tests and observations are the tools used in this research.

Additionally, external factors should also be considered as a limitation to the study. The study may not account for external factors that could influence students 'ability to solve quadratic equations. These could be home environment, teacher quality or socio-economic status. Time constraints is another limitation beyond the researchers'' control. The study may have limited time to assess the students' problem-solving abilities thoroughly. This may lead to incomplete or inconclusive results.

Last but not least, researcher bias should be considered as a limitation to the study. The researchers' conducting the study may have their biases or preconceived notions that could impact the study's findings and interpretation of the results. In research, bias occurs when systematic error is introduced into sampling or testing by selecting or encouraging one outcome over others. Bias can occur at any phase of research, including study design or data collection, as well as in the process of data analysis and publication.

While the study of challenges encountered by learners in solving quadratic equations is important for improving mathematics education, it is essential to acknowledge the limitations that researchers may encounter in this area.

1.7   DELIMITATIONS

Delimitations in a study outline the boundaries or limitations that the researcher has set for the study. Delimitations included in this study are as follows: geographical delimitation, time delimitation, research methodology delimitation, sample size and educational level delimitation.

Concerning the geographical delimitation, the study will focus on secondary school learners at Glenview 2 High School in Harare province. The study will only consider data within a specific time frame, that is, the 2024 academic year to ensure the relevance and timeliness of the findings.

On sample size delimitation, the study will have a sample size of thirty form three learners and three mathematics teachers. However, this small sample size may limit the generalizability of the findings. With regards to research methodology, the study will only use specific research methodology, that is, interviews, observations and tests.

On educational level delimitation, the study will focus only on secondary school learners and will not consider primary or tertiary level learners.

1.8   ASSUMPTIONS OF THE STUDY

Some common assumptions in the study of why secondary school learners fail to solve quadratic equations may include:

Lack of understanding of the concepts:

One assumption could be that students may not have a solid grasp of the basic concepts and properties related to quadratic equations, such as factorization, the quadratic formula, and completing the square.

Neglect of practice

It may be assumed that students who struggle with quadratic equations do not practice enough or do not engage in enough problem-solving activities to master the skills required.

Misconceptions

Another assumption could be   that students may hold misconceptions or misunderstandings about quadratic equations that hinder their ability to solve problems accurately.

Lack of motivation or interest

It may be assumed that some students lack motivation or interest in mathematics, which could lead to a lack of effort in learning and practicing quadratic equation-solving techniques.

Ineffective teaching methods an assumption could be that ineffective teaching methods or approaches used by educators may contribute to students' difficulties in understanding and solving quadratic equations.

Individual differences It might be assumed that students have different learning styles, abilities, and backgrounds that influence their success in solving quadratic equations.

Limited resources:

Another assumption could be that students may not have access to adequate resources such as textbooks, technology, or additional help outside of the classroom, which could impact their ability to learn quadratic equations effectively.

These assumptions are important to consider when studying why secondary school learners may struggle with quadratic equations, as they can help inform targeted interventions and support strategies to improve student outcomes in mathematics.

1.9   DEFINITION OF KEY TERMS

Struggle can be defined as a state of conflict, difficulty, or challenge that a person or group faces hen trying to achieve a goal or overcome an obstacle. -Smith and Johnson (2018)

Quadratic equations

Quadratic equations can be defined as polynomial equation of a second degree, which implies that it comprises a minimum of 1 term that is squared. Ulz (2023)

Solve

Solve means find an answer to, explanation for or means of effectively dealing with a problem or mystery. Oxford dictionary (2024)

1.10   SUMMARY

The chapter focuses on background of the study, statement of the problem, research objectives and questions. Assumptions of the study and organization of the study were also outlined.

CHAPTER TWO: LITERATURE REVIEW

2.0 INTRODUCTION

In this chapter, the researcher focuses on review of related literature. The focus is on previous research and studies that have investigated why secondary school learners struggle to solve quadratic equations. The review of literature has been organized under a thematic approach. Thus, literature review shall be argued around recurring central themes which mirror the research questions.

2.1 LACK OF UNDERSTANDING OF CONCEPTS

Many studies have shown that students struggle with quadratic equations due to a lack of understanding of the underlying concepts involved. This includes difficulties in comprehending the nature of quadratic equations, their properties and how they can be solved. According to Zakaria (2015), researchers have found that a firm background of algebra is crucial for solving quadratic equations and challenges can crop up when students have not fully mastered previous topics in algebra. Understanding quadratic equations, therefore, requires a solid understanding of basic algebraic concepts such as solving linear equations, manipulating variables and understanding the properties of exponents. If a student lacks a strong foundation in algebra, they may find it difficult to grasp quadratic equations.

Hattie (2019) notes that fluency with prerequisite knowledge, even at a very early stage, is highly predictive of latter success. This assertion is also supported by O'Connor and Norton (2016) whose research findings indicates that difficulties with critical prerequisite concepts such as algebraic conventions impeded students' success in understanding and working with quadratic equations. It

can be noted that prerequisite knowledge is crucial and its absence can contribute to lack of understanding of concepts.

Hiebert and Carpenter (2016) conducted research titled " Learning and teaching with understanding " which explores the concept of learning and teaching mathematics with understanding, emphasizing the importance of developing deep conceptual understanding in students. The authors discussed the challenges students face in grasping the underlying principles of quadratic equations and suggest instructional approaches to address these issues. One such approach, according to Hiebert and Carpenter (2016) is building conceptual understanding. This is whereby the emphasis is on a deep understanding of key mathematical concepts and connections rather than just memorization of procedures.

2.2   MISCONCEPTIONS AND ERRORS

Research has highlighted common misconceptions and errors that students make when working with quadratic equations. For example, students may struggle with factoring quadratic expressions, solving quadratic equations using the quadratic formula, or interpreting solutions in real-world contexts. According to O'Connor and Norton (2016) analysis of student errors identified misconceptions associated with the null factor law and the nature of quadratic equations. Students may not fully understand the null factor law and its application in solving equations. This can lead to confusion and errors when attempting to apply the law to different problems.

In research conducted by Zakaria and Mistime (2015) titled "Analysis of student errors in learning of quadratic equations ", the findings showed that most students make errors in transformation and process skill in solving quadratic equations. Errors of carelessness and reading were very small. The researchers noted that the students' error in solving quadratic equations was due to their

weaknesses in mastering topics such as algebra, fractions, negative numbers and algebraic expansions.

A study conducted by Singh (2015) titled "A study of student difficulties in learning secondary level algebra " investigated the common misconceptions and difficulties students face when learning algebra, including quadratic equations. The findings suggest that many students struggle with the basic concepts of algebra leading to difficulty in understanding quadratic equations.

Common misconceptions and errors in solving quadratic equations among secondary school learners include incorrect application of the quadratic formula, incorrectly factoring quadratic expressions, neglecting to simplify expressions and so on. By addressing these common errors and misconceptions through practice and understanding the underlying concepts, students can improve their skills in solving quadratic equations accurately.

2.3   TEACHING STRATEGIES AND APPROACHES

Ygano (2020) asserts that a study conducted by Ezeh (2019) showed that poor teaching methods employed by teachers affect students' performance in solving quadratic equations. One such poor teaching method as explained by O'Connor and Norton (2016) is that some students and teachers favor factorization over other methods of solving quadratic equations. Completing the square, graphical method and use of the quadratic formula are the other methods of solving quadratic equations. According to O'Connor and Norton (2016) overemphasis on seemingly simple factorization is done by teachers using coefficients that are easy to factorize. However, many quadratic equations cannot be factorized. Other methods that are more efficient or that develop conceptualization may be neglected in teaching.

According to Zakaria (2010), studies have shown that teachers tend to avoid teaching alternative methods when using methods such as quadratic formulas or completing the square due to high rate of technical errors. Norton (2015) suggests using the geometric models as they are useful in adding understanding in developing the quadratic formula via the completing the square procedure. Hiebert and Carpenter (2016) suggests using graphing calculators to plot quadratics with no roots, one root or two roots. The research findings by O'Connor and Norton (2016) asserts that by not using alternative methods, such as geometric models, leads to lack of understanding of quadratic equations.

Smith and Johnson (2017) carried out research titled "Effective Teaching Strategies in Middle School Mathematics " which examines the impact of different teaching strategies on high school students' understanding of quadratic equations. The study compares methods such as direct instruction, problem-based learning and manipulatives. The research highlights the importance of engaging students, differentiating instruction, utilizing technology, promoting collaboration and connecting math concepts to the real world.

Technology can play a significant role in teaching quadratic equations by providing various tools and resources that can enhance the learning experience for students. An example of research study on technology is "Technology Integration in Quadratic Equations Instruction: A Review of Current Research " by Lee and Kim (2020). The research reviews existing research on the use of technology tools such as graphing calculators, software, and applications in teaching quadratic equations. The study highlights the advantages and challenges of technology integration in mathematics education.

These studies contribute to the growing body of research on effective teaching strategies and approaches in quadratic equations. Thus, offering insights into how educators can enhance

students' learning experiences in this mathematical topic. Review of related literature has shown that teaching strategies and approaches have an impact on students' ability to solve quadratic equations. Poor teaching techniques and approaches has an adverse effect on learners' understanding and ability to solve quadratic equations. Effective instructional methods, such as using real-life examples, hands-on activities, technology integration and formative assessment have been shown to enhance student learning outcomes.

2.4   PROCEDURAL VERSUS CONCEPTUAL UNDERSTANDING

Some research studies have emphasized the difference between procedural understanding and conceptual understanding. Nahdi (2020) asserts that procedural knowledge involves understanding the rules and routines of mathematics while conceptual knowledge involves an understanding of mathematical facts and properties. Procedural understanding is when students follow steps to solve equations without truly understanding the concepts. Conceptual understanding, on the other hand, entails having a deep understanding of the mathematical principles behind solving quadratic equations.

Research has shown that students who rely solely on procedures may face challenges in problem-solving and application. According to Harripersaud (2021), learners need to develop procedural and conceptual knowledge through various learning experiences in an integrated manner. The Australian Academy of Science (2015) cited by Harripersaud (2021) also recognizes the intertwined relationship between conceptual understanding, procedural fluency and problem solving and reasoning due to the hierarchical nature of mathematics.

A study by Alcock, Inglis and Simpson (2014) investigated students' procedural and conceptual understanding of factorization of quadratic expressions. The research highlights the importance of

developing both procedural fluency and conceptual understanding to effectively solve quadratic equations. Therefore, they go hand in glove.

Bozkurt, Inan and Oztuna (2017) explores the relationship between students' procedural and conceptual knowledge of quadratic equations. The study found that students who had a strong conceptual understanding of quadratic equations were more likely to perform well on procedural tasks. Thus, places major emphasis on the need for teachers to cater for both in the teaching and learning of quadratic equations.

In a study by Sing and Khine (2017), researchers examined the effectiveness of a computer-based instructional intervention on students' procedural and conceptual understanding of quadratic equations. The research showed that the intervention significantly improved students' performance on solving quadratic equations and also deepened their conceptual understanding of the topic.

Overly, these studies highlight the importance of addressing both procedural and conceptual aspects of quadratic equations in teaching and learning to facilitate students' understanding and problem-solving abilities in this area.

2.5   NEGATIVE ATTITUDES AND BELIEFS

Negative attitudes and beliefs in learning quadratic equations can hinder a student's ability to grasp the concept and perform well in related tasks. Smith and Johnson (2018) conducted a study to investigate the impact of negative attitude towards quadratic equations on student learning outcomes. The research findings show that negative attitudes do have an impact on learning outcomes. Learners who have negative attitudes towards quadratic equations tend to perform poorly in the topic.

Several factors contribute to the negative attitudes toward quadratic equations. One primary reason, according to Abdullah and Suhairom (2018) is the perception of quadratic equations as abstract and disconnected from real-world applications. Students often struggle to see the practical relevance of solving quadratic equations, leading to disinterest and disengagement with the subject matter.

Another factor as alluded to by Tendere (2020) is the perceived difficulty of mastering the concepts and techniques involved in quadratic equations. The complex nature of quadratic equations including factoring, completing the square and using the quadratic formula, can be daunting for students. Tendere (2020) asserts that this difficulty can lead to frustration and lack of motivation to engage with the material.

Additionally, traditional methods of teaching quadratic equations can further contribute to negative attitudes. According to Todorovic (2020) traditional teaching methods often rely on rote memorization and procedural problem-solving which can make learners develop negative attitudes towards quadratic equations. These methods may fail to promote a deep understanding of the underlying concepts and limit students' ability to apply quadratic equations.

In a study by Garcia and Lee (2016), to address the negative attitudes towards quadratic equations, it is essential to adopt teaching approaches that emphasize the practical relevance and real-world applications of quadratic equations. By connecting the concepts to tangible examples and demonstrating their use in various disciplines, educators can help students and researchers appreciate the value of quadratic equations.

Moreover, research findings of a study by Smith and Johnson (2020) points out that promoting active learning strategies that encourage critical thinking and problem-solving skills can enhance

engagement with quadratic equations and foster a deeper understanding of the underlying principles. By incorporating interactive activities, educators can make quadratic equations accessible and engaging for learners.

In conclusion, negative attitudes towards learning and understanding quadratic equations can be detrimental to a student's academic progress and success. To address these negative attitudes and beliefs, it is important to create a supportive learning environment that encourages students to approach quadratic equations with a growth mindset. Providing opportunities for practice, offering positive reinforcement, and breaking down the concept into manageable steps can help build confidence and reduce anxiety around the topic. Encouraging a growth mindset by emphasizing that mistakes are a natural part of learning and that improvement is possible with effort can also help students develop a more positive attitude towards learning quadratic equations.

2.6   SUMMARY

The literature review on the study of why secondary school learners struggle to solve quadratic equations explored various factors that may contribute to this issue. Researchers have identified several possible reasons for students' difficulties with quadratic equations, including a lack of foundational algebra skills, misconceptions about the concepts involved, ineffective teaching methods and inadequate practice opportunities.

By synthesizing the findings from existing literature, it becomes evident that a multifaceted approach is needed to address the challenges faced by secondary school learners in solving quadratic equations. The chapter highlights the importance of addressing conceptual, procedural, motivational and instructional factors to improve students' proficiency in this essential mathematical skill.

CHAPTER 3: RESEARCH METHODOLOGY

3.0   INTRODUCTION

The aim of the study is to find out challenges encountered by learners when it comes to solving quadratic equations at Glen view 2 High School in Glen View/Mufakose District in Harare Metropolitan Province. As such, this chapter discusses the methodology of the study, research design, population, sample, sampling techniques, research instruments, data collection procedures, data presentation, analysis and ethical considerations.

3.1   RESEARCH PARADIGM

Abbadia (2022) defines a research paradigm as " a method, model or pattern for conducting research. " She propounds that a research paradigm is a process of constructing a research plan that can assist the researcher in quickly understanding how the theories and practices of an research project work. Thus, research paradigm provides a framework for conducting research by outlining the basic principles, methods and concepts that researchers in that field adhere to.

Research paradigms influence how researchers conceptualize problems, design studies, collect and analyze data and interpret results. Different research paradigms include positivism, interpretivism, critical theory and constructivism, among others. This research employs the positivist paradigm. Ulz (2023) explains positivists paradigm as a process which " tends to propose an empirical hypothesis, which is then supported or refuted through the data collection and analysis. " It is therefore characterized by a belief in the existence of an objective reality that can be studied through an empirical, systematic and quantifiable approach.

In this case, the positivist paradigm will involve using quantitative research methods to collect and analyze data on secondary school learners 'ability to solve quadratic equations. The research

shall aim to identify patterns, trends and relationship in the data to understand the factors contributing to their difficulties in solving these equations.

3.2   RESEARCH DESIGN

Understanding the reasons why secondary school learners struggle to solve quadratic equations is crucial for improving mathematics education. This research aims to investigate the factors contributing to the difficulties faced by learners in this area. Quantitative and qualitative methods shall be employed in this study. Qualitative method focuses on collecting and analyzing non-numerical data to gain a deep understanding of human behavior, attitudes and motivations.it involves collecting data through methods such as interviews and observations. The researcher employed qualitative research since it provides detailed insights into people's thoughts, feelings and behaviors. Qualitative research encourages participants to share their thoughts and feelings in detail. Data collection methods to be used include interviews, observations and tests.

On the other hand, quantitative research method focuses on collecting and analyzing numerical data to test hypotheses and predict phenomena. The researcher employed quantitative research as it provides objective data that can be clearly communicated through statistics and numbers. Quantitative research also allows for generalizations to larger populations outside the test sample. Data collection methods to be used include interviews, observations and standardized tests.

3.3   POPULATION AND SAMPLE

The study will involve Form Three learners from Glen View 2 High School and Mathematics teachers. A mix of genders and academic performance levels will be included to ensure a diverse participant pool. The target of the research is a sample size of three Mathematics teachers and thirty form three learners. Stratified random sampling was adopted whereby the population was

divided into subgroups basing on mathematics achievement levels of the learners. The researcher obtained a list of learners from school administration then stratified learners by achievement level, that is, advanced,average and struggling. The learners were stratified to ensure representation from different subgroups. The sample of thirty learners were randomly selected from the subgroups, taking equal numbers from each subgroup. The selected learners were invited to participate after obtaining informed consent.

3.4   RESEARCH INSTRUMENTS

Mallory-Kani (2022) defines a research instrument as a " tool used by a researcher to help collect, measure and analyze the data you use as part of the research. " These tools or instruments take various forms, such as questionnaires, surveys, interviews, observation protocols, tests or experiments. Research instruments are carefully designed and implemented to ensure the collection of reliable and valid data that can be analyzed to address the research questions. Questionnaires, interviews, observations and tests are the research instruments employed in this research.

Interviews

Tegan (2022) defines an interview as a qualitative research method that relies on asking questions in order to collect data. Interviews involve one person, the researcher, asking questions and one or more responding. Interviews as a method for gathering information in research have both advantages and disadvantages. Sampson (2022) asserts that on the positive side, interviews provide a unique opportunity to understand people 's knowledge, views and experiences, which are meaningful in understanding social realities. Thus, interviews allow researchers to get an in-depth perception of a subject. Differences in opinion, viewpoints and habits can also be captured.

According to Tegan (2022) another benefit of interviews is that an interview allows probing and clarifying of participants' responses. Probing involves asking questions to gain a deeper understanding of a subject or issue. This is very important in the context of research as it helps to delve into specific aspects or to uncover hidden insights.

One of the drawbacks of an interview, according to Sampson (2022) is the possibility of interviewer stress. Some interviews involve some aspect of manipulation, so some people might not want to reveal much more personal information out of concern that it might be used against them. According to Babbie (2015) another disadvantage of interviews is that "the researcher may generate bias by the communication style used to deliver questions or possible response and can steer the interview in a particular direction, potentially influencing the candidate's answers and the overall assessment. Interviews are a valuable research instruments, with benefits as well as drawbacks. By being aware of the potential drawbacks, interviewers can take steps to minimize their impact and ensure a fair and objective evaluation of all candidates.

Questionnaires

Cint (2022) defines a questionnaire as a research instrument consisting of series of questions used to collect useful information from respondents. Questionnaires can be administrated in various formats, including paper-based, online or through interviews.

Questionnaires are commonly used in research and have their benefits as well as demerits. Dillman (2007) asserts that questionnaires are a cost-effective and efficient way to collect data from a large number of people. They can easily be distributed and administrated to a wide audience. Additionally, participants feel more comfortable sharing sensitive or personal information in a questionnaire since their responses are usually anonymous. Robson (2016) seems to be in support

22

of this assertion as he writes that respondents can answer the questionnaire without revealing their identity. Anonymity can lead to more honest and accurate data.

Furthermore, questionnaires allow for consistency in data collection since all participants receive the same questions in the same format. Kothari (2004) asserts that this helps in ensuring reliability and comparability of responses. Another advantage of a questionnaire as given by Cint (2022) is that questionnaires are well- suited for collecting data that can be easily analyzed using statistical methods, providing researchers with valuable insights and trends.

Besides having many benefits or advantages, questionnaires also do have disadvantages. According to Neuman (2016) response bias is one such disadvantage of questionnaires. Participants may provide inaccurate information or biased responses due to misunderstanding of questions, social desirability bias, or lack of motivation to complete the questionnaire thoroughly. Another disadvantage of questionnaires as explained by Cint (2022) is that questionnaires often provide limited opportunity for participants to elaborate on their responses which can lead to superficial or incomplete data.

While questionnaires offer many advantages in terms of efficiency, anonymity and standardization, researchers should be aware of the limitations such as response bias, limited depth of responses and difficulties in interpretation when using this research method.

Observations

According to Fraenkel, Wallen and Hyun (2019) observations in research refer to the process of gathering data through direct observation of subjects or events in their natural setting. This can involve watching behaviors, interactions, or other phenomena without interference or

manipulation by the researcher. Observations in research can be done through various methods such as field notes, audio or video recording.

Neuman (2016) asserts that observations in research are important as they provide researchers with firsthand, real-time information about the subject of study. This method allows researchers to see behavior as it naturally occurs, which can be more valid and reliable than relying on self-reports or surveys.

However, there are some limitations to using observations in research. Fraenkel, et al (2019) propounds that researchers may bring their biases or interpretation to the observation, leading to subjective findings. Additionally, observations can be time consuming and may not always capture the full complexity of a situation.

overall, observations in research can provide valuable insights into a subject or phenomenon by allowing researchers to directly witness and document behaviors and interactions in a natural setting.

Tests

Ojerinde (1986) defines tests as tools used to measure or collect data on a variety of variables, depending on the research questions. Tests are commonly used as research tools to gather data, measure specific variables and draw conclusions related to the research questions.

According to Miller (2019) tests are used to measure various attributes such as intelligence, personality traits, skills, knowledge, attitudes and behaviors. A researcher should therefore design tests to quantity these attributes objectively and systematically. One attribute of tests according to Creswell and Creswell (2017) is that tests are administrated to collect data from participants in a

standard and consistent manner. This allows researchers to gather data that can be analyzed statistically to draw conclusions and make predictions.

Miller (2019) asserts that tests can be used to compare different groups of participants or conditions. By administering tests to different groups and comparing the results, researchers can identify differences, similarities, patterns and trends.

overly, tests serve as valuable tools in research by providing systematic, standardized, and objective ways to measure, assess and analyze various aspects of the research topic. Researchers need to carefully design tests, ensure their reliability and validity, and interpret the results accurately to draw meaningful conclusions.

3.5   DATA COLLECTION PROCEDURES

Data collection methods which were used are interviews, questionnaires, classroom observations and tests. The data was collected as follows:

Interviews

The researcher conducted face-to-face in-depth interviews with a selected group of learners and mathematics teachers to gain insights into the challenges and teaching methodologies.

Questionnaires

The researcher issued out questionnaires to thirty learners. Questionnaires were administrated in order to collect data on learners' perceptions, attitudes and beliefs regarding quadratic equations.

Classroom observations

The researcher observed mathematics classes focusing on quadratic equations to note teaching styles, learner engagement and immediate learner responses to teaching methods.

Tests

The researcher administrated tests to a sample of thirty learners. The tests were administrated since they allow for quantification of variables, making it easier to analyze and interpret research data in a statistical manner. The tests were structured to be objective measures of specific constructs, reducing the potential for bias in data collection and analysis.

3.6   DATA PRESENTATION

Data presentation methods in research, according to Creswell (2013), refer to the techniques used to visually or numerically represent data collected during a study. Effective data presentation methods are important for conveying the findings of a research study in a clear and meaningful way. Here are the methods used in this research

Tables

Tables are commonly used to present numerical data in an organized and easy-to-read format. They are useful for presenting data that can be easily compared to different categories or variables.

Graphs

Bar graphs and pie charts are often used to visually represent data and trends. Graphs can help researchers and readers quickly understand patterns and relationships in the data.

Descriptive statistics

Descriptive statistics, such as mean, median, mode, standard deviation, and range are numerical summaries that provide key insights into central tendency, variability and distribution of data.

3.7   DATA ANALYSIS

The researcher utilized both qualitative and quantitative analysis methods to interpret data collected. Qualitative data from interviews will be analyzed thematically to extract in-depth insights.

Caulfield (2019) propounded that thematic analysis is a qualitative data analysis technique which is frequently used to describe a group of texts, such as, subjects, concepts and patterns. Thus, thematic analysis is a very good research method for determining people's views, opinions, knowledge, experiences or values from interviews or surveys. Claude (2019) is of the view that, thematic analysis allows a lot of flexibility in interpreting the data and dealing with large data sets more easily by sorting them into broad themes.

3.8   ETHICAL CONSIDERATIONS

Ethical considerations in research refer to the principles and guidelines that researchers must adhere to in order to ensure that their research is conducted in a morally responsible manner. Creswell (2013) asserts that these considerations are essential for protecting the rights and wellbeing of research participants, maintaining the integrity of the research process, and upholding public trust in the research findings. Some of the key ethical considerations in research which were incorporated in this research are discussed below.

Informed consent

According to Cooper and Schindler (2011), researchers must obtain voluntary and informed consent from participants before they can participate in the study. This involves providing participants with clear information about the study purpose, procedures, risks, benefits, and their rights, and allowing them to freely decide whether or not to participate.

Privacy and confidentiality

Cohen, et al (2013) asserts that researchers must protect the privacy of participants by ensuring that their personal information is kept confidential and not shared with unauthorized individuals. The researcher, to this effect, used anonymized data and secure storage methods to protect participants' identities.

Respect for participants

The researcher respected the dignity, autonomy and rights of research participants throughout the research process. This includes treating participants with honesty, fairness and respect, and taking steps to empower participants to make informed decisions about their participation.

Integrity and objectivity

According to Creswell (2013), researchers must conduct their research with integrity and objectivity, avoiding biases, conflicts of interest, and any form of misconduct. This include accurately reporting research results, acknowledging sources of funding and potential conflicts of interest, and refraining from fabricating or falsification of data.

3.9 CHAPTER SUMMARY

The chapter discussed how the researcher carried out the research. Research method, research design, research instruments, population and sample, data collection, data analysis and ethical considerations were all discussed.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.0   INTRODUCTION

This chapter focuses on the presentation, analysis and discussion of data collected through tests, classroom observations and interviews with mathematics teachers and form three learners. The results obtained are displayed in form of tables, bar charts and pie charts. The discussion is based on qualitative interview data.

4.1   DEMOGRAPHIC DATA

The study involves thirty form three learners and three Mathematics teachers from Glen View 2 High School in Glen View/Mufakose District in Harare Metropolitan Province. Demographic data of the teachers pertaining to gender, age, position, years of experience is presented in the table below

Table 4.1: Presentation of Descriptive Characteristics of Respondent Teachers

Teacher	Gender	Age	Position	Years of experience
X	F	36	Senior Teacher	10
Y	M	42	Senior Teacher	15
Z	F	26	Teacher	2

The information in the table shows that two of the teachers have many years of experience in the teaching field. One of the teachers has only two years of experience. The thirty learners are of mixed ability and are in the age group 15 - 17 years.

4.2 ORGANIZATION OF DATA ANALYSIS

The study aims to analyze the performance of a group of learners in solving quadratic equations and identify common difficulties they encounter. By collecting and analyzing data on students' responses to quadratic equation problem, patterns, trends and correlations that may shed light on the underlying factors contributing to their struggles, will be uncovered. Through this analysis, the researcher hopes to develop evident-based recommendations for educators to better support students in mastering quadratic equations.

In this case study, both quantitative and qualitative methods of data presentation will be employed to provide a comprehensive overview of the issue. Quantitative data was gathered through assessments and tests that measure students' proficiency in solving quadratic equations. Quantitative data will be presented using numerical figures, bar charts and pie charts and statistical analysis to show the overall performance of students.

Qualitative data was collected through interviews with students and teachers to understand their perspectives on why learners struggle with quadratic equations. Classroom observations were also conducted in order to provide valuable data on how students engage with quadratic equations during lessons. Observational data is presented in the form of anecdotal notes or observational checklists.

By presenting data in these different ways, the case study can offer a multifaceted view of why secondary school learners struggle with solving quadratic equations, leading to a richer analysis and more targeted recommendations for intervention and support.

4.3 RESEARCH QUESTIONS AND ASSOCIATED HYPOTHESIS

Four research questions were formulated in this case study. Each of the four questions and their related hypotheses will be analyzed below.

4.4   ANALYSIS OF DATA

Research Question 1

What are the common misconceptions and errors made by secondary school learners when solving quadratic equations?

Descriptive statistics will be employed to help summarize and describe the data related to the common misconceptions and errors made by students when solving quadratic equations. Common misconceptions and errors identified can be found in Appendix A. A table showing frequency distributions of common misconceptions and errors is shown below

Table 4.2: Table showing frequency distributions of common misconceptions and errors

MISCONCEPTION OR ERROR	FREQUENCY
Confusion between factoring and solving	13
Incorrect application of zero-product property	8
Mistakes in completing the square	17
Incorrectly applying the quadratic formula	18
Neglecting to check solutions	21

Fig 4.1: Pie chart showing frequency distributions of common misconceptions and errors
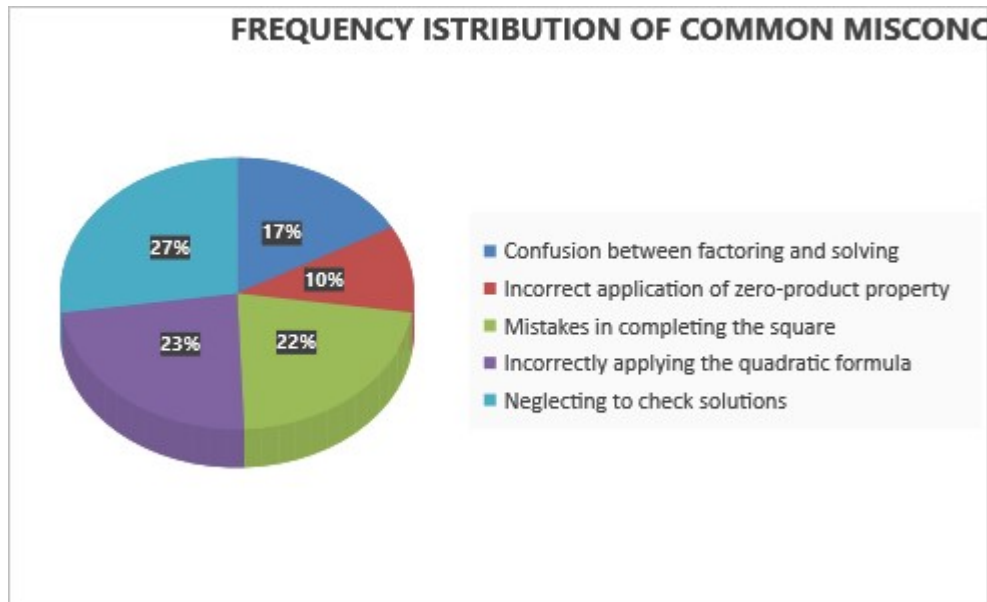
Most of the learners neglected to check their solutions for correctness. A considerable number made mistakes in applying the quadratic formula and completing the square and most of the learners confused factoring and actually solving the equation. Here are a few examples of errors made by learners.

$2) \quad x^2 + 5x = 24$

$x^2 + 5x - 24 = 0$

$24 x^2$

$x^2 - 8x + 3x - 24 = 0$

$x(x-8) + 3(x-8) = 0$

$(x+3)(x-8) = 0$

$x + 3 = 0 \quad \text{or} \quad x - 8 = 0$

$x = -3 \quad \text{or} \quad 8$

$4.b) \quad x = -9 \pm \sqrt{-(9)^2-}$

$-9 \pm \dfrac{\sqrt{(9)^2 - 4(3)(5)}}{2(3)}$

$= -9 \pm \dfrac{\sqrt{81-60}}{6}$

$= \dfrac{-9 \pm \sqrt{21}}{6}$

$x = 2,26 \quad \text{or} \quad x = 0,74$

The first picture shows that the learner used wrong factors when factoring the equation, leading to incorrect solutions. In the second picture, the learner applied the quadratic formula incorrectly and failed to simplify correctly. The researcher also noted that when solving quadratic equations some

participants incorrectly applied the zero-product property. The errors made included failing to consider both roots of the equation, forgetting to set each factor equal to zero and incorrectly assuming that both factors must be zero. For instance, some participants gave _6 and +1 as roots of the equation x^2 _5x_6=0.When it came to using the method of completing the square, the common mistakes noted include forgetting to halve the coefficient of the linear term before squaring it, failing to balance the equation by adding the same value to both sides and errors in keeping track of negative signs while completing the square. For example, some participants did not find the half of -3 when solving the equation $3x^2$ -9x-5=0.

Helping students understand these common misconceptions and errors can improve their ability to solve quadratic equations accurately and confidently.

Research Question 2

How do cognitive abilities and mathematical background of secondary school learners impact their ability to solve quadratic equations?

Analysis of cognitive abilities and mathematical background of participants is conducted through diagnostic tests, observations, one-on-one interviews of both learners and teachers. Quantitative analysis of diagnostic test in Appendix B gave a mean of 10.4 and a variance of 70.83. The researcher gave the participants a test and calculated the mean and variance of the participants` test scores. The mean score of 10.4 indicates that, on average, the participants achieved a score of 10.4 out of 20 on the test. This means that the performance of the students, on average, was below 50% as 10.4 is slightly above half of 20. The variance of 70.83 suggests that there is some variability in the scores, with some scores deviating from the mean. The scores are spread out or varied around the mean. In the context of test scores out of 20, a variance of 70.83 would indicate

that the scores are not tightly clustered around the mean score of 10.4, but rather scattered with a wide range of scores. Some scores are close to the mean, while others are far away, indicating varying levels of achievement. This suggests that there is a significant difference between the highest and lowest scores in the data set. The distribution of scores suggests that learners understanding of algebraic concepts and problem-solving skills are shallow.

Research Question 3

What teaching strategies or methods are most effective in helping secondary school learners understand and solve quadratic equations?

The researcher compared the traditional lecture method and the problem- solving based strategy. The researcher randomly assigned the participants to two groups and taught them quadratic equations separately. One of the groups was taught using the lecture method and the other group was taught using the problem- solving based technique. Tests were used as assessment methods to measure students understanding and ability to solve quadratic equations. Data was gathered on students' performance before and after the implementation of the teaching methods. Grouped data of test scores of participants is given below

Table 4.3: Frequency table showing distribution of marks of traditional method

MARK	1- 5	6 - 10	11- 15	16 - 20
FREQUENCY	5	7	2	1

Table 4.4: Frequency table showing distribution of marks of problem-solving based technique

MARK	1 – 5	6 - 10	11- 15	16 - 20
FREQUENCY	1	4	7	3

The information in the table is presented in the bar chart below

Fig 4.2: Bar Chart showing comparison of marks between traditional method and problem-solving based method
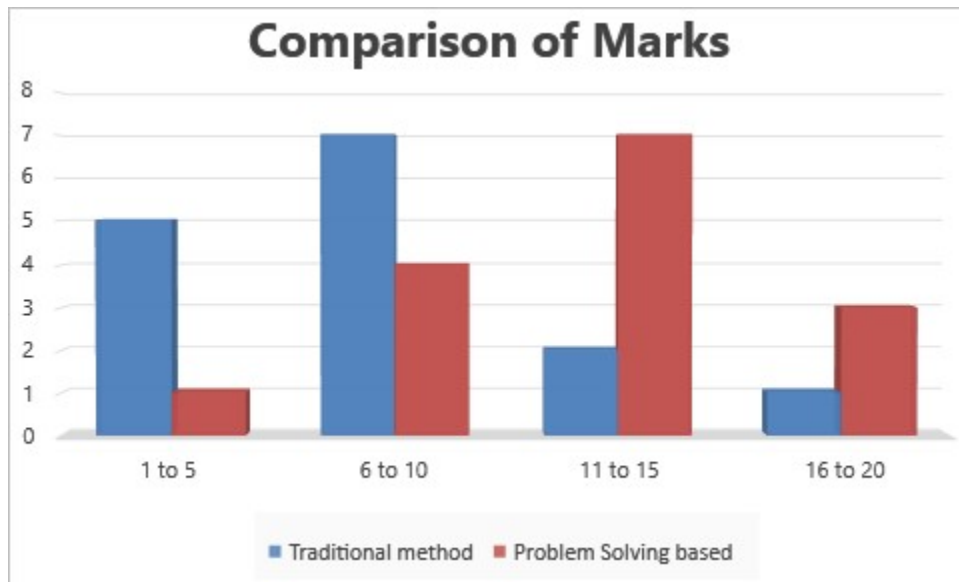
The bar chart shows that categories for the problem-solving method are higher for good marks as compared to traditional method. Since the bars representing the outcomes of the problem-solving based method are higher than those of the lecture method, it means that the problem-solving based method is more effective in achieving the desired learning outcomes compared to lecture method.

Research Questiont 4

To what extent do technology tools and resources enhance or hinder secondary school learners' ability to solve quadratic equations?

Interviews and observations were employed to collect data in a bid to answer the research question. Qualitative analysis of interviews was conducted. Findings from the interviewed teachers showed that technology tools and resources enhance learners' ability to solve quadratic equations. One of the teachers was quoted saying that,

"Technology tools make learning more interactive and engaging for students, leading to increased interest and motivation. "

Another point raised was that of skill development. Using technology tools can help students develop important skills such as critical thinking, problem-solving and digital literacy. However, according to Sing and Khine (2017), technology tools and resources can also potentially hinder secondary school learners if not used effectively. Another teacher, to this effect, was quoted saying,

"Students may become reliant on technology tools and struggle to solve quadratic equations without them. "

Abramovich (2016) asserts that when used appropriately and in moderation, technology tools and resources can enhance secondary school learners understanding and proficiency in solving quadratic equations. Understanding and proficiency is achieved since learners will be motivated to learn. The learners involved in this study showed a lot of enthusiasm when asked how

comfortable they are with using technology tools to learn mathematical concepts like quadratic equations. One participant responded by saying,

I would be very happy to use technology tools and I think it would be quite interesting and much easier for us learners to use technology tools to solve quadratic equations.

Most of the interviewed learners responded positively when asked whether technology tools hindered or improved their learning of quadratic equations. They were of the opinion that technology tools can improve their understanding of quadratic equations. One participant responded by saying,

Technology tools can improve learning of quadratic equations since using tech tools can make the process more engaging and interesting

Overall, technology tools can be a valuable resource for students studying quadratic equations. The participants, that is both teachers and learners, alluded to this fact.

4.5   DISCUSSION

In this section, the findings from the study are discussed under four subheadings derived from the sub questions given in importance of study. These subtopics are misconceptions and errors made by learners when solving quadratic equations, impact of cognitive abilities and mathematical background on learners' ability to solve quadratic equations, teaching methods and effect of technology tools and resources on quadratic equations.

In the first section, the findings of the study on misconceptions and errors are discussed. The discussion is presented in relation to the available literature.

Misconceptions and errors made by secondary school learners when solving quadratic equations

The study attempts to answer the research question, what are the misconceptions and errors made by secondary school learners when solving quadratic equations. The study revealed that common misconceptions or errors noted were confusion between factoring and solving, incorrect application of zero-product property, mistakes in completing the square, incorrectly applying the quadratic formula and neglecting to check solutions. This finding coincides with Moore (2021) who writes that common errors are computational and in terms of completing the square, the most common error is when students forget to divide both sides by a term to get the squared term.

Impact of cognitive abilities and mathematical background of secondary school learners on ability to solve quadratic equations

It was revealed from the study that cognitive abilities and mathematical background of secondary school learners have an impact on solving of quadratic equations. Cognitive abilities include critical thinking, logical reasoning, ability to visualize concepts and memory. The researcher observed that students with strong critical thinking skills can effectively analyze quadratic equations, identify patterns and develop problem-solving strategies. According to Moore (2021), cognitive abilities such as logical reasoning help students understand the steps involved in solving quadratic equations and make connections between different mathematical concepts. Abramovich (2016) asserts that having a good memory is a cognitive ability which helps students recall mathematical formulas, methods and strategies. The researcher noted that among the study participants, there were some who were able to recall, for instance, the quadratic formula and apply it correctly. There were also some students who were able to correctly solve quadratic equations

by completing the square. It follows therefore that cognitive abilities do have an impact on learners' ability to solve quadratic equations.

Students with a strong cognitive ability, a solid mathematical background and ample practice are more likely to excel in solving quadratic equations. O'Connor and Norton (2022) seem to be in agreement as they write that not having prior knowledge of algebra can have a negative impact on students' ability to work with quadratic equations. Thus, a solid foundation in algebra is essential for solving quadratic equations as it involves manipulating variables, constants and coefficients. The researcher noted that students who did not have a solid background in algebra struggled with simple concepts such as addition and subtraction of different variables. Proficiency in factoring quadratic expressions and applying the formula significantly aids in solving quadratic equations.

Teaching methods or strategies that are most effective in helping secondary school learners understand and solve quadratic equations

This section attempts to answer the research question; Which teaching methods or strategies that are most effective in helping secondary school learners understand and solve quadratic equations. The study revealed that traditional lecture method of teaching promotes rote memorization or procedural fluency whereas problem-solving learning is a learner- centered approach.

Technology Integration in Quadratic Equations Instruction

This section attempts to answer the research question, to what extent do technology tools and resources enhance or hinder secondary school learners' ability to solve quadratic equations. The study revealed that technology can play a significant role in teaching quadratic equations by providing various tools and resources that can enhance the learning experience of students.

Technology tools such as graphing calculators can be used to draw graphs of quadratic equations and visualize their shapes, roots, turning points and other properties. You tube is rich in video tutorials, interactive lessons and practice problems that can help students learn quadratic equations at their own pace. This coincides with the findings of Lee and Kim (2020) who conducted research on graphing calculators, software and apps in teaching quadratic equations. The study highlights the advantages and challenges of technology integration in mathematics education.

In a study by Sing and Khine (2017), researchers examined the effectiveness of a computer-based instructional intervention on students procedural and conceptual understanding of quadratic equations. The research showed that the intervention significantly improved students' performance on solving quadratic equations and also deepened their conceptual understanding of the topic.

4.6   CHAPTER SUMMARY

The findings of the research were presented in form of tables, graphs and pie charts, discussed and analyzed under subheadings derived from the sub research questions and supported by available literature. The study seeks to find out why secondary school learners struggle to solve quadratic equations.

CHAPTER FIVE: SUMMARY AND RECOMMENDATIONS

5.0   INTRODUCTION

The purpose of this chapter is to give a summary of the key findings of this study as well as giving recommendations. The researcher intended to find out why learners struggle to solve quadratic equations at Glen view 2 High School in Glen View/ Mufakose District in Harare Metropolitan Province. This chapter contains summary of the study, conclusions, recommendations and future research.

5.1   SUMMARY OF THE STUDY

The results of the study revealed that most learners struggle to solve quadratic equations. Factors such as misconceptions and errors made by learners, ineffective teaching methods and impact of technology tools on learning of quadratic equations were explored in order to find out if they contribute to learners' struggle with solving quadratic equations.

Research questions were construed based on the above-mentioned factors. Review of related literature on previous research and studies that have investigated why secondary school learners struggle to solve quadratic equations was conducted. The literature review was argued around recurring central themes which mirror the research questions. The literature review explored various factors that may contribute to learner's struggle with quadratic equations. These include misconceptions about the concepts involved, ineffective teaching methods, lack of foundational algebra skills and use of technology tools. By synthesizing the findings from existing literature, it becomes evident that a multifaceted approach is needed to address the challenges faced by secondary school learners in solving quadratic equations.

In gathering information, the researcher issued out tests to learners, made observations in classroom set up, as well as interviewed the participants who included three Mathematics teachers and thirty form three learners. From the gathered information, tables, statistical analysis, pie charts and bar charts were used to present the data which was analyzed and discussed.

Findings emerging from the study are that, on misconceptions or errors, most respondents neglected to check solutions and a good number made mistakes in completing the square. The study also revealed that learners understanding of algebraic concepts problem-solving skills are shallow. It was also revealed that there is a tendency by teachers to teach using traditional lecture method which encourages procedural learning versus conceptual learning.

5.2   CONCLUSION

Factors such as lack of prior mathematical knowledge, ineffective teaching methods and limited engagement with the material may contribute to learners struggles in solving quadratic equations.

5.3   RECOMMENDATIONS

From the findings, the researcher made the following recommendations to the learners, parents, teachers, schools and Ministry of Primary and Secondary Education.

Differentiated instruction

Teachers should tailor instruction to meet the diverse needs of students. Multiple methods of teaching quadratic equations should be engaged to accommodate various learning styles.

Hands-on activities

Teachers should incorporate hands-on activities and real-world examples to help students visualize and understand the concepts of quadratic equations.

Peer tutoring

Learners should be engaged in peer tutoring programs where they can help each other understand and solve quadratic equations.

Technology Integration

Schools should make available educational technology such as graphing calculators, projectors, interactive simulations, or online tools so that learners can easily access them.

Formative assessment

Regular formative assessment should be conducted to monitor students' progress and identify areas of difficulty. Timely feedback should be provided to guide students towards improvement. This could mean that re-introduction of ZJC examinations instead of waiting for four years to administer examinations.

Self -regulation skills

Learners can be provided with self - regulation skills, such as goal setting, time management and self -monitoring, to help students take ownership of their learning progress in solving quadratic equations.

Parent involvement

Parents can be encouraged to be involved in supporting their children's learning of quadratic equations. Resources and guidance can be provided to parents to assist their children with homework and practice outside of school.

5.4   SUMMARY

These recommendations aim to address learners struggle with solving quadratic equations through a combination of instructional approaches, support mechanism and student- centered strategies to enhance learning.

REFERENCES

Abramovich, S. (2016). Exploring quadratic equations with digital tools in Mathematics Teacher education.

Alcock, S.,Inglis T. & Simpson, A (2014). Students' procedural and conceptual understanding of factorization of quadratic expressions. McGraw-Hill

Babbie, E. (2015). The practice of social research. Cengage learning

Bozkurt, I., Inan, T., & Oztuna, R. (2017). Students' procedural and conceptual knowledge of quadratic equations.

Chazan, Z. (1996). Conceptions of school algebra and uses of variables.

Caulfield, J. (2019). How to do Thematic analysis. McGraw-Hill, USA.

Cohen, L.,Manion L., and Morrison, K. (2013). Research Methods in Education. 7 ed. Routledge: New York.

Cooper, D. and Schindler, P. (2011). Business Research Methods. McGraw-Hill Education.

Creswell, J. W. (2013). Qualitative Inquiry and Research Design: Choosing Among Five Approaches. Limited ed.

Creswell, J. W. and Creswell, J. D. (2017). Research Design: Qualitative, quantitative and mixed methods approach. Sage Publications.

Cint, S. (2022). What is a questionnaire and how is it Used in Research? https://www. 41

Dillman, W. (2007). The research methods knowledge base. Atomic Dog Publishing.

Du Plooy-Cillers, F., Davis, C. and Bezuidenhout, R. (2014). Research matters. Juta and Co. Ltd. Cape town

Fraenkel, J.R., Wallen, N.E. and Hyun, H.H. (2019). How to design and evaluate research in education. McGraw-Hill Education

Garcia, M. and Lee, K. (2016). The Effect of Negative Attitudes on the Learning of Quadratic Equations in High School Students

Hiebert, J. and Carpenter, T.P. (2016). Learning and teaching with understanding. Hoxton: Eric Clearinghouse.

Joshi, T.R. (2019). Investigating students' mathematical difficulties in quadratic equations. https://elibrary.tucl.edu.np>t

Miller, R. (2019). Findings and Using Tests for Research. Liberty University. USA. https://guides.lib.berkeley.edu>Tests

Moore, T. (2021). What are the common errors in solving quadratic equations? University of Southampton

Neuman, W.L. (2016). Social Research methods: Qualitative and quantitative approaches. Pearson Education

Robson, C. (2016). Real World research. John Wiley & Sons

Smith, L. and Johnson. (2018). Effective Teaching Strategies for Quadratic Equations in Middle School Mathematics

O'Connor B.R. and Norton's. (2022). Exploring the challenges of learning quadratic equations

Zakaria, E. (2010). Analysis of Students' Error in Learning of Quadratic Equation. https://files.eric.ed.gov.>ful42

Zakaria, E. and mistimes. (2015). Analysis of Students' Errors in Learning of Quadratic Equations. University Kembangan. Malaysia

APPENDIX A: PRE-TEST

1. Solve the following equations

    (a) $x^2 + 3x = 0$ [2]

    (b) $4y^2 - 9 = 0$ [2]

    2. Solve the equation

    a) $y^2 - 6y + 8 = 0$ [2]

    b) $5x^2 - 3x - 2 = 0$ [3]

3. Solve the following equations

    (i) $(t + 5)^2 = 6\frac{1}{4}$ [3]

    (ii) $(y - \frac{1}{5})^2 = \frac{9}{25}$ [3]

4. Solve the equations, giving your answer correct to two decimal places

    (i) $2x^2 + x - 12 = 0$ [5]

    (ii) $3x^2 - 5x - 5 = 0$ [5]

50

1.   The solution of a quadratic equation as $x = -1$ and x=3.Write down the quadratic equation
      in the form ax² +bx+ c=0 where a, b, c are integers.

2a)   Solve the equation $x^2 - 5x - 6 = 0$ [2]

b) $x^2 + 5$ x = 24   [2]

3.   Solve the equation

a) $(2x - 1)^2 = 1$ [3]

b) $(y + \frac{1}{4})^2 = \frac{1}{2}$ [3]

4a)   Show that the equation $x - 3 = \frac{5}{3x}$ reduces to 3x²_ 9 x_5=0.   [2]

b)   Solve the equation $3x^2 - 9x - 5 = 0$. Give the answers correct to 2 decimal places   [5]

My name is Chinyani Gillian. I am a student at Bindura University of Science Education doing research on why form three learners' study to solve the quadratic equation Glenview \Mufakose District of Harare Metropolitan Province in Zimbabwe. The research is purely academic and the information you provide will be strictly confidential

Your cooperation will be greatly appreciated

GENERAL INSTRUCTION

Please tick the appropriate bracket [] or column to fill in the blank spaces where necessary

   1 Gender: Male [ ] female [ ]

   2 Age ……………………

   3   Professional Qualification ……………………………………………………………………

   4   Years of experience …………………

   5   Which method of teaching do you prefer to use when teaching quadratic equations?
       …………………………………………………………………………………..

   6   Comment   on   your   preferred   choice   of   teaching   method
       …………………………………………………………………………………

   7   Can you describe a specific lesson where you used technology tools to teach quadratic?
       …………………………………………………………………………………………

………………………………………………………………………………………………………..

What   was   the   impact   on   student

learning?..

8   How do you assess the effectiveness of technology of tools in teaching quadratic equations?

     ………………………………………………………………………………….

9   Have you encountered any challenges in integrating technology tools into your teaching of

     quadratic equations? ……………………………………………………………… How

     have you addressed these challenges?..

10 In your own opinion, what are the key benefits of using technology tools in teaching

     quadratic equations?..

APPENDIX D: INTERVIEW GUIDE FOR STUDENTS

Introduction

My name is Chinyani Gillian. I am a student at Bindura University of Science Education doing research on why form three learners' study to solve the quadratic equation Glenview \Mufakose District of Harare Metropolitan Province in Zimbabwe. The research is purely academic and the information you provide will be strictly confidential

Your cooperation will be greatly appreciated

GENERAL INSTRUCTION

Please tick the appropriate bracket [ ] or column to fill in the blank spaces where necessary

1 Gender: Male [ ] female [ ]

2 Age ………………………….

3 Class ………………………………….

4 How often do you use technology tools to learn quadratic equations?.................................

5 What specific technology tool do you find most helpful in learning quadratic equations?
……………………………………………………………………………………………………
…………………..

6 Have you noticed any differences in your learning when using technology tools compared to traditional materials?..

7 How comfortable are you with using technology tools to learn mathematical concepts like quadratic equations?...

8 Do you think technology tools make learning quadratic equations more engaging for you?..

9 Do you believe that technology tools are essential for enhancing your learning of quadratic equations?...

10 in your opinion, do technology, tools hinder or improve the overall learning experience of quadratic equations?...