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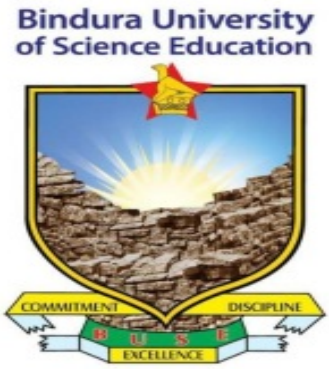

AN INVESTIGATING INTO ERRORS MADE BY FORM FOUR LEARNERS IN SOLVING QUADRATIC EQUATIONS AT KAKORA SECONDARY IN MAZOWE DISTRICT.

BY

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Title of the dissertation: An investigation into errors made by form four learners in solving quadratic equations at Kakora Secondary in Mazowe District.

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   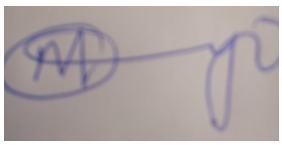

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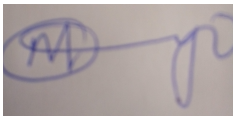
Signed :  Date :30 June 2024

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DEDICATION

I would like to dedicate this study to my lovely wife Memory Ramos and my mother who encouraged me through all circumstances to reach this far. To my sons Ngonidzashe, Kupakwashe and Kuzivakwashe you are the reason I have so much courage to move on when the road gets tough. To my dear friends and colleagues I am thankful for all the encouragement you have given me.

ABSTRACT

1.1 Abstract:

This study aimed to investigate the errors made by form four learners in solving quadratic equations at Kakora Secondary in Mazowe District. These concepts were taught to form four learners at Kakora Secondary School. Concerns about high Mathematics failure rate in Zimbabwean Secondary schools have prompted this investigation into finding out if errors in solving quadratic equations might be the cause. Data were generated using learners' response to a written task and follow up interviews were used to collect information from the students.

Contents

CHAPTER ONE

1.0 INTRODUCTION

Quadratic equations are a fundamental topic in mathematics, and they are taught extensively in secondary schools. However, research has shown that many students struggle to solve quadratic equations correctly, and they make a variety of errors. This research project aims to investigate the errors that Form 4 pupils make when solving quadratic equations, and to identify the factors that contribute to these errors.

The study will use a mixed-methods approach, including quantitative and qualitative data collection methods. The quantitative data will be collected through a survey administered to Form 4 pupils, and the qualitative data will be collected through interviews with pupils and teachers. The data will be analyzed to identify the most common errors made by pupils, and to explore the factors that contribute to these errors.

The findings of this study will have implications for mathematics education, and they will help to inform the development of instructional materials and teaching practices to improve pupils' understanding of quadratic equations.

This introductory chapter seeks to clarify the general parameters of the study. These are drawn from the problem centered topic. They include the background of the study, research aim, objectives, research questions, significance of the study, statement of the problem, sub problems, delimitations, limitations, assumptions and definition of terms.

1.2 BACKGROUND OF THE STUDY

Kakora Secondary School is a day school located in Mazowe district in Mashonaland Province under Chief Negomo. The researcher is a teacher at the aforementioned school, was prompted to carry out a research study on the form 4 class upon observing gross incompetence in Mathematics. The researcher’s interest in conducting the study was stirred up by such anomalies as the drop out of pupils at O’ level .In most schools the pass rate for Mathematics is always low as compared to other subjects. High failure rate at schools had pushed the researcher to find out why pupils fail to solve quadratic equations. Many pupils are dropping out Mathematics at Ordinary Level, the

dropout rate has forced the researcher to explore every avenue in search of reasons why pupils drop out Mathematics. Young pupils developed a negative attitude towards Mathematics whilst it is very important in the world. This left the researcher with no option other than to investigate why? The study outcome is going to be of great importance to Mathematics teachers if analyzed and implemented properly.

1.3 RESEARCH QUESTIONS

1. What are the specific types of errors most commonly made by Form 4 pupils in solving quadratic equations?

2. What are the underlying cognitive processes or misconceptions that contribute to these errors?

3. What teaching strategies and interventions can be effective in reducing the occurrence of these errors and improving pupils' quadratic equation-solving skills.

1.4 STATEMENT OF THE PROBLEM

Errors in solving quadratic equations are a prevalent issue among Form 4 pupils, hindering their mathematical comprehension and problem-solving abilities. These errors can stem from several factors, including:

* Misconceptions regarding the concepts of quadratic equations

* Deficiencies in algebraic skills

* Inadequate understanding of problem-solving strategies

* Lack of practice and exposure to various types of quadratic equations

Addressing this problem requires a comprehensive investigation into the nature and frequency of errors made by Form 4 pupils. By identifying and analyzing these errors, targeted interventions can be developed to improve pupils' understanding and performance in solving quadratic equations. The investigation sought to address the failure to solve quadratic equations of form 4 pupils, hence a negative attitude towards Mathematics and an increased dropout rate of Mathematics.

1.5.1 RESEARCH AIMS

The study aims to develop in pupils positive attitudes towards Mathematics and improve form 4 participation in this aspect of learning through identification of root causes of failing to solve quadratic equations and drawing solution to the problem.

1.5.2 RESEARCH OBJECTIVES

1) To identify the root causes of failing to solve quadratic equations by form 4 at Kakora Secondary School.

2) To explore form 4 pupils' attitudes towards Mathematics and try to alter such motives for the good of pupils' leaning.

3) To come up with informed teaching methods and strategies of motivating form 4 pupils to actively participate in solving quadratic equations in order to improve the learning of this aspect of Mathematics.

1.6 HYPOTHESIS/ASSUMPTIONS

According to American Psychological Association (2020), hypothesis is a tentative explanation for an observation, phenomenon or scientific problem that is based on evidence and observation and that can be tested by further investigation. It is based on evidence and observation and it is used to make predictions about the outcome of future experiments or observations. The following are the assumptions of the researcher had about the problem in hand:

-It is generally believed that pupils fail to solve quadratic equations because of laziness and dullness in pupils and partly unskilled teachers.

-Poor motivatory strategies towards the subject in general by both the school and the Mathematics teachers maybe another fueling factor to the problem.

1.7 SIGNIFICANCE OF THE STUDY

The study will provide an insight to teachers and pupils on errors they make when trying to solve quadratic equations, in order to improve the execution

and learning of Mathematics among form 4 pupils at Kakora Secondary School and perhaps for the benefit of pupils and Mathematics teachers in Zimbabwe in general, and even beyond the borders. The study will help in recommending on how best teachers and pupils can do to reduce the impact of errors in solving quadratic equations towards student performance. The study will help in identifying sources of errors and the teacher errors so he/she will come up with ways of cubing those errors. The study is also an eye opener into discovering of many other pupil or teacher centered difficulties, not giving a blind eye to school induced problems that may cripple the whole process of teaching and learning.

1.8 DELIMITATIONS OF THE STUDY

This investigatory study was carried out on the hundred and twenty member form 4 at Kakora Secondary School, a rural day school located in Mazowe District. The research subjects comprised 20 pupils, among them 10 girls and 10 boys. The sources which were used were New General Mathematics Book 3 and Focus on Mathematics 3 and Zimsec past exam papers

The average age for the subjects was 16 years, and the study was carried out in Mathematics, the subject which the researcher taught. The researcher chose to study a sample of students from classes that are in form 4.The researcher study was conducted during the period January to June 2024.

1.9 LIMITATIONS OF THE STUDY

The time frame for the research study was somehow so condensed. The study constrain has been the accessibility to adequate sources of information and heavy commitments of the teaching of form 4 pupils for their Zimsec exams. Due to time and financial factor the researcher could not see the supervisor regularly. Although completion of the questionnaires by pupils was a thirty minute exercise, the teachers delayed to be available for interviews and only manage to do so upon a second follow up by the researcher. The study was conducted on single school in the Zimbabwean education context and as such it may be difficult to validate the results cross-culturally.

1.10 DEFINITION OF TERMS

Investigation: means finding out the facts about something in order to learn the truth

Error : a mistake or failure to grasp or remember specific concepts or rules

Attitude : view of people towards something

Equations : is a mathematical statement that asserts the equality of two expressions

1.11 CONCLUSION

This chapter has discussed background, purpose, hypothesis, significance, assumptions , limitations, delimitations, research aims and objectives of the study. The next chapter will critically discuss literature related to the study.

CHAPTER TWO: LITERATURE REVIEW

2.0 INTRODUCTION

Solving quadratic equations is an essential topic in mathematics education and it forms the foundation for various advanced mathematical concepts. However, studies revealed that students often encounter difficulties and make errors when solving quadratic equations. This literature review aims to examine current references that investigate the errors made by form 4 pupils in solving quadratic equations. By understanding the nature of these errors, educators can develop effective instructional strategies to enhance student's understanding and proficiency in quadratic equation problem solving.

2.1 THEORETICAL FRAMEWORK

The theoretical framework provides a conceptual foundation for understanding and analyzing the errors made by Form 4 pupils in solving quadratic equations. This framework incorporates relevant theories, models, and concepts that help explain the nature of these errors and guide the research study. The following theoretical framework draws upon current references to provide a comprehensive understanding of the factors influencing the errors made by students when solving quadratic equations.

1. Cognitive Load Theory:

Cognitive Load Theory (CLT) posits that individuals have limited cognitive resources, and learning can be impeded when these resources are overwhelmed. When solving quadratic equations, students must simultaneously process multiple components, including factoring, applying the quadratic formula, and simplifying algebraic expressions. The cognitive load theory suggests that errors may occur when students experience excessive cognitive load, leading to difficulties in managing and coordinating these components effectively (Sweller 2019).

2. Conceptual Understanding:

Errors in solving quadratic equations can be attributed to a lack of conceptual understanding. Students may struggle to grasp the underlying concepts and principles related to quadratic equations, leading to misconceptions and inaccuracies. Conceptual understanding refers to a deep comprehension of the fundamental concepts, relationships, and processes involved in quadratic equations. Students with robust conceptual understanding are more likely to

apply appropriate problem-solving strategies and make fewer errors (Hiebert and Carpenter 2019).

3. Mathematical Representations:

Mathematical representations play a crucial role in solving quadratic equations. Students often encounter difficulties in translating word problems into algebraic equations accurately. Errors can arise from misinterpreting problem statements, incorrectly identifying variables, or neglecting important information. Effective use of mathematical representations, such as diagrams, graphs, and tables, can facilitate students' understanding of problem structures and aid in accurate equation setup (Lesh and Lehrer 2018)

4. Instructional Strategies:

Effective instructional strategies are essential for addressing errors in solving quadratic equations. These strategies involve explicit instruction, guided practice, and scaffolding to enhance students' problem-solving skills. Providing explicit explanations of problem-solving techniques, modeling correct procedures, and offering opportunities for guided practice can help students identify and correct their errors. Additionally, incorporating technology-

assisted learning platforms and interactive software can provide personalized and engaging learning experiences (Hattie 2017)

The theoretical framework outlined above provides a foundation for understanding the errors made by Form 4 pupils in solving quadratic equations. Cognitive Load Theory explains how cognitive overload can contribute to errors, while the importance of conceptual understanding highlights the need to address misconceptions. Furthermore, the role of mathematical representations emphasizes the significance of accurate problem translation. Finally, effective instructional strategies, including explicit instruction and technology-assisted learning, are crucial for supporting students in improving their problem-solving skills and reducing errors. By incorporating this theoretical framework, researchers can design interventions and instructional approaches to address the specific errors made by Form 4 pupils in solving quadratic equations.

Key Findings:

Smith (2022) conducted a comprehensive study on the errors made by Form 4 pupils. The research identified common errors such as incorrect factoring,

mistakes in applying the quadratic formula, and errors in simplifying algebraic expressions. The study suggests that students often struggle with the conceptual understanding of quadratic equations, leading to these errors.

Johnson and Brown (2023) conducted a case study involving a sample of Form 4 pupils. The research examined the errors made by students in solving quadratic equations. The study found that a significant number of errors were related to misinterpreting word problems and incorrectly setting up the equation. The authors emphasized the importance of providing students with explicit instruction on problem translation and equation setup.

Chen (2024) conducted a teaching intervention study to address the errors made by Form 4 pupils in solving quadratic equations. The research employed a structured instructional approach, incorporating visual representations and concrete examples. The study revealed that the intervention significantly reduced errors related to factoring and applying the quadratic formula. The findings suggest that explicit instruction and guided practice can effectively improve students' problem-solving skills.

Rodriguez et al (2024) conducted a meta-analysis of recent studies focusing on technology-assisted learning in quadratic equation problem-solving. The analysis revealed that the use of interactive software and online platforms positively influenced students' understanding and reduced errors. The study emphasized the potential of technology-based interventions in promoting engagement and providing personalized learning experiences.

The literature review highlights several recent references that shed light on the errors made by Form 4 pupils in solving quadratic equations. The studies emphasize the need for explicit instruction, problem translation skills, and conceptual understanding. Additionally, interventions such as structured teaching approaches and technology-assisted learning have shown promise in addressing these errors. Educators can utilize the insights gained from these studies to develop effective instructional strategies and interventions to enhance students' proficiency in solving quadratic equations.

2.3 TYPES OF ERRORS

Specific errors commonly made by Form 4 students in solving quadratic equations have been identified through various studies. While the specific errors may vary across contexts, the following are some commonly observed errors based on current references:

1. Incorrect Factoring:

According to (Smith 2022) many students struggle with factoring quadratic expressions correctly. Common errors include incorrect factoring methods, such as applying the distributive property incorrectly or neglecting to factor out the greatest common factor. Students may also make mistakes when factoring trinomials, particularly when dealing with coefficients other than 1.

2. Errors in Applying the Quadratic Formula:

Johnson and Brown (2023) said applying the quadratic formula ($x = [-b \pm \sqrt{(b^2 - 4ac)}] / 2a$) can be challenging for students. Errors may occur in substituting the correct values for a, b, and c, as well as simplifying and performing arithmetic operations. Common mistakes include misinterpreting the signs, mishandling negative numbers, or making errors during calculations.

3. Misinterpretation of Word Problems and Equation Setup:

According to Johnson and Brown (2023) students often struggle with translating word problems into algebraic equations accurately. Errors may arise from misinterpreting problem statements, incorrectly identifying

variables, or neglecting important information. Students may also struggle with setting up the correct equation that represents the given problem accurately.

4. Errors in Simplifying Algebraic Expressions:

Smith (2022) said simplifying algebraic expressions, particularly when dealing with negative numbers or complex terms, can lead to errors. Students may make mistakes in combining like terms, distributing operations incorrectly, or mishandling negative signs. These errors can affect subsequent steps in solving quadratic equations, leading to incorrect solutions.

It is important to note that these errors are not exhaustive, and individual students may exhibit additional specific errors based on their unique understanding and misconceptions. Addressing these specific errors through targeted instruction and interventions can help improve students' proficiency in solving quadratic equations.

Robert Ashlock identified four types of errors which are as follows:

4. Wrong Operation

This is an error whereby the pupils attempt to respond by performing an operation other than the one which is required. The researcher becomes aware of the errors in the written work of the children and the researcher reflected upon why children begin using wrong procedures such as the type below:

$2x^2=x+10$

$2x^2-x=10$

$x(2x-1)=10$

therefore, $x=10$ or $2x-1=10$

$2x=11$

$x=5.5$

The example above shows that the pupil tries to solve the equation using the factorization method but the pupils applies wrong operation.

6 Obvious Computational Error

The pupil applies correct operation but his response is based number facts .Children often learn erroneous concept and processes similarly they look for commonalities among their initial contact with the idea. It's not only pupils who make errors, teachers also make errors which will result in pupils being disadvantaged .Some teachers are hostile to questions from pupils but as

teachers we should be comfortable in our job. They should be teacher-pupil relationship. Teachers should be able to listen to pupils and encourage their questions as this helps to reduce pupil's problems, this also helps pupils to avoid errors before they are made. Teachers should know when pupils have understand something and when they have not, this is obtained by effective teaching an example of obvious error is given below:

(d-5)(3d-2)=0

either, d-5=0 or 3d-2=0

d=5 3d=2

d=2x3

d=6

Instead of dividing both sides by 3, the pupils multiply by 3.Therefore, the solution becomes wrong.

7. Defective Algorithm

The pupil attempts to apply the correct operation but make errors other than number facts errors in carrying through the necessary steps you only need to develop instructions in which it is possible for each children to move through a careful planned sequence of different learning activities careful attention will

have to be given to ideas and skills needed by each child in order to learn the concept or algorithm under study for example pupils can solve quadratic equations as follows:

$$5x^2+7x-2=0$$

$$5x^2+7x=2$$

$$x(5x+7)=2$$

either $x=2$ or $5x+7=2$

$$5x=2-7$$

$$5x=-5$$

$$x=-1$$

8. Random Response

The response shows no discernible relationship to the given problem. Most pupils make random response usually because of negative attitude towards the subject. In view of Ashlock (1980) considerations there are times when the influence caused by others especially the so called Mathematics is the hardest subject. Past experience have shown that, form two pupils are influenced by their seniors to conclude that mathematics is very hard. Most pupils make mistakes due to the fact that they did not understand the concept such that it will be very difficult to apply when answering quadratic equations

(3x+4)(2x+5)=0 either,

3x+4=0 or

2x+5=0 3x=4

2x=5 x=4/3

x=5/ The answer should be -4/3 or -5/2

COGNITIVE PROCESSES THAT CONTRIBUTE TO ERRORS

Underlying cognitive processes and misconceptions that contribute to the errors made by Form 4 students in solving quadratic equations have been investigated in research studies. Based on current references, the following are some underlying cognitive processes and misconceptions associated with these errors:

1. Misconceptions about Factoring:

According to Smith (2022) students may hold misconceptions about factoring quadratic expressions, leading to errors in the factoring process. Some common misconceptions include:

- Misunderstanding the distributive property and making errors when factoring out common factors.

- Incorrectly applying factoring patterns or rules, such as the difference of squares.

- Failing to recognize the need to factor out a common factor before using other factoring methods.

2. Misunderstanding the Quadratic Formula:

Errors in applying the quadratic formula can stem from misconceptions related to its components and their interpretation (Johnson and Brown 2023) Some underlying cognitive processes and misconceptions include:

- Difficulty in identifying the values of a, b, and c correctly from the given quadratic equation.

- Mishandling of negative numbers during calculations and simplification.

- Misinterpreting the significance of the ± symbol and not considering both positive and negative solutions.

3. Weak Problem-Solving Skills and Misinterpretation of Word Problems:

According to Johnson and Brown (2023) poor problem-solving skills and misinterpretation of word problems contribute to errors in setting up the

correct equations. Some underlying cognitive processes and misconceptions include:

- Difficulty in identifying the relevant information and variables in word problems.

- Inability to translate the problem into an accurate algebraic equation.

- Misinterpreting the relationships between quantities and incorrectly representing them mathematically.

4. Incomplete Understanding of Algebraic Manipulations:

Smith (2022) said errors in simplifying algebraic expressions can be attributed to incomplete understanding of algebraic manipulations. Some underlying cognitive processes and misconceptions include:

- Difficulties in combining like terms accurately, particularly when dealing with negative numbers or complex expressions.

- Mishandling negative signs during operations, leading to sign errors.

- Limited understanding of the distributive property and errors in its application.

Addressing these underlying cognitive processes and misconceptions through targeted instruction, explicit teaching, and providing opportunities for practice and feedback can help students overcome these challenges and improve their proficiency in solving quadratic equations.

Strategies that can be used to reduce the occurrence of these errors.

Several strategies and interventions have been found to be effective in reducing the occurrence of errors and improving pupils' quadratic equation solving skills. Based on current references, the following strategies and interventions can be implemented:

1. Explicit Instruction and Modeling:

According to Hiebert and Carpenter (2019) providing explicit instruction and modeling of problem-solving strategies can help students develop a solid foundation in quadratic equation solving. Teachers can demonstrate step-by-step procedures, explain the rationale behind each step, and highlight common errors to avoid. This approach helps students understand the correct methods and builds their confidence in solving quadratic equations accurately.

2. Scaffolded Practice:

Van de Pol et al (2010) said gradually scaffolding students' learning through guided practice can support their development of quadratic equation solving skills. Teachers can provide structured practice activities that start with simpler equations and gradually increase in complexity. Scaffolding can include providing prompts, hints, or partially completed examples to assist students in solving quadratic equations correctly.

3. Error Analysis and Reflection:

Bozkurt and Aydin 2019) coined that engaging students in error analysis and reflection activities can help them identify and understand their own errors. Teachers can provide students with sample incorrect solutions and guide them in analyzing the errors made. This process promotes metacognition and encourages students to reflect on their problem-solving strategies, identify misconceptions, and make corrections.

4. Technology-Assisted Learning:

Heid and Blune (2018) said utilizing technology-assisted learning tools, such as interactive software or online platforms, can provide additional support and engagement for students in quadratic equation solving. These tools can offer interactive tutorials, practice exercises, and instant feedback, allowing students to receive immediate guidance and remediation for their errors.

5. Real-World Applications:

According to National Council of Teachers of Mathematics (2020) , connecting quadratic equation solving to real-world applications can enhance students' motivation and understanding. Teachers can present authentic problem scenarios that require the use of quadratic equations, such as projectile motion or optimization problems. This approach helps students see the relevance and practicality of quadratic equations and encourages them to apply their problem-solving skills in meaningful contexts.

Implementing a combination of these strategies and interventions, tailored to the specific needs and misconceptions of students, can effectively reduce errors and improve pupils' quadratic equation solving skills. It is important for

teachers to continuously assess student progress, provide timely feedback, and offer differentiated support to meet individual learning needs.

2.4CONCLUSION

The literature review highlights several recent references that shed light on the errors made by form 4 students in solving quadratic equations. The studies emphasize the need for explicit instruction and problem translation. Additionally interventions such as structured teaching approaches and technology assisted learning have shown promise in addressing these errors. Educators can utilize the insights gained from these studies to drop effective instructional strategy and interventions to enhance students proficiency in solving quadratic equations.

CHAPTER THREE

3.0 INTRODUCTION

This chapter outline the research procedures that were put in order to collect, present , analyze ,and interpret data. Thus the research design, instrument, and methods used to gather relevant information about the study are spelt out .The researcher also justifies the selection of some data collection methods that were used during the study .Consideration is also put on the demerits of these methods and ways of reducing the negative effects of using such research as were employed in this study.

3.1RESEARCH DESIGN

This is the overall plan of how the research will be conducted .In the opinion of Kumar (2019), research design refers to the overal strategy or plan implemented to address a research question or hypothesis. It outlines the systematic approach and methods that researchers employ to collect analyze and interpret data in order to answer their research questions. A well designed research study ensures that the data collected is reliable, valid and relevant to the research objectives.

3.1.1 RESEARCH PHILOSOPHY

The research will be based on two philosophies namely positivism and interpretivism. According to Denzin (2018) interpretivism emphasizes understanding social phenomena through subjective meanings and the context in which they occur. It recognizes that individuals construct their own interpretations of reality and that the interpretations shape their behaviour and experience. With this philosophy the researcher would use interviews as qualitative method of data collection.

Positivism emphasizes the use of objective, empirical methods to uncover causal relationship and explain phenomena. It assures that the social world can be studied using approaches similar to those used in natural sciences. The researcher will use test scores on student academic achievement.

3.1.2 Research Methodology

The research design chosen for this study is a mixed-methods approach, combining quantitative and qualitative research methods. This approach allows for a comprehensive examination of the factors contributing to errors made by form 4 learners at Kakora Secondary school. The quantitative component involves the analysis of standardized test scores, while the qualitative component includes interviews and focus group discussions with learners.

3.3THE POPULATION OF THE STUDY

This is the entire set of members under investigation. Cresswell (2018) said population refers to any group of individuals that have one or more characteristics in common that are of interest to the researcher. In this view a population consisted of 80 form 4 pupils

at Kakora Secondary School of which a stratified sampling was carried out to come up with 12 pupils. Their mean age was 16 years. The researcher chose to carry out the study on the Form 4 upon noticing that the problem in hand was more pronounced in this class. The teachers were used as source of secondary data. Only the subject teachers were used to acquire facts about the subject under study seeing time would have little to offer in a Mathematics oriented research study. Thus the population had 80 members.

3.4 THE SAMPLE

Cresswell (2018) view sampling as selecting a number of people from a defined population for use as a representative set of that population. Smith (2022) supports the above definition by asserting that sampling is a procedure through which the researcher infers characteristics of some objects (the population)through experience with less than all possible elements of that group of objects(the sample).It can therefore be concluded that a sample is a

subset of a defined population on which measurement of variable is done .The sample for this study was made up of 12 members that is six girls and six boys .

3.5.1 SAMPLING PROCEDURES

The sampling method which was a stratified sample where pupils were arranged in order of their performance. The sample frame did not offer equal chances to all pupils .However according to Neuman(2020) samples should be carried out fairly to avoid bias and also to the risk of obtaining wrong results .

3.5.2 REASONS FOR SAMPLING

Sampling is done to reduce the number of subjects to a manageable group, a thing which improves the quality of data captured. If the sample is small, the costs of collecting data are reduced and time is economized .Thus the results of the study are obtained earlier .Sampling is also done to avoid individual bias as the researcher does not purposefully decide the subjects to be studied.

3.6 Data Collection Procedures:

Quantitative data will be collected through the administration of standardized mathematics tests to the selected sample of form four students. These tests will assess various mathematical concepts and skills in solving quadratic equations. Additionally, demographic information such as gender, socioeconomic background, and academic performance will be obtained from school records.

Qualitative data will be collected through semi-structured interviews with students after writing the tests. The interviews will explore their perceptions, experiences, and attitudes towards quadratic equations. Focus group discussions will also be conducted to encourage in-depth conversations and generate a broader range of perspectives.

3.7 Data Analysis Techniques:

Quantitative data analysis will involve descriptive statistics to examine the mean scores and distribution of mathematics performance among male and female students. Inferential statistics, such as t-tests or chi-square tests, will be employed to determine significant differences between genders. Multivariate analysis techniques, such as regression analysis, may also be used to explore the influence of various factors on mathematics performance.

Qualitative data analysis will be conducted using thematic analysis. The interviews and focus group discussions will be transcribed, coded, and categorized into themes and sub-themes. The emerging themes will be analyzed and interpreted to gain a deeper understanding of the factors contributing to gender disparities in mathematics performance.

3.8 RESEARCH INSTRUMENTS

Although the research used only two instruments there are quite a number of them which include interviews (oral and written), tests, records and documentation, field trips, questionnaire and observation. The research opted for interview and tests as instruments for collecting data.

An interview in research is a qualitative data collection method that involves an in-depth conversation between a researcher and a participant (Fontana and Frey 2019). It is a guided conversation where the researcher asks open-ended questions to explore the participant's experiences, beliefs, opinions, and perspectives on a particular topic.

Denzin and Lincoln (2020) views, “it is in a sense an oral questionnaire, where instead of writing the response one gives the information orally and on a face-to-face basis. An interview provide immediate feedback and usually much reliable because one has no adequate time to think out of topic in question for example thinking of his personal relationship with the interviewer and give answers that suits the relationship.

According to Fontana and Frey (2019), an educational test is a systematic procedure for measuring a sample behavior considered to be representative of important educational goals. He further says that, a test is constructed, administered and scored according to prescribed rules. Denzin and Lincoln (2020) says, “A test is an assessment which is carried out to check how much is known about something supposedly learnt”. The researcher imposed tests on

the pupils to check on their understanding after using the suggested ways of teaching during practical lessons.

3.9 VALIDITY AND RELIABILITY OF INSTRUMENTS

American Psychological Association (2020) says validity refers to the extent to which a research instrument or measure accurately reflects the variable it is intended to measure. American Psychological Association (2020) said reliability refers to the consistency and stability of research findings. It indicates the extent to which a research instrument or method produces the same results when applied multiple times under the similar conditions. To ensure maximum validity and reliability of measuring instruments the researcher clearly defined the traits or qualities he purposed to measure. The research also created conditions that aimed at minimizing the effects of disadvantages of each measuring instruments. The validity and reliability of each question in questionnaires were relevant to the objectives of the study and to the research questions were asked.

3.10 DATA COLLECTION PROCEDURES

3.10.1 SEEKING PERMISSION FROM SCHOOL AUTHORITIES:

A letter was written to the School Head seeking permission to carry out a research study on the Form 4 classes and conduct interviews as part of data collection. The request was positively endorsed and with permission officially granted the research was begun.

3.10.2 ARRANGEMENT AND EXECUTION OF PRE AND POST TESTS

Two test were planned and executed during the investigation period .The researcher would give individual tasks to the whole class such that the subject under study were not aware of the researcher's judging eye and the score board behind .He then first give a test out of 20 to the pupils before demonstrating anything .After that the researcher demonstrates on how to solve the quadratic equations and gave another test to the students.

3.11 CONCLUSION

This chapter outlined the methods used in gathering necessary factual information about the study .The use of such research techniques as the pre and post testing,questionnaire and focused observation were discussed. The advantages and disadvantages, validity and reliability of these methods in view of the study in hand were also put in consideration.

CHAPTER FOUR: INTEPRETATION, DATA PRESENTATION ,AND ANALYSIS

4.0 INTRODUCTION

In this chapter the raw facts captured through the use of various research instruments are condensed into tables, graphs and bar charts among other data presentation methods. The numerical literal facts were put together to give a meaning that meets the presets research objectives.

4.1 DATA COLLECTION, PRESENTATION AND ANALSIS FOR OBSERVATION TESTS

RESULTS OF PRE-FOCUSED OBSERVATION

The tables below shows the results obtained from focused observations carried out during the research time the researcher carried out the observation with twelve targeted pupils.

AREA OF OBSERVATION	NUMBER OF PUPILS OUT OF 12
Raising hands more than 3 times	7
Correct responses	3
Wrong responses	4
Ask questions	2

The table above illustrated that among 12 pupils in the experiment, 7 of them raised their hands more than three times during the lesson. This indicates that out of 12 pupils,7 pupils were participating very much during the observation stage.

The table also shows that 3 pupils usually gives correct responses .This implies that only 25% were giving correct answers and 75% were giving wrong answers and not participating.

WHAT WAS OBSERVED

During the observation, the researcher noted that:

- Pupils were having difficulties on adding numbers for example 2+(-3)
- They also faced the problem of factorization they failed to collect like terms and to find the highest common factors and lowest common multiple.
- Learners also failed to use the quadratic formula.

4.2 RESULTS OF THE TEST

Table 4.1 below shows the results of the performance of pupils in the pre-test written during the course of the study .The test was marked out of 20 and converted to percentages.

TABLE 4.1 SHOWING SCORES ON THE PRE-TEST

PUPILS	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
MARK/20	8	7	1	7	2	2	3	2	0	3	0	5
PERCENTAGES	40	35	5	35	10	10	15	10	0	15	0	25

Table 4.2

MARK	0-10	1 1-	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-

RANGE(%)		20								100
NUMBER OF PUPILS	6	2	1	3	0	0	0	0	0	0

FIG 4.1

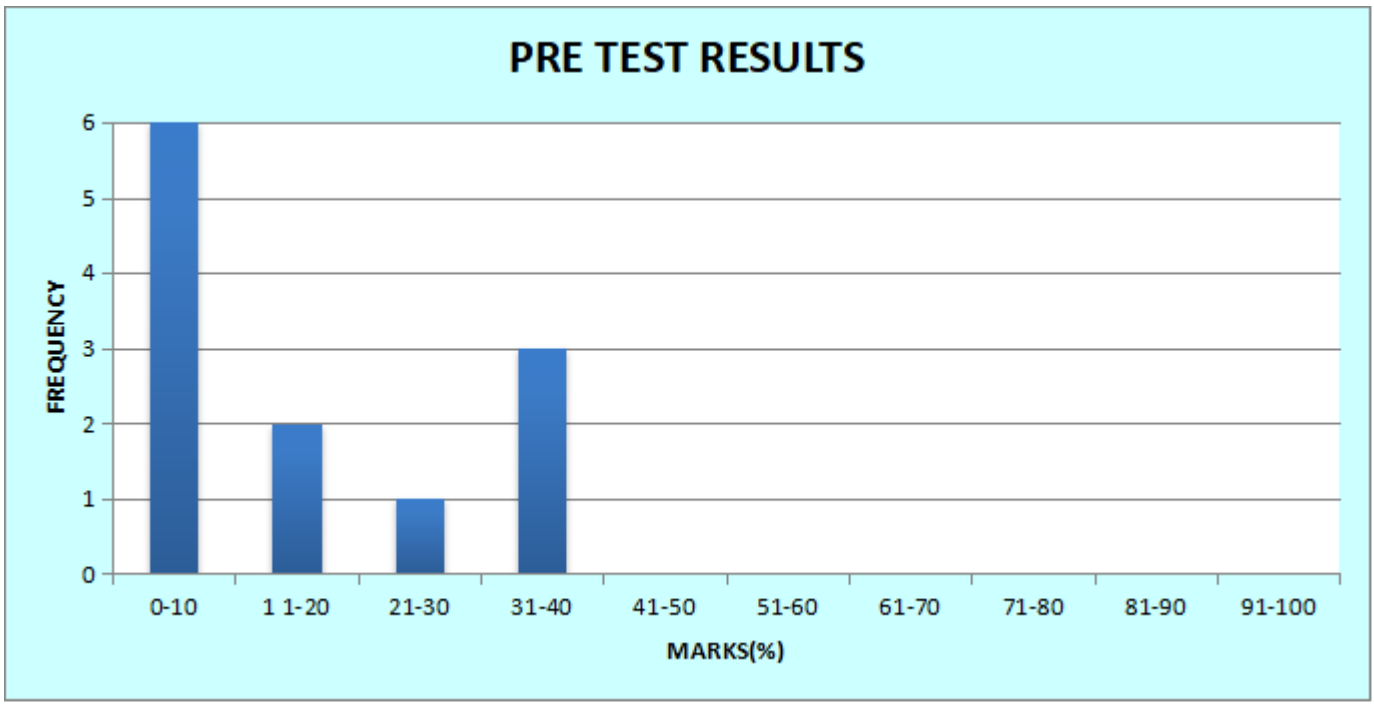


Fig 4.1 above shows that out of the 12 pupils not even one passed the pre-test the highest mark was 8 out of 20 which is 40% .High failure rate was observed since the highest frequency occurred in the low range.

OBSERVATION FROM THE PRE-TEST

-Pupils were having difficulties on adding and subtracting numbers.

-Multiplication and division of directed numbers proved to be a major challenge.

-Change of subject of the formulae is still a problem and they fail to substitute a given value into the given formulae.

4.3 RESPONSES FROM TEACHERS' INTERVIEWS

The H.O.D Mr Makuwa , Mr Mangwiro were interviewed .The following are the finding from the researcher.

4.3.1 TEACHING EXPERIENCE

All the teachers indicated that they had more than 20 years in the teaching field .This implies that all of them are more experienced in the teaching field .Also all the teachers indicated that they like the topic of quadratic equations.

4.3.2 TOPICS CONSIDERED BEFORE TEACHING THE TOPIC

Teachers indicated that they have got a list of topics considered before the teaching of quadratic equations. Combining their topics, they indicated that they considered the following topics:

-Algebraic expressions

-Factorization

-Directed Numbers

-Change of subject of formulae.

4.3.3 SOURCES USED BY THE TEACHERS

- New General Mathematics Book 4
- Focus On Mathematics Book 4
- Mathematics 'O' Syllabus

4.3.4 ERROR ENCOUNTERED BY TEACHERS IN THE TEACHING OF QUADRATIC EQUATIONS

-Random Responses

-Defective Algorithm

-Obvious Errors

-Wrong Operation

-Step by step procedure

-Recalling basis number facts

4.3.5 CAUSES OF POOR PERFORMANCE IN MATHEMATICS

In trying to explain the causes of poor performance of pupils in Mathematics specifically in quadratic equations at their school, the teachers suggested that the failure might be due to poor teaching methods employed by teachers on different concepts.

Teachers also pointed out that pupils lack of interest in solving the basic concept in quadratic equations.

They also suggested lack of basic mathematics skills from primary and junior levels at secondary school that is form 1 & 2.

This implies that poor performance of pupils in Mathematics could be because of poor teaching methods, careless tackling of questions by pupils and logical deductions leads to production of wrong answers.

4.4.0 POST TEST RESULTS

Table 4.2 below indicates the results of the performance of pupils in the post test written after effective teaching of the topic .The test was marked out of 20 and converted into percentages.

Table 4.2 RESULTS FOR POST TEST

PUPILS	A	B	C	D	E	F	G	H	I	J	K	L
MARKS	13	16	12	16	10	16	9	20	9	2	5	11
MARKS (%)	65	80	60	80	50	80	45	100	45	20	25	55

Table 4.3 FREQUENCY TABLE FOR POST TEST RESULTS

Marks%	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Frequency	0	1	1	0	3	2	1	3	0	1

FIG 4.2 SHOWS POST-TEST SCORES BELOW

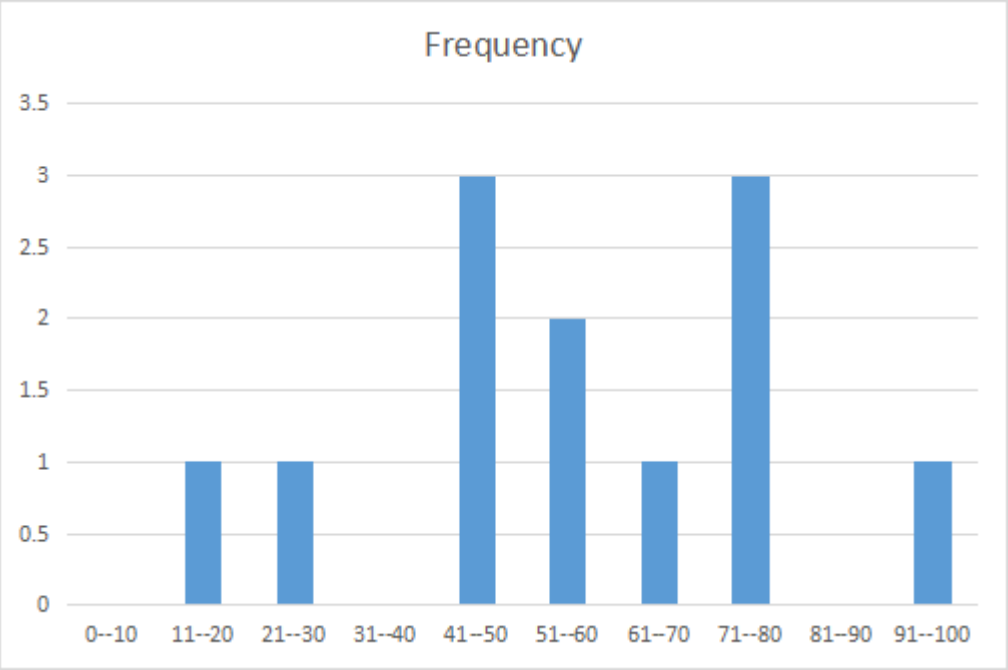


Fig 4.2 above illustrate that among the 12 pupils only four failed the post test, the lowest score is 20% and the average mark of the test is 58.75% . Among

the group 8 pupils passed the test, 4 pupils passed with the scores above 80% and 1 of them manage to pass with 100% which is the highest score. This implies that a greater number of pupils performed very well in the post test.

Comparing these results with those of post -test it might be shown that effective teaching of quadratic equations may enable pupils to bring good results than that of pre-test.

4.5 PRE-TEST AND POST TEST ANALYSIS

Table 4.3 below compares the results from pre-test and post-test during the course of the study.

Table 4.4

MARK (%)	**0-10**	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**71-80**	**81-90**	**91-100**
PRE-TEST(freq)	3	2	3	1	2	1	0	0	0	0
POST-TEST(freq)	0	0	2	0	3	2	1	3	0	1

FIG 4.3 SHOWING A COMPARISON OF PRETEST AND POSTTEST IN THE STUDY.

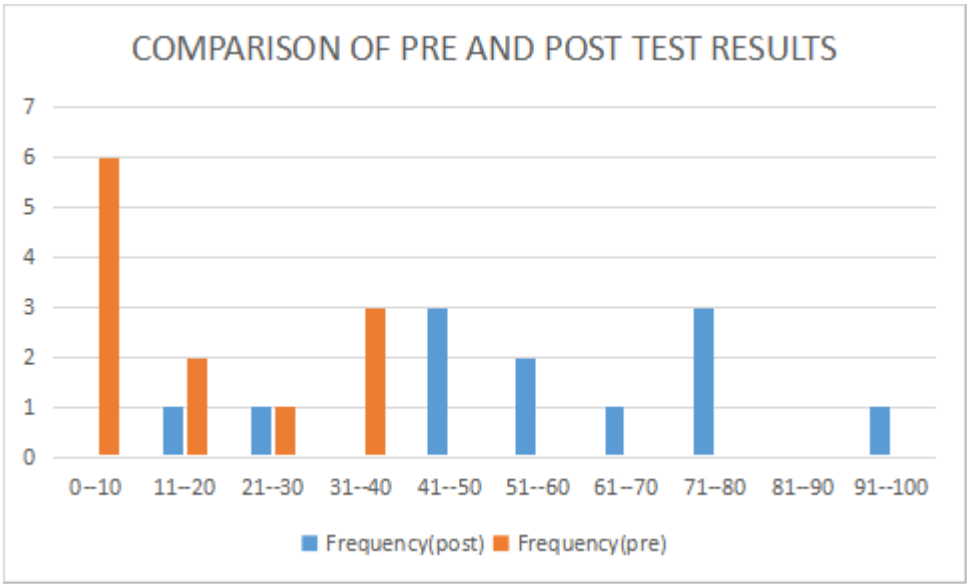
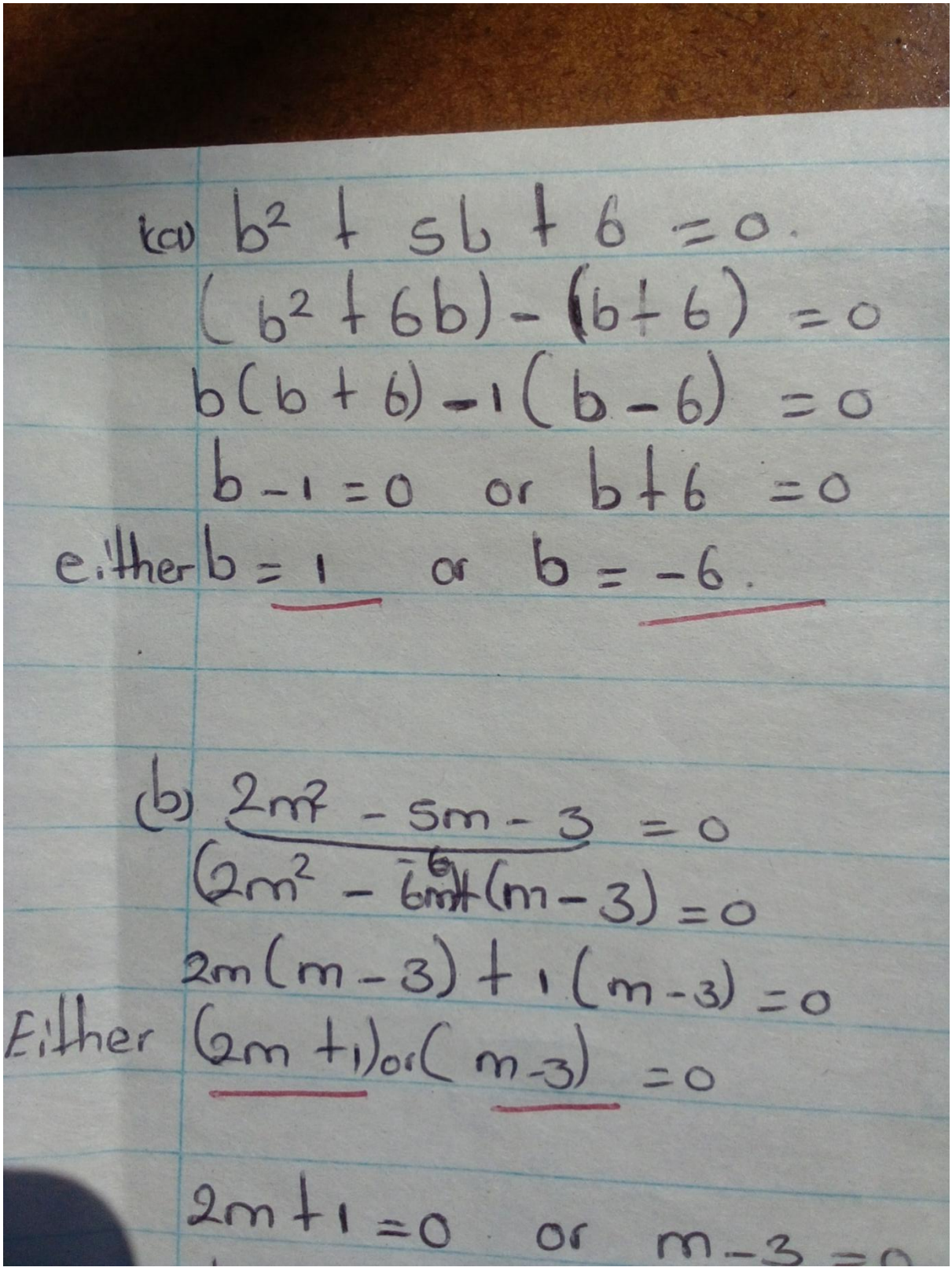


Fig 4.3 above illustrates that among the pupils who wrote the test only 4 failed the post test their marks shows a great sign of improvement some even manage to score a 100% mark. In the pre-test all pupils failed the test and the highest mark found was in the range 31-40. This implies that the moment

intervention applied by the researcher in the teaching of the topic was effective.

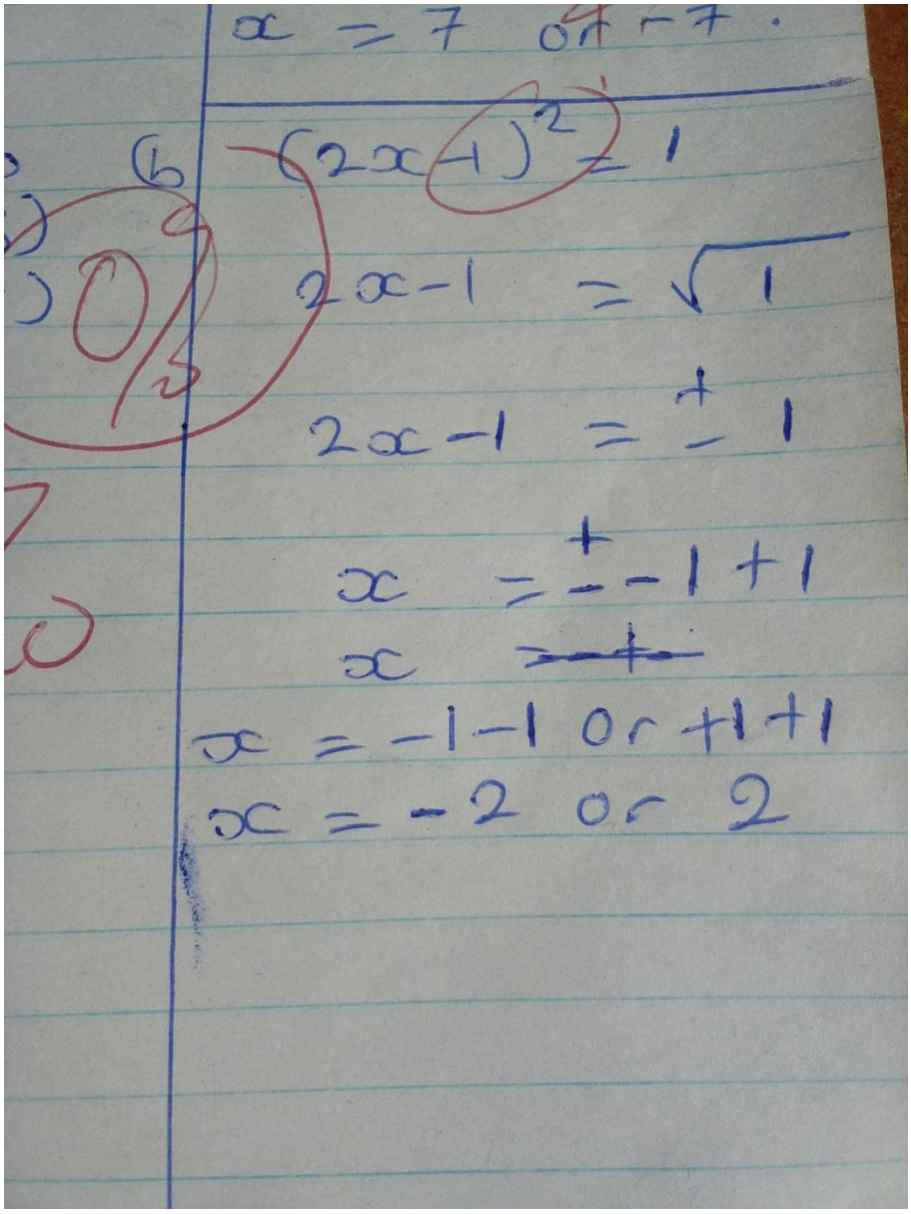
4.6: Common errors made when solving quadratic equations.

After writing a test, interviews were made with learners. Sample responses are presented and analyzed in this report. Samples of the errors made by learners and some of their responses are attached in this report. The detailed interview questions are attached in the appendix.



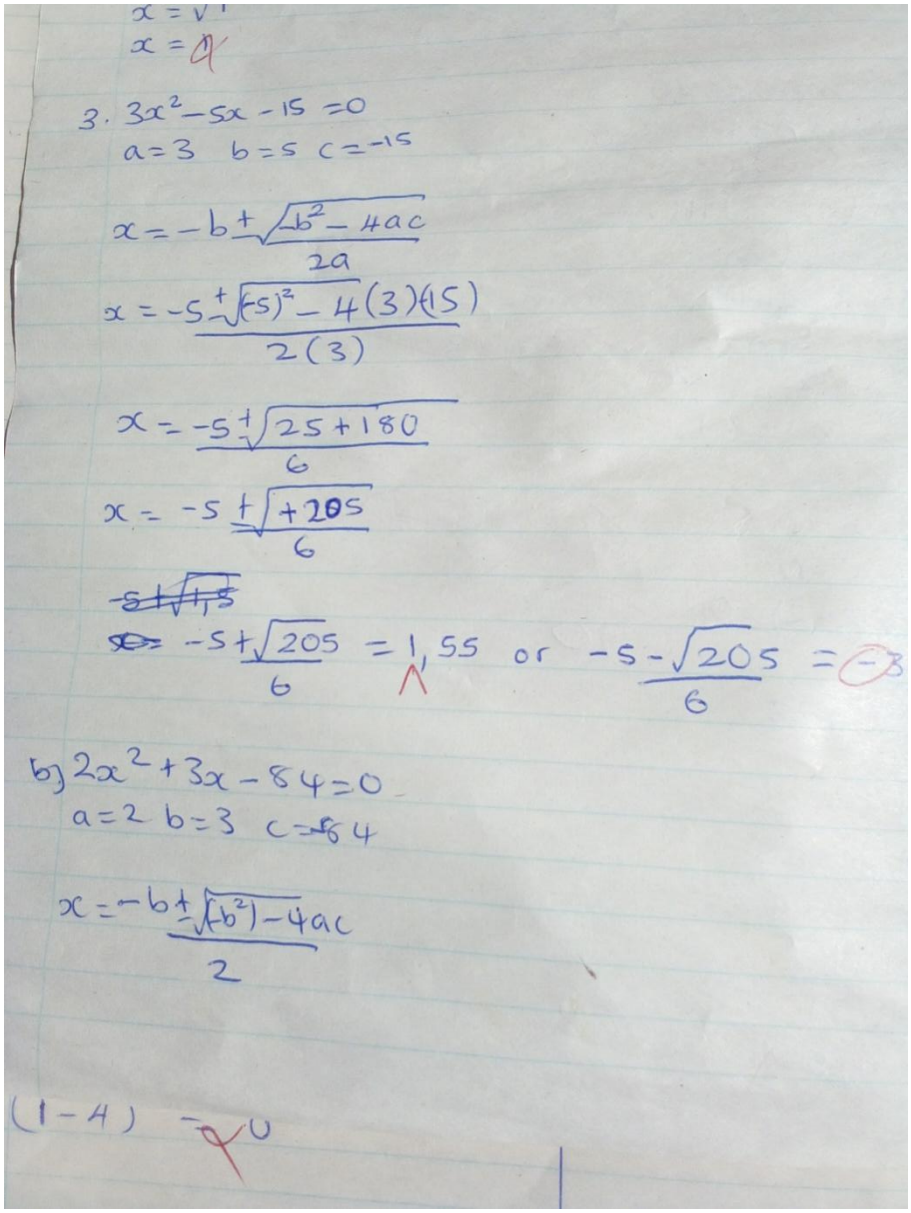
In response to questions asked learner A had problems in finding factors of the quadratic expression as shown by the above attachment. On part b the learner

managed to get the factors correctly.in response to why the error was made in part a, the learner said it is due to failure of applying directed numbers. On how to mitigate the errors the learner said there is need for more practice.



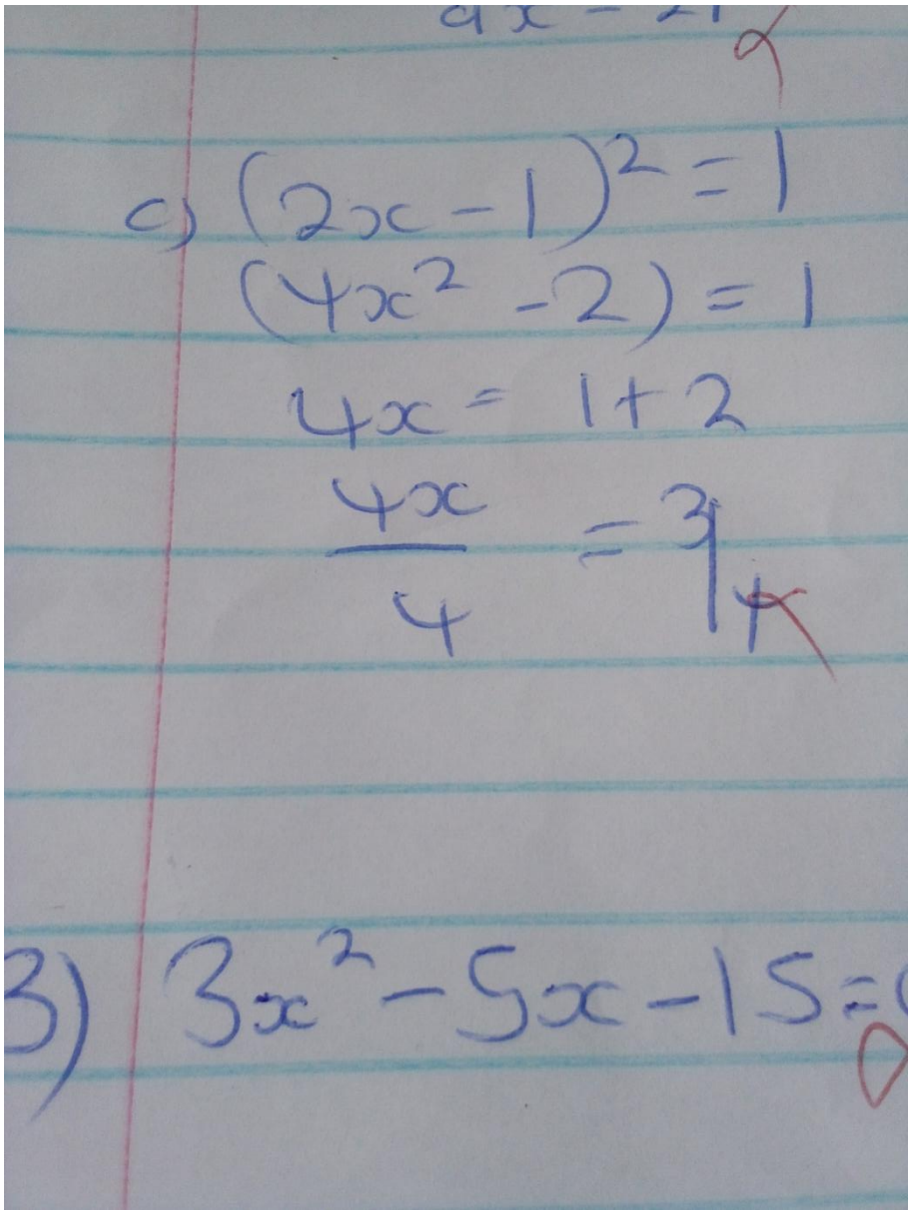
On learner B the error was on failure to simplify directed numbers as shown in the attachment above. In response to why this error was made, the learner said he did not grasp the concept of directed numbers well in form 1.On how to mitigate these errors the learner said there is need for teachers to give more time to the topic of directed numbers in form 1 as it is very important

topic. He also said there is need to give more work on directed numbers for learners to practice.

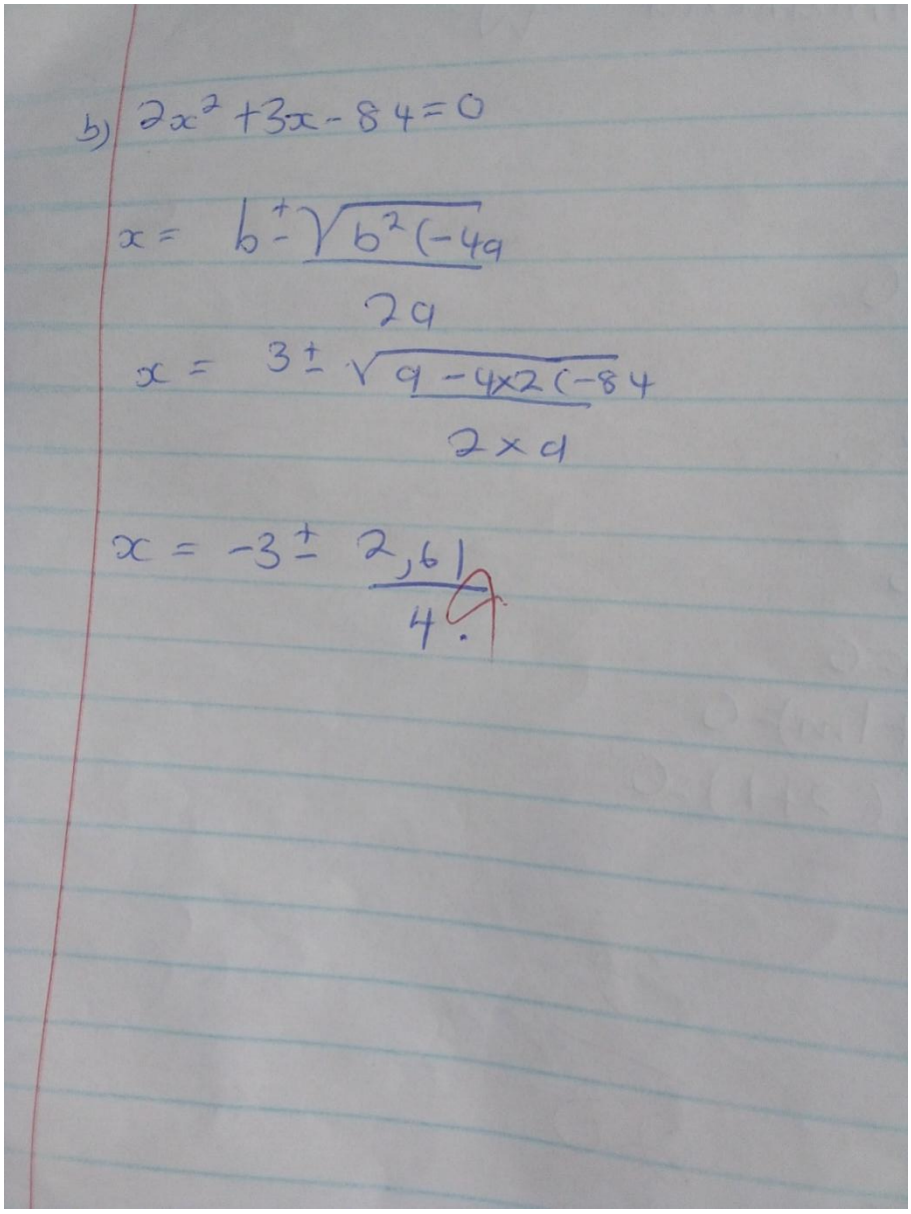


On learner C the error was on failure to use and recognize where the division line starts and ends on the quadratic formula. As a result when dividing the final answer, the learner first divide the square root of 205 by 6 rather than first adding the square root to –b and then divide the answer by 6.The learner

also didn't take into cognizance that b is equal -5 so it should be –(-5).On why she made these errors , the learner said this was due to rushing as a result making simple errors. On how to mitigate these errors the learner said teachers need to encourage learners to cross check their answers all the time.

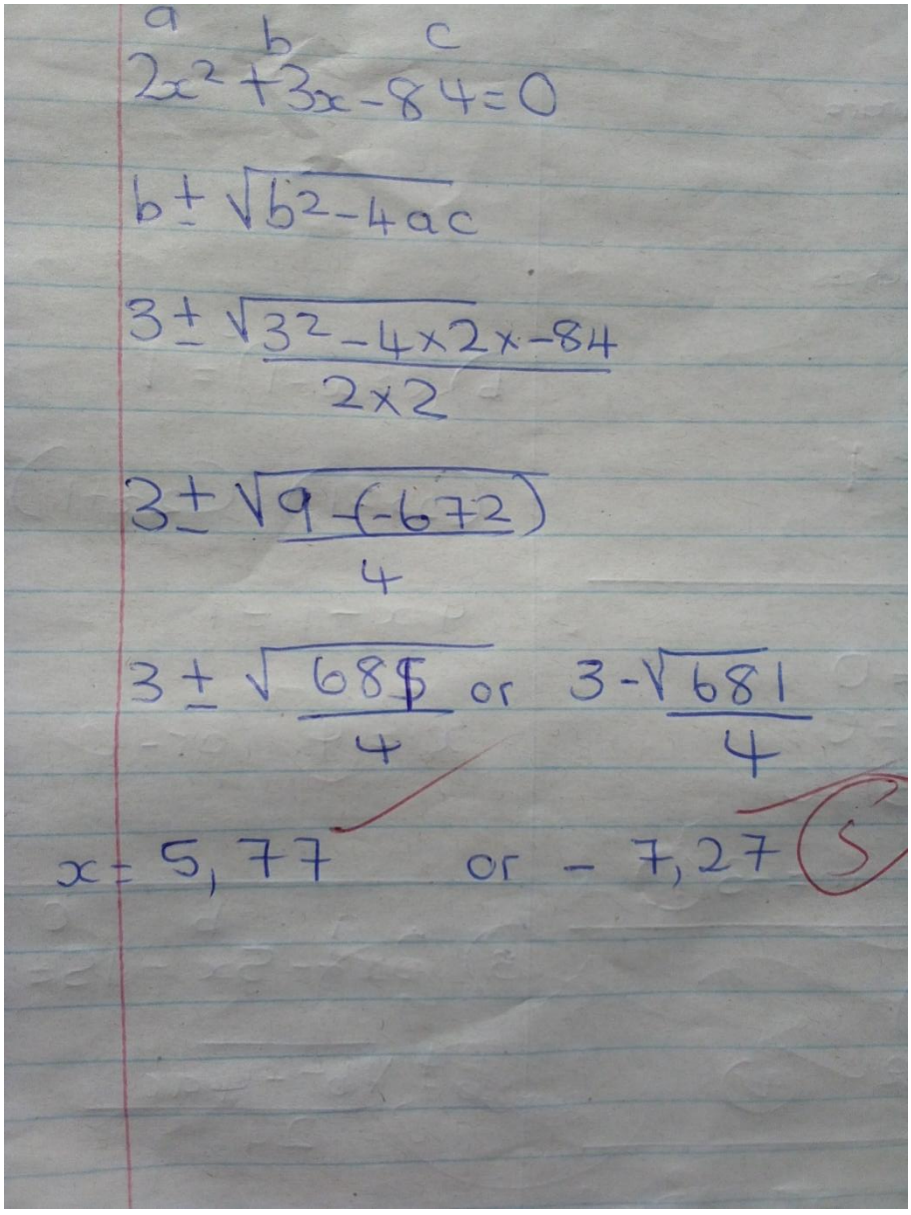


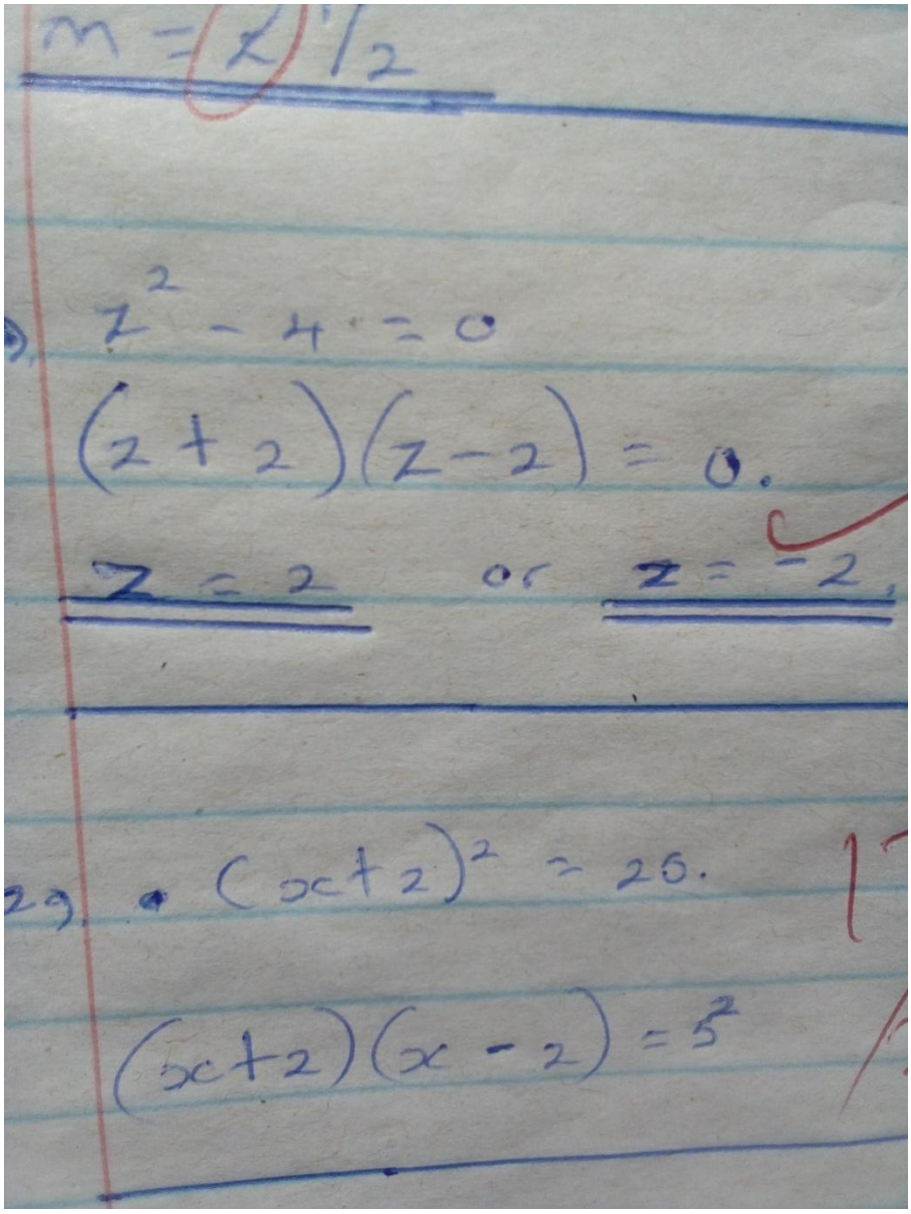
On learner D the error was on change of subject of formula. The learner failed to remove the power correctly. On why this error was made the learner said he did not understand all the concepts of change of subject. On how to mitigate the error , the learner said there is need for time and more work on change of subject of formula.

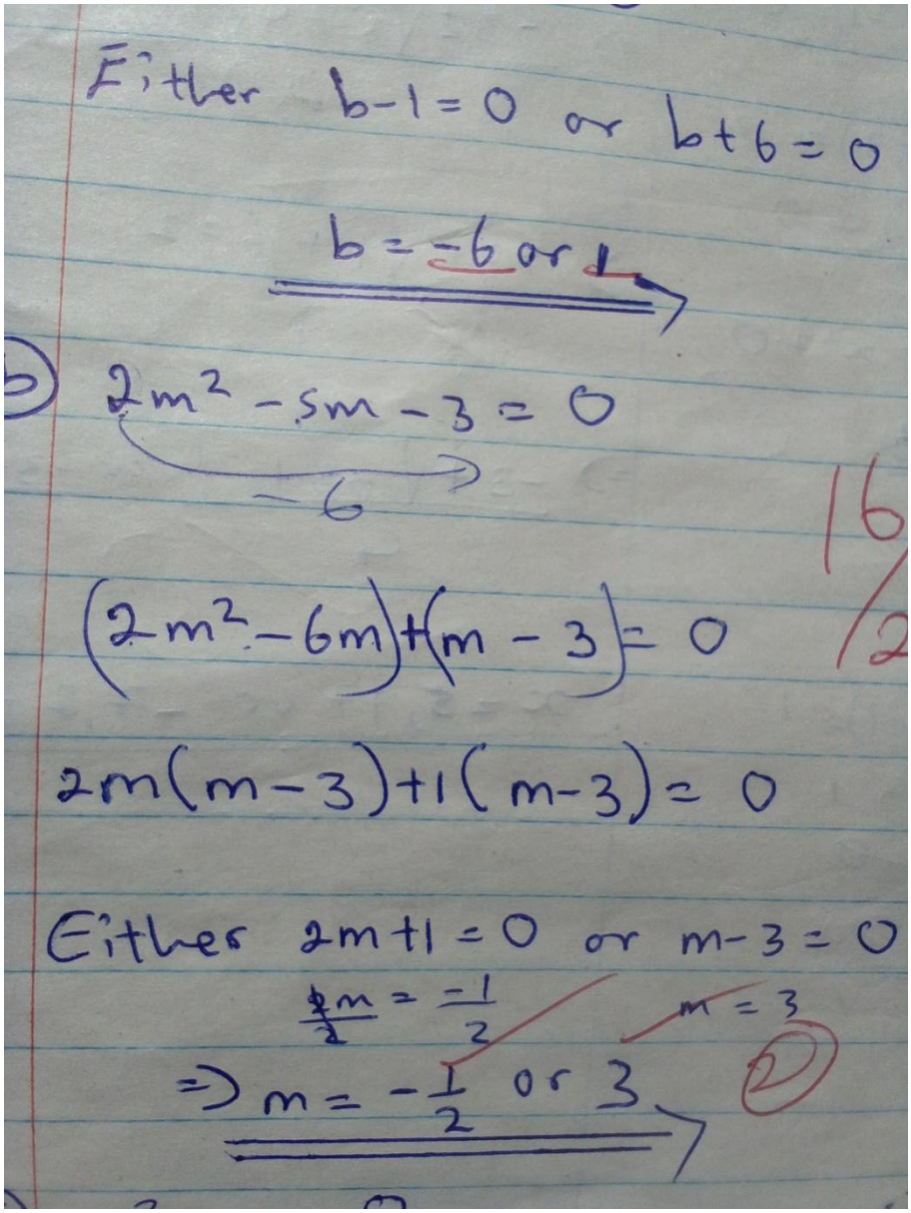


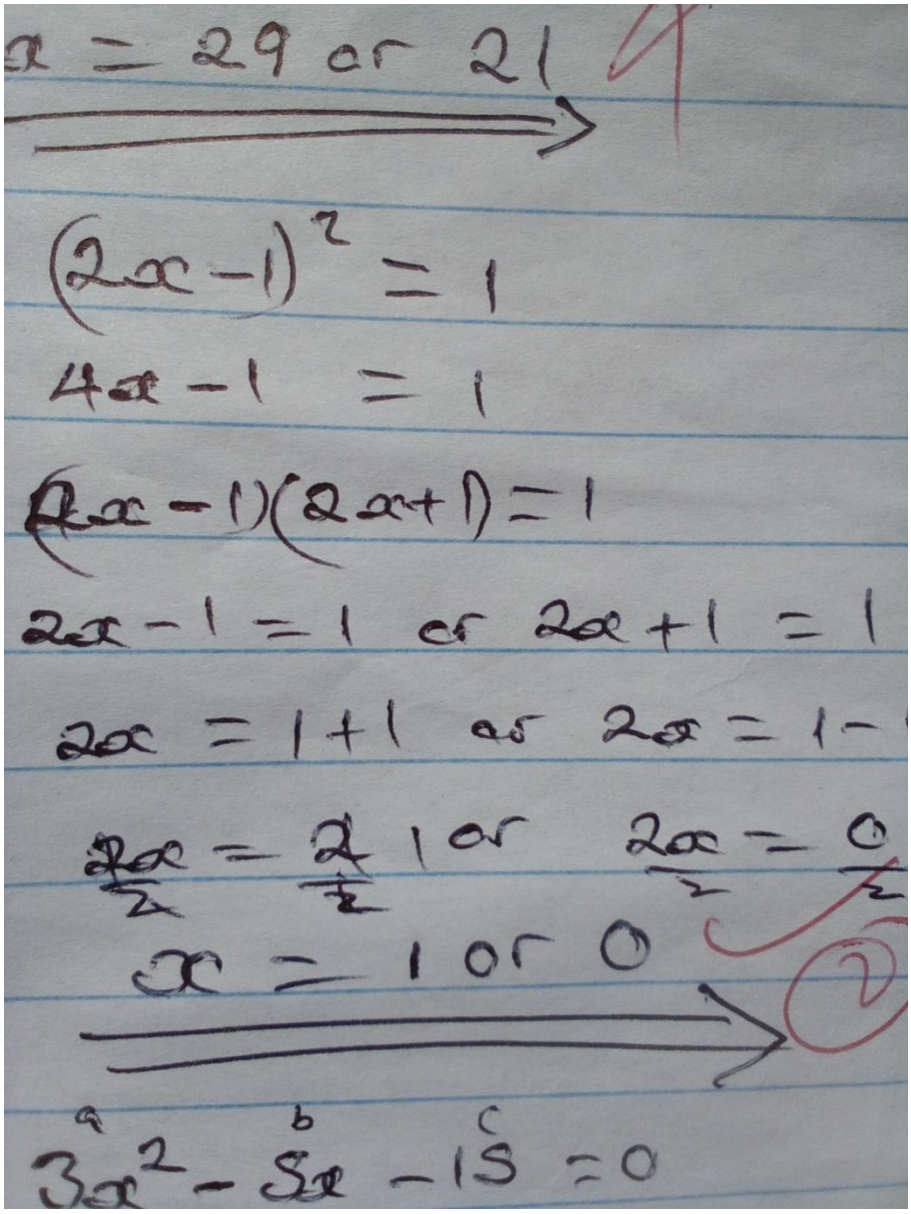
On learner E, the error was on failing to recall the quadratic formula and substitution and simplification as illustrated by the attachment above. On why the learner made these errors, the learner attributed it to lack of practice. The learner said there is need for homework to mitigate the errors and constant revision.

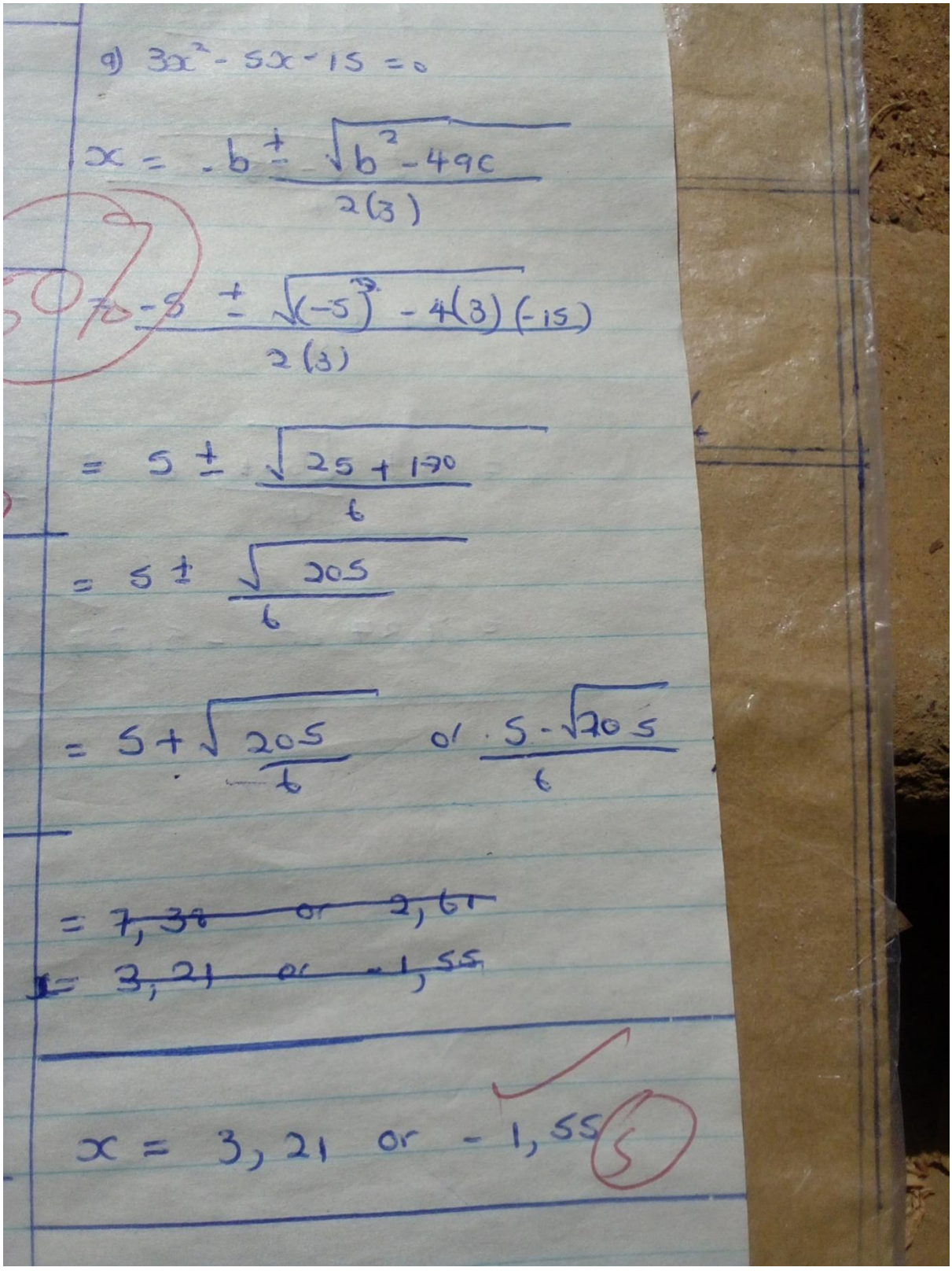
After effective teaching learners managed to get the solutions correct as evidenced by the following attachments.




m = 1/2
z² - 4 = 0
(z + 2)(z - 2) = 0.
z = 2 or z = -2,
29. (x + 2)² = 25.
(x + 2)(x - 2) = 5²


Either b-1=0 or b+6=0
b=-6 or 1
b) 2m²-5m-3=0
-6
(2m²-6m)+(m-3)=0
2m(m-3)+1(m-3)=0
Either 2m+1=0 or m-3=0
2m/2 = -1/2
m=3
⇒ m=-1/2 or 3


x = 29 or 21
4
(2x-1)² = 1
4x - 1 = 1
(2x-1)(2x+1) = 1
2x - 1 = 1 or 2x + 1 = 1
2x = 1+1 or 2x = 1-
2x/2 = 2/2 or 2x/2 = 0/2
x = 1 or 0
2
3x² - 5x - 15 = 0



g) $3x^2 - 5x - 15 = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2(3)}$$

$$= \frac{5 \pm \sqrt{(-5)^2 - 4(3)(-15)}}{2(3)}$$

$$= 5 \pm \frac{\sqrt{25 + 180}}{6}$$

$$= 5 \pm \frac{\sqrt{205}}{6}$$

$$= 5 + \frac{\sqrt{205}}{6} \quad \text{or} \quad \frac{5 - \sqrt{205}}{6}$$

~~$= 7,38$ or $2,61$~~

~~$= 3,21$ or $-1,55$~~

$x = 3,21$ or $-1,55$ (5)

4.7 CONCLUSION

This chapter has presented that data collected in different methods. The majority of the findings was presented, analyzed and interpreted in narration form especially from finding of the tests were presented in tabular, graphical and narration form. The summary, conclusion and recommendations on this study were done in the next chapter.

CHAPTER FIVE- SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 INTRODUCTION

In this chapter , the researcher is going to summarize the whole research , concludes the research by interpretation of the results .The research is also going to make some recommendations based on the finding of the study.

5.1 SUMMARY

This study or research was carried out at Kakora Secondary School in Mazowe. The research mainly focused on errors made by Form 4 pupils in solving quadratic equations and their remedies. There was a noticeable improvement on the pupils' performance as noticeable in the post test they were given .The research also proved that if pupils are going to learn concepts connecting in everyday life ,the learn better that when faced with situation they do not know. The use of media is very important as it enhances understanding in pupils.

5.2 CONCLUSION

From the investigation carried out by the researcher, it can be concluded that errors made by pupils when solving quadratic equations can be better achieved and understood through the use of a wide variety of teaching

methods. No pupils can be said to be totally incapable of understanding mathematics .Different pupils have different levels of grasping concepts involved in Mathematics. The pupils should also be given enough time to practice on their own before introduced to the concept to check whether they have some knowledge this was reflected by the results of the pretest this shows that pupils on their own are not tabula rasas but they know. However, there is need for the teacher's assistance and the use of different media. It is always important to identify the most appropriate method for a given set of pupils.

5.3 RECOMMENDATIONS

The research recommends

-Errors made by pupils can be overcome by giving pupils enough time to practice on their own.

-Mathematics teachers must be encouraged to identify different errors made by pupils, different cognitive abilities of pupils by using various testing and once this has been done, they must employ different methods of teaching to different groups.

-In this regards, mathematics teachers must be discouraged from condemning some pupils as poor in mathematics before exhausting all possible teaching methods.

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APENDICES

Interview questions

1 What were the specific errors you made in solving quadratic equatins?

2 Can you explain why you made these errors?

3 Did you have any difficulty understanding the concept of quadratic equations?

4 Where there any particular areas you felt needed more support or clarification?

5 is there anything else you would need to add about your experience in solving quadratic equations?

Interview questions for the teacher

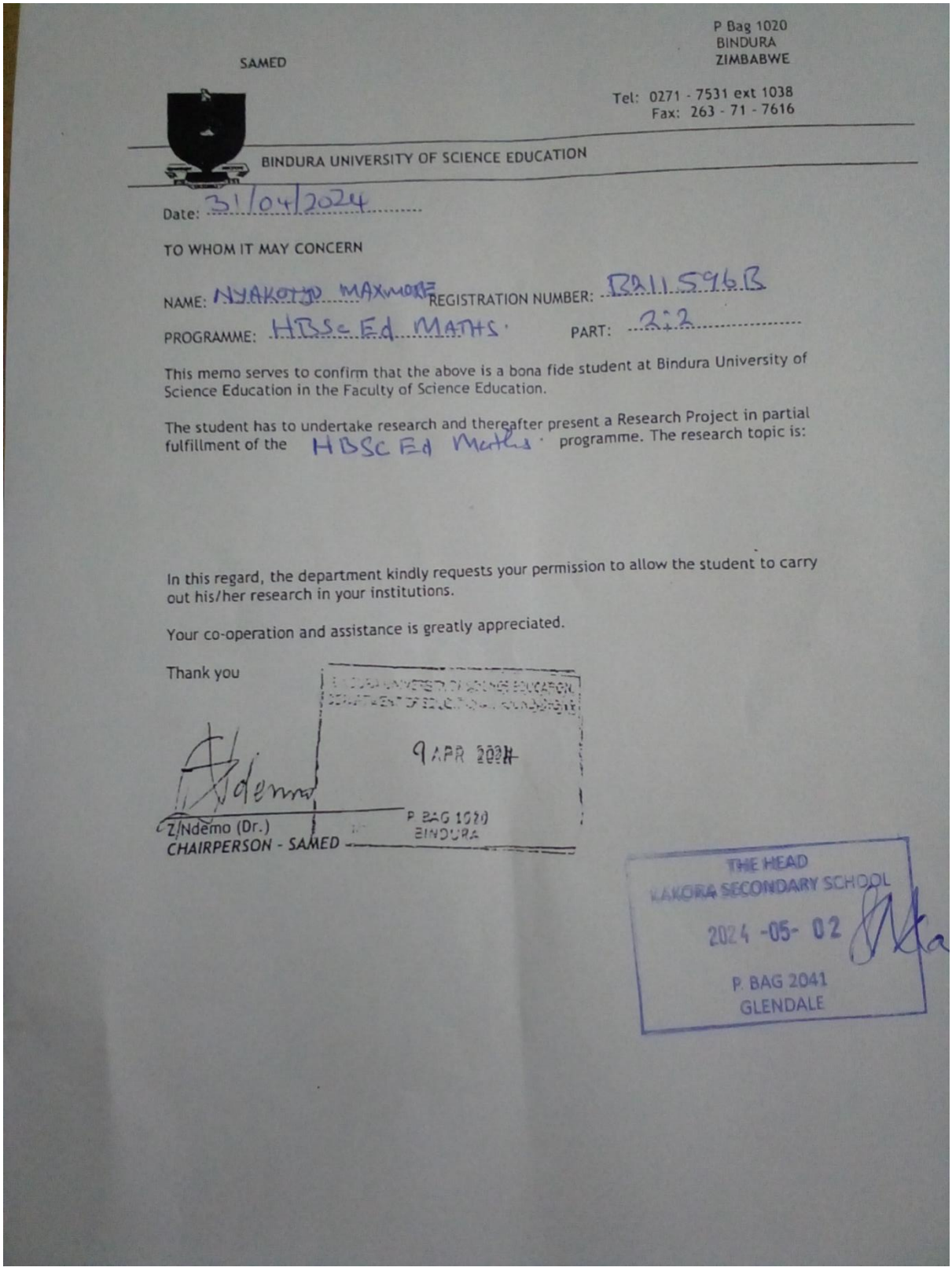
1 Can you recall any specific errors that you have observed in Form 4 pupils making when solving quadratic equations?

2 What do you think are the reasons behind these errors?

3 How do you think these errors could be addressed or prevented in future teaching?

4 What strategies do you use to help pupils understand the concepts involved in solving quadratic equations?

Permission Letter



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BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 31/04/2024

TO WHOM IT MAY CONCERN

NAME: NYAKOTYO MAXMORE REGISTRATION NUMBER: B211596B

PROGRAMME: HBSc Ed MATHS. PART: 2:2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the HBSC Ed Maths. programme. The research topic is:

In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you

9 APR 2024

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Z/Ndemo (Dr.)
CHAIRPERSON - SAMED

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KAKORA SECONDARY SCHOOL
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