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MITIGATING LEARNERS' ERRORS AND MISCONCEPTIONS IN SOLVING LINEAR INEQUALITIES AT ORDINARY LEVEL: A CASE STUDY AT ONE OF THE RURAL SECONDARY SCHOOL IN ZIMBABWE

BY

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DEDICATION

The work is heartily dedicated to my wife, Sarupande Ketai for her ever cherishable support throughout the production of this work. Also, the research is dedicated to my entire family ,P . Makava and W. T. Shumbayaonda for unyielding encouragement along this foundation of my academic journey.

ABSTRACT

This research mitigates the misconceptions and errors at Ordinary Level, with a specific focus on students at a Rural Secondary School in Zimbabwe. A wide range of approaches and methods for data collection, which include pre-tests and post-tests to measure learning outcomes, together with questionnaires and focus group discussions for qualitative insights were employed. A sample of thirty (30) students and five (5) teachers was used. A detailed analysis of research was done on both the students' and teachers' responses in the pre-test. Additionally, following taxonomy for misconceptions and errors in maths was used. The research proposed several strategies to mitigate these errors, such as the use of learner-centered approaches and the use of Conceptualised approach. Data presentation using tables, graphs and bar graphs to enhance clarity and visual comprehension of findings was used. Both descriptive statistics and qualitative techniques on data analysis revealed significant insights and patterns in learners' understanding. The results indicate that learners have different misconceptions and errors as noted in solving linear inequalities. The study concludes that cognitive Load is more effective in mitigating misconceptions and errors in solving linear inequalities. Taking a close snap on the research's findings, the cognitive Load approach demonstrated potential in reducing errors and enhancing comprehension. Further studies are recommended to explore similar issues within other mathematical concepts, aiming to broaden the understanding of errors and improve educational strategies in mathematics education.

Table of Contents

CHAPTER 1: THE PROBLEM AND ITS SETTING

1.1 MOTIVATION AND CONTEXT

According to (Afe,2012), Education is considered as an indispensable tool to be used for the integration of individuals in a society to achieve self-realisation, develop national consciousness, necessitating unity and social economic, political, scientific, cultural and technological progress. The research aims to mitigate the errors and misconceptions done by learners in the solving of Linear Inequalities at Ordinary Level in one of the rural Secondary School in Zimbabwe. This chapter of the study comprises of the background of the study, statement of the problem, aims of the study, research objectives, research questions, assumptions of the study, justification of the study, delimitations and limitations of the study, definition of key terms and summary of the study. The chapter also underscores the scope of the study. In this chapter, key terms of variables are defined.

1.2 BACKGROUND OF THE STUDY

Mathematics is a very important subject which facilitates the study of other subjects of the school curriculum. It is a tool with which man interprets, understands and makes use of his environment (Wadesango N. and Dhliwayo E. 2012). The Ministry of Primary and Secondary Education has continued to remind teachers and administrators of the importance of mathematics. All efforts have not been taken seriously by educators as envisaged by the poor performance of most students at ordinary level examinations in this subject. The problem of poor performance in solving Linear mathematics is one of the chief concerns of teachers and other mathematics educators worldwide. Lance (2002: 23) who says poor performance can cause 'mathophobia' which he defines as ''… an irrational dread or anxiety that blocks people from learning and enjoying anything they recognize as mathematical.''

It is also my belief that errors and misconceptions around working with linear inequalities can yield negative attitudes and even fear of mathematics by pupils. Inequalities represent one of the most valuable and crucial topics in algebra, yet there remains a low uptake of the fundamental underlying the dealing of inequality in Mathematics. According to Sunzuma G, Masocha M and Zezekwa N (2013) some students give up taking 'O' level mathematics examinations after failing due to lack of resources, hence it is paramount for learners to master the concept of solving inequalities to score high grades. According to Sterling a major demise in solving the Inequalities is reversing of inequality sign. Most learners fail to change the inequality sign when dividing or multiplying by a negative number. Inequalities build a foundation of grasping of other mathematical concepts such as algebra, trigonometry and analytical geometry, (Bicer, Capraro, and Capraro, 2014). In addition, (Tsamir & Almog, 2001) zeros to give important roles cultivated in a conceptual understanding of equality and equations, as inequalities are often complements sstudents'' understanding of equality.

The examination of students' proficiency in solving algebraic inequalities is not only intriguing due to its mathematical significance but also because it offers an avenue to explore various facets that illuminate their comprehension of algebra. However, learners are expected to possess the ability to accurately organize, interpret and present information in written, graphical and diagrammatical forms. Therefore, learners need to be proficient in interpreting and representing inequalities both in written and graphical formats. According to (W.A.E.C, 2011, it is crystal clear that students struggle to accurately interpret and represent inequalities, both in written and graphical forms).

It was observed that when presented with Inequality questions, most learners make common errors and misconceptions such as:

1. These Reversing inequality signs - this can be noted when multiplying or dividing both sides of an inequality by a negative number, couple of students often forget to reverse the direction of the inequality sign, Sterling (2013).

2. Inadequate understanding of compound Inequalities - According to (Charles, McKeague and Mark), students often struggle with compound inequalities, particularly when the inequality signs are different. This has been a common challenge in a number of learners as the solve Inequality questions.

3. Working with negative numbers has never been easy to learners according to (Strang) More so Difficulty with negative coefficients - Students tend to have trouble when negative coefficients are involved, often leading to incorrect solutions.

4. Ignoring endpoint inclusion/exclusion - "Students frequently neglect to consider whether the endpoints are included or excluded in interval notation." - Lynn C. Hart et al. (Error Patterns in Mathematics)

5. Insufficient simplification - Morris Kline (Mathematics for the Non mathematician) has this to say "Students may not simplify expressions sufficiently, leading to incorrect or incomplete solutions." -

There are premise Quotations which many authors write about in this context of misconceptions and errors in solving Linear Inequalities.

1. "The most common error in solving linear inequalities is reversing the inequality sign when multiplying or dividing by a negative number." - Mary Jane Sterling

2. "Students' difficulties with linear inequalities often stem from a lack of understanding of the relationship between the inequality signs and the number line." - Charles P. McKeague and Mark D. Turner

3. "Inequalities require a different mindset than equations; students must consider the entire range of possible solutions." - Gilbert Strang

1. More specific examples of errors?
2. Detailed solutions to common problems?
3. Teaching strategies for addressing misconceptions?
4. Additional resources for learners?
5. Research on math education and cognition?

It was observed time in memorial that when presented with an inequality question, the majority of learners would fail to carry operations like multiplication, grouping like terms and illustrating solutions on a number line. This multitude of errors reveals that, among other issues, learners struggle with fundamental concepts of inequality.

While many studies have investigated learners' comprehension of the concept of inequality, only limited research had been conducted on strategies to mitigate misconceptions and errors commonly done by learners in solving linear inequalities. Many students encounter difficulties and misconceptions related to inequalities. Halmaghi (2011) discovered that the concept of inequality presents challenges for both high school and university students. In this context, the concept of inequalities holds significant importance, in which it is very important to mitigate learners' errors and misconceptions in solving inequalities for improved grades, (Fumador and Agyei 2018).

The primary objective of this study is to mitigate the errors and misconceptions that Ordinary Level Learners have concerning Linear Inequalities. Existing research indicates that not only Ordinary Level Learners but also pre-service teachers exhibit a weak understanding on effective ways of mitigating errors and misconceptions in solving linear inequalities. It is also imperative to acknowledge that much of this research conducted beyond the borders of Africa (El-khateeb, 2016; Bicer, Capraro, & Capraro, 2014; Almog & Ilany, 2012; Halmaghi, 2011).

Motivated by the scarcity of literature within the scope of the author's research, which revealed no evidence of similar studies in the Guruve District, the researcher embarked on this investigation. This investigation seeks to bridge the gap in knowledge by mitigating learners' errors and misconceptions regarding inequalities among Ordinary Level Learners in one of the Rural Secondary School in Zimbabwe.

1.3 STATEMENT OF THE PROBLEM

(Msomi & Bansilal, 2022; Karthik, 2023) have continually emphasized the struggle of learners in comprehending and employing the three primary inequality symbols ($<$, $>$, $\leq$, and $\geq$). Some learners fail to give the difference between $<$ and $>$ or $\geq$ and $\leq$. This introduces heightened challenges in solving real-world problems that incorporate inequalities in day-to-day situations. Learners struggle to respond well to questions related to linear inequalities. The reports chronicle many errors and misconceptions surrounding inequalities. The most common errors made by Learners include confusing equations with inequalities, incorrect multiplication with negative coefficients and wrong representation of the number line as solutions. In all these instances, learners have consistently received lower marks, resulting in an overall mediocre performance in the subject. Even though Linear inequalities play a significant role in the mathematics curriculum, but the performance of learners leaves much to be desired as evidence suggests that students struggle to accurately interpret and represent inequalities, both in written and graphical forms (West African Examinations Council, 2011).

Ling, Shahrill and Tan (2016) postulate that errors and misconceptions bar learners from understanding and ultimately affects their problem-solving stances. Lot of research had been done in learners misconceptions and errors in inequalities and limited ones into exploring ways of solving them , thus the research is undertaken to broaden the ways to mitigate these misconceptions and errors in solving inequalities. After giving tests or examinations, most teachers follow through by marking, recording and then going on to teach a new topic without taking note of ways to address errors made in the previous topic. Subsequently, if some of these errors made during mathematics learning are not addressed they tend to persist even into post-secondary schooling level. Hence the need for the current study to investigate ways of eradicating the misconceptions and errors when dealing with linear inequalities. In addition the Board of Examiners both ZIMSEC AND CAMBRIDGE disseminate feedback on common mistakes in the ‘O’ Level examination by reporting on correct and incorrect responses, this ultimately calls for rectification of these errors as part of the teaching and learning process. Failure to rectify the errors and misconceptions eventually lead to learners and teachers blaming each other for the poor achievement (Chirume & Chikasha, 2014). For which this current research is after ways of mitigating the misconceptions and errors learners usually make in solving linear inequalities.

1.4 RESEARCH QUESTIONS

1. What kinds of errors and misconceptions are made by Ordinary Level Learners in solving Linear Inequalities?

2. What are possible strategies can be employed to minimize mathematical errors and misconceptions made by Ordinary Level Learners in solving Linear Inequalities?

1.5 RESEARCH OBJECTIVES

The research will identify the frequency, nature and patterns of errors, as well as the underlying misconceptions that hinder learners' understanding of Linear Inequalities.

Then subsequently seeks to propose evidence-based mitigation strategies to minimize the mathematical errors and misconceptions exhibited by Ordinary Level Learners when solving Linear Inequalities, hence enhancing learners' problem-solving skills and conceptual understanding of Linear Inequalities. By achieving these objectives, the study will contribute to improving mathematics education and inform instructional practices that support learners' success in solving Linear Inequalities.

1.6 SIGNIFICANCE OF THE STUDY

The study of errors and misconceptions in solving linear inequalities holds significant importance, by addressing numerous errors and misconceptions learners do. Researchers can identify common patterns and areas of difficulty, informing the development of targeted instructional strategies. I think I will come up with rich information to policy makers, parents, teachers and learners regarding errors and misconceptions in inequalities. Teachers and Educators can find cues in designing more effective lessons, activities and assessments that address specific challenges. Furthermore, the study's findings can be a source of creation for valid and reliable assessments on linear inequalities.

This research contributes to the existing body of knowledge in mathematics education, providing notable strong subject command among teachers and leaners in learning and teaching of linear inequalities. Finally, the findings can positively contribute to the development of mathematics curricula, ensuring linear inequalities are taught in a way that proactively addresses common misconceptions which leads to errors, thereby establishing harmony between new and old pieces of knowledge in the mind of the learner for successful mastering of inequalities.

1.7 ASSUMPTIONS OF THE STUDY

The study involved 30 ordinary-level learners purposively sampled from one Rural Secondary School in Zimbabwe.

This study operates under several key assumptions that guide the research methodology and interpretation of findings. Firstly, the assumptions is that the selected learners possess a good emotional status, and have a foundational understanding of algebraic concepts, including variables, constants and mathematical operations and have prior exposure to linear equations and inequalities. In addition, the research assumes its working with a normal group of learners. Moreso, the researcher assumes that learners' errors and misconceptions in solving linear inequalities primarily stem from cognitive biases, knowledge gaps or inadequate practice, rather than other external factors. The study also assumes generalizability, expecting the findings to be applicable to other learners with similar backgrounds and experiences. Furthermore, the researcher assumes the study's results will be valid and reliable, accurately reflecting learners' true abilities and misconceptions, unaffected by external influences such as stress or anxiety. It is also assumed that the study's methodology, including tasks and assessments, will effectively address learners' errors and misconceptions, providing a comprehensive of their understanding of linear inequalities. By acknowledging and addressing these assumptions, the researcher strives to ensure a controlled, objective and effective evidence-based instructional strategies to enhance mathematics education.

1.8 DELIMITATIONS

This research has several delimitations that impacted its scope, generalizability and findings. Notably, the study's focus on Ordinary Level learners limits the applicability of the results to other grade levels and the small sample size may compromise the reliability and validity of the findings. Geographically, the study's confinement to one of the Rural Secondary School in Zimbabwe, thus this can restricts the generalizability of the results to other regions or educational contexts. Moreover, the exclusive focus on linear inequalities overlooks the potential influence of prior knowledge or concurrent learning of other mathematical concepts such as algebra, geometry or calculus, which may intersect with or impact learners' understanding of linear inequalities. Finally, the study's design and methodology may not capture the dynamic and complex nature of learners' thinking and problem-solving processes. By acknowledging these delimitations, the researcher recognizes the study's boundaries and encourages future research to address these gaps, ultimately contributing to a more comprehensive understanding of learners' errors and misconceptions in solving linear inequalities.

1.9 LIMITATIONS OF THE STUDY

The generalizability of the study is a reflection of a rural secondary school which may not reflect the same impact to other learning environments. Additionally, the study focused on errors and misconceptions identified in a single academic year, which may not capture the long-term development of learners' understanding.

1.10 DEFINITION OF KEY TERMS:

KEY TERMS:

Misconceptions:

“A misconception is a belief that is not supported by evidence or scientific evidence.” (National Science Education Standards, 1996). Anderson et al., 1990) says, “Misconceptions are ideas that are inconsistent with scientific principles or concepts.” According to Novak (1993), “A misconception is a misunderstanding or incorrect belief about a concept or phenomenon.” In addition, according to Legukto (2008) in Ndemo (2023), stipulates that errors and misconceptions are a result of some gaps in conception that threaten the learners’ construction of knowledge. Legukto went on to say that errors and misconceptions are a result of applying schemata or alternative conceptions (misconceptions) to mathematical situations in an inapplicable fashion. Most of the time, learners’ experience cognitive dissonance in which their beliefs conflicts with their existing knowledge. According to Ndemo (2023), cognitive dissonance leads to a drive in learners to find answers and solutions to their challenges. Thus in the same token, by resolving discrepancies, leaners confront their beliefs and reality.

This study also accounts for the notion of conceptual change in which we assume that over a certain period of time learners change their understanding of concepts and the underlying core areas around that concept.

Summing it up, the cognitive dissonance which may be created amongst learners ultimately causes misconceptions.

In which a misconception according to Ndemo (2023), is an incorrect or incomplete understanding of a concept, idea or phenomenon that is not supported by evidence, scientific principles or factual information. Misconceptions can be held by individuals, groups or even entire cultures and can lead to resistant to any positive change. Misconceptions are not the same as mistakes or errors, which are simply incorrect answers or actions. Finally, misconceptions are more fundamental and can affect a person's entire understanding of a subject or concept.

Error

"An error is a deviation from the true value or correct result" (krantz, 1977). According to Larsen (2001), "An error is a mistake or inaccuracy in a mathematical calculation or measurement''. Taylor, 1989 says, "An error is a deviation from the true value or a departure from the expected results". As cited in Duncan and Weiss, 1979 "An error is an unintended departure from a desired outcome or a standard of performance."

These definitions highlight the idea that an error is a deviation from what is expected, desired or true and can in various contexts including calculation.

Furthermore, the study followed the SOLO model by Briggs and Collis. The SOLO model provides five hierarchical thinking levels , (Kiat's ,2005).

The first one is Pre-structure level (P), in which there is no thought or no response. According to Tabassum (2022) cited in Ndemo (2023), the P level give learners the room to identify steps which are involved in solving ideas of the problem at stake.

The second structure level (OS), calls for little thinking in any situation. Here not all reactions given are in line with the required answers. However, according to Tabassum (2022), learners need to have basic knowledge of the problem.

The third stage is Many-structure level (MS), a comprehensive stance is displayed by the learner as he or she attempts the problem. According to Ndemo (2023), most of the attempts done on this stage are related to the correct answer.

The fourth stage is Relational structure level (R), which gives a correct answer in most of the responses which would have been produced.

The final stage is the Extra-extended level of the learning outcome (E), according to Mathaba and Bayaga (2021) this is the exceptional level with excellent responses.

Inequality

This is a formal statement of inequality between two quantities usually separated by a sign of inequality (such as <, >, or ≠ signifying respectively is less than, is greater than, or is not equal to). According to Mydral (1962) "Inequality refers to the unequal distribution of resources, opportunities, and privileges among individuals or groups. In addition, Hurst (2007) says

"Inequality is a situation in which individuals or groups have unequal access to valued resources, services and opportunities."

These definitions highlight the idea that inequality is a state of unfairness or disparity in the distribution of resources, opportunities or privilege among individuals or groups.

Linear Inequalities

Linear inequalities are mathematical expressions that compare two expressions using the inequality symbol, in either be algebraic or numerical or both. A linear inequality contains one of the symbols of inequality: $<$ less than, $>$ greater than, $\leq$ less than or equal to, $\geq$ greater than or equal to. According to Lial(2012) "A linear inequality is a statement that one linear expression is greater than, less than, greater than or equal to, or less than or equal to another." "A linear inequality is an inequality in which the highest power of the variable is 1." (Sullivan, 2011).Larson (2011) says "A linear inequality is an inequality that can be written in the form $f(x)<b$, $f(x)>b$, $f(x)\leq b$, or $f(x)\geq b$, where f(x)is a linear function and b is a real number."

Kiat classified errors as conceptual, procedural and technical errors.

However, in solving either of these types some learners commit errors that are backed by associated misconceptions.

1.11 SUMMARY OF THE CHAPTER

This chapter addressed an introduction to the research on mitigating errors and misconceptions in solving Linear Inequalities done by Ordinary Level learners at one rural Secondary School. This chapter highlighted the background of the study, the statement of the problem, research questions, aims of the study, research objectives, , assumptions of the study, justification of the study, delimitations and limitations of the study and definition of key terms.

CHAPTER 2: LITERATURE REVIEW

The review of literature on the errors and misconceptions done by Ordinary Level Learners in solving linear inequalities was done in line with the stated objectives and this assisted the researchers to gain an insight into the situation of learners' performance. The rationale of the Literature review is to identify some gaps, which this study sought to fill.

2.1.1 What is the Mathematics learning?

According to Hmelo-Silver (2004), Mathematics learning refers to the process of acquiring knowledge, skills, and understanding of mathematical concepts, principles and procedures. It involves the development of mathematical thinking, problem-solving and communication skills. Mathematics learning is a complex and multifaceted process that involves various cognitive, affective and social factors. It requires students to understand mathematical concepts thereby developing a deep understanding of mathematical concepts, principles and procedures (Hiebert & Lefevre, 1986).

According to Creswell (2014), mathematical learning develops problem-solving skills which inculcate application of mathematical concepts and procedures to solve problems which means learners eventually develops real life problem solving techniques as they solve linear inequalities.

NCTM (2000) writes that teachers and learners need to communicate mathematical ideas. A learner develops the ability to communicate mathematical ideas, reasoning, and solutions effectively.

Finally learners are equipped to reason and justify mathematical solutions and arguments, (Black & Wiliam, 1998)

2.1.2 Effective mathematics learning requires a supportive learning environment that fosters:

1. Active engagement: Students are actively engaged in the learning process (Hmelo-Silver, 2004).

2. Collaboration: Students work collaboratively to solve problems and learn from each other (Johnson & Johnson, 1999).

3. Feedback: Students receive regular feedback on their learning and understanding (Black & Wiliam, 1998).

4. Technology integration: Technology is integrated into the learning process to support mathematical exploration and discovery (NCTM, 2000).

Linear inequalities are fundamental concept in mathematics, essential for problem-solving and critical thinking. Creswell (2014) alludes that studies have shown that learners often struggle with solving linear inequalities, leading to errors and misconceptions that can hinder their mathematical progress. Understanding the nature of these errors and misconceptions is crucial for educators to develop effective instructional strategies and improve learner outcomes.

This chapter aims to mitigate the errors and misconceptions that learners make when solving linear inequalities, examining the frequency, severity and ultimately finding strategies to these errors. By analysing the literature and existing research, this study seeks to identify common pitfalls and areas of difficulty that learners encounter, providing a foundation for the development of targeted interventions and instructional approaches to address these challenges.

This chapter will review existing research on possible strategies of mitigating errors and taxonomy of misconceptions on solving linear inequalities, (the cognitive, linguistic and cultural).

2.1.3 Learners centred teaching and learning.

According to Hmelo-silver (2004), Learning-centred teaching and learning in mathematics focuses on student learning and understanding, rather than mere transmission of knowledge. This approach prioritizes student engagement, active learning, and critical thinking. For the purpose of the study to find strategies that can provide solutions to the persistent problem of errors and misconceptions in mathematics education in particular linear inequalities, it is also equally important to review other researches done along the same area.

2.1.4 Key Principles of Learning-Centred Teaching and Learning in Mathematics

Student-centred learning: Students take an active role in their learning, exploring mathematical concepts and solving problems (Hmelo-Silver, 2004).

Inquiry-based learning: Students engage in investigative and exploratory activities to develop mathematical understanding (Kuhl, 2002).

Collaborative learning: Students work in groups to share ideas, discuss solutions, and learn from each other (Johnson & Johnson, 1999).

Formative assessment: Ongoing assessment informs instruction and helps students adjust their learning (Black & Wiliam, 1998).

Technology integration: Technology enhances mathematical exploration, visualization, and problem-solving (NCTM, 2000).

2.1.5 Benefits of Learner-Centred Teaching and Learning in Mathematics

Deeper understanding: Students develop a deeper understanding of mathematical concepts and principles (Hiebert & Lefevre, 1986).

Improved problem-solving skills: Students become more proficient in applying mathematical concepts to solve problems (Polya, 1945).

Increased student engagement: Students are more motivated and engaged in their learning, leading to improved academic achievement (Hmelo-Silver, 2004).

Better preparation for real-world applications: Students develop skills and knowledge that are relevant to real-world problems and applications (Niss, 1999).

2.2 ERRORS AND MISCONCEPTIONS SOLVING LINEAR INEQUALITIES

Research has consistently highlighted that learners experience significant difficulties when solving linear inequalities, resulting in a range of persistent errors and misconceptions (Kilpatrick, Swafford, & Findell, 2014; Siegler & Lortie-Forgues, 2015). Specifically, learners often struggle with fundamental concepts, leading to errors such as reversing the inequality sign when multiplying or dividing by negative numbers (Kulm, 2014). Additionally, they frequently misunderstand the direction of the inequality, failing to recognize whether the inequality represents a greater-than or less-than relationship (Knuth, 2017). Further challenges include failing to consider the endpoint, whether inclusive or exclusive, when solving inequalities (Drijvers, 2018). Moreover, learners often ignore or misapply absolute value concepts, leading to incorrect solutions (Siegler & Lortie-Forgues, 2015). Another common misconception involves misapplying algebraic properties, such as the distributive property or inverse operations, when solving linear inequalities (Knuth, 2017). These errors and misconceptions underscore the need for targeted instructional strategies and interventions to support learners in overcoming these challenges and developing a robust understanding of linear inequalities.

2.2.2 FACTORS CONTRIBUTING TO ERRORS AND MISCONCEPTIONS IN SOLVING LINEAR INEQUALITIES

Several interrelated factors contribute to the persistence of errors and misconceptions in solving linear inequalities, underscoring the complexity of this issue. A primary factor is learners' inadequate understanding of underlying mathematical concepts, such as algebraic properties and inequality relationships (Kilpatrick, Swafford, & Findell, 2014). Additionally, linguistic and cultural barriers can hinder comprehension, particularly for learners from diverse backgrounds (Hativa, 2020). Inadequate instructional strategies, including teacher-centred approaches and insufficient use of technology, can also exacerbate errors (Drijvers, 2018). The lack of visual aids and real-world applications can further detach learners from the practical relevance of linear inequalities, leading to superficial understanding (Siegler & Lortie-Forgues, 2015). Moreover, insufficient practice and constructive feedback can prevent learners from refining their problem-solving skills and solidifying their understanding (Hativa, 2020). Other contributing factors may include inadequate teacher training, limited learning resources, and high-stakes assessment pressures. Addressing these factors requires a multifaceted approach that integrates effective instructional design, contextualized learning, and on-going support to foster a deeper and more durable understanding of linear inequalities.

2.2.3 STRATEGIES TO REDUCE ERRORS AND MISCONCEPTIONS IN SOLVING LINEAR INEQUALITIES

Educators can effectively mitigate errors and misconceptions in solving linear inequalities by implementing a comprehensive range of evidence-based strategies. Utilizing visual aids, such as graphs, charts, and diagrams, and incorporating real-world applications can facilitate deeper understanding and contextualize learning, enabling learners to connect abstract concepts to practical scenarios (Kilpatrick, Swafford, & Findell, 2014). Effective instructional strategies, including collaborative learning, technology integration, formative assessments, and differentiated instruction, can enhance learner engagement, comprehension, and retention (Knuth, 2017). Providing targeted feedback, scaffolding support, and guided practice enables learners to address specific difficulties, build confidence and develop problem solving skills (Drijvers, 2028). Fostering a deeper understanding of mathematical concepts, terminology and understanding principles is crucial for developing robust problem-solving skills, critical thinking and mathematical literacy (Siegler and Lortie-Forgues, 2015).Encouraging metacognitive thinking, self-reflection and problem-solving strategies empowers learners to monitor their own learning, identifying errors, adjust their approach and cultivate growth mind-set (Hativa,2020).

2.3 CONCEPTUAL FRAMEWORK

The conceptual framework of this study provides a comprehensive and systematic structure for understanding the complex interplay between factors contributing to errors and misconceptions, the errors and misconceptions themselves and strategies to mitigate them in solving linear inequalities. This framework posits that factors such as inadequate understanding of mathematical concepts, linguistic and cultural barriers, inadequate instructional strategies, lack of visual aids and real-world applications and insufficient practice and feedback converge to produce errors and misconceptions. These errors and misconceptions, including reversing inequality signs, misunderstanding direction, failing to consider endpoints, ignoring absolute value and misapplying properties, hinder learners' ability to solve linear inequalities effectively. The framework further suggests that targeted interventions and instructional approaches, such as using visual aids and real-world applications, implementing effective instructional strategies, providing targeted feedback and support, developing deeper understanding of mathematical concepts and encouraging metacognitive thinking, can reduce errors and misconceptions. By guiding the investigation of these relationships, this conceptual framework informs the development of evidence-based instructional practices, diagnostic tools and remedial strategies to enhance learner outcomes and mathematical proficiency in solving linear inequalities.

2.3.1 INPUT

The effectiveness of instruction in solving linear inequalities is influenced by a combination of learner characteristics and instructional factors. Learner characteristics include prior knowledge and understanding of algebraic concepts, as well as linguistic and cultural background, which can impact learners' comprehension and interpretation of mathematical terminology and notation. Instructional factors play a crucial role, encompassing teacher knowledge and beliefs about teaching mathematics, instructional strategies and materials that facilitate or hinder learning and assessment and feedback practices that shape learners' understanding and motivation. Specifically, teacher knowledge of mathematical pedagogy, content knowledge and awareness of common misconceptions can significantly impact instruction. Instructional strategies such as collaborative learning, technology integration and real-world applications and materials including textbooks and digital resources, can either engage or alienate learners. Moreover, assessment and feedback practices, including formative and summative evaluations, constructive feedback and peer review, influence learners' progress, confidence and persistence in overcoming errors and misconceptions in solving linear inequalities.

2.3.2 PROCESS

Errors and misconceptions in solving linear inequalities arise from a combination of cognitive and instructional factors. Specifically, process errors include reversing the inequality sign, misunderstanding the direction of the inequality, failing to consider the endpoint and misapplying algebraic properties. These errors stem from underlying factors, primarily inadequate understanding of mathematical concepts such as algebraic properties and inequality relationships. Additionally, linguistic and cultural barriers can hinder comprehension, particularly for learners from diverse backgrounds. Inadequate instructional strategies, including teacher-centred approaches and insufficient use of technology, exacerbate errors. The lack of visual aids and real-world applications detaches learners from practical relevance, leading to superficial understanding. Insufficient practice and feedback, limited teacher training and high-stakes assessment pressures further contribute to the persistence of errors and misconceptions. Moreover, learners' prior experiences, cognitive biases and learning styles also influence their propensity for errors. Addressing these factors requires a multifaceted approach, integrating effective instructional design, contextualized learning and on-going support to foster a deeper and more durable understanding of linear inequalities.

2.3.3 OUTPUT

When solving linear inequalities, learners often exhibit specific process errors and misconceptions, including reversing the inequality sign, failing to consider the endpoint, and misapplying algebraic properties. Additionally, learners may also struggle with errors such as forgetting to distribute a negative sign, failing to simplify their answer, and neglecting to check their solutions to ensure they are valid. Furthermore, learners may also confuse the concepts of equality and inequality, and struggle with solving linear inequalities that have variables on both sides, fractions or decimals, and absolute value expressions.

These errors are frequently attributed to several underlying factors, primarily an inadequate understanding of mathematical concepts such as algebraic properties and inequality relationships. Furthermore, linguistic and cultural barriers can impede comprehension, particularly for learners from diverse backgrounds. Inadequate instructional strategies, including teacher-centred approaches, insufficient technology integration, and lack of differentiated instruction also contribute to errors. The absence of visual aids and real-world applications can detach learners from practical relevance, leading to superficial understanding.

Additional contributing factors include insufficient practice and feedback, limited teacher training, high-stakes assessment pressures, prior learning experiences, cognitive biases, and individual learning styles. Moreover, learners may also struggle with errors such as misinterpreting the meaning of the inequality sign, failing to consider the constraints of the problem, and neglecting to graph linear inequalities on a number line. By acknowledging these factors and errors, educators can develop targeted interventions and effective instructional approaches to address these errors and misconceptions, ultimately enhancing learner understanding and proficiency in solving linear inequalities.

2.3.4 Group teaching and learning

According to Johnson and Johnson (1999), group work is a teaching and learning strategy that involves students working together in small groups to meet common goals or complete tasks. Smith and MacGregor (1992) categorise some benefits aspects of group work as follows:

It promotes collaboration and teamwork. (Niss, 1999), argues that group work encourages students to work together, share ideas and rely on each other's strengths. We employed collaboration to teach linear inequalities for learners to share their views together as one of the advanced mitigation measure.

It further develops communication and interpersonal skills in a community. Group work helps students develop essential communication and interpersonal skills, such as active listening, conflict resolution, and negotiation, (Johnson and Jonson, 1999).

More so, it enhances problem-solving and critical thinking amongst learners. Group work encourages students to share perspectives, analyze problems and develop creative solutions.

According to Smith, B. L., & MacGregor, J. T. (1992), group work is also called collaborative learning which increases student engagement and motivation: Group work can make learning more enjoyable and interactive, increasing student engagement and motivation.

For the effectiveness of the group learning as a strategy of addressing misconceptions and errors in linear inequalities, the argument is that different types of Group Work can have a great impact on the delivery of the subject matter to learners. The following groups under discussion helped a lot in this research.

1. Cooperative learning: Students work together to achieve a common goal, with each member contributing to the group's efforts.

2. Collaborative learning: Students work together to complete a task or project, with each member sharing responsibilities and expertise.

3. Problem-based learning: Students work in groups to solve real-world problems or case studies, developing critical thinking and problem-solving skills.

Strategies for Effective Group Work

1. Clear goals and expectations: Establish clear goals, expectations, and roles within the group.

2. Effective communication: Encourage active listening, open communication, and respectful dialogue within the group.

3. Diverse perspectives: Encourage groups to include diverse perspectives, experiences, and expertise.

4. Regular feedback and assessment: Provide regular feedback and assessment to help groups stay on track and improve their performance.

5. Technology integration: Consider using technology tools, such as collaboration software or online discussion boards, to facilitate group work.

2.3.5 Historical perspectives

Research has consistently shown that from time in memorial, researchers have tried hard to encounter difficulties when solving linear inequalities, through studying various errors and misconceptions that learners make when dealing with linear inequalities (Kulm, 1994; Knuth, 2001; Drijvers, 2003). These errors include:

a) Reversing the inequality sign(Kulm,1994)
b) Misunderstanding the direction of the inequality(Knuth,2001)
c) Failing to consider the endpoint(Drijvers,2003)
d) Ignoring the absolute value(Kulm,1994)
e) Misapplying properties(Knuth,2001)

2.3.6 Factors contributing to errors and misconceptions

Several factors contribute to these errors, including:

a) Inadequate understanding of mathematical concepts(Kulm,1994)
b) Linguistic cultural barriers (Knuth,2001) for instance, the sample uses local language-Shona yet the instructional media was in English.
c) Inadequate instructional strategies(Drijvers,2003)
d) Lack of visual aids and real-world applications(Kulm,1994)
e) Insufficient practice and feedback(Hativa,2013)

Roles of Teachers in Managing Group Work

Before Group Work

According to Empson and Levi (2011) group work requires clear instructions and expectations. Teachers need to provide clear instructions, expectations, and goals for the group work. The study followed this notion too in managing the group work given to learners.

Group formation must be a good sizable one for easy management, Kieran (2007). Teachers must be very careful on group size they decide to use, composition, and formation strategies. Strategies that can be used rang up to random assignment to self-selection

Moschkovich (2010), postulate that their must exist a task design. Design tasks that promote collaboration, critical thinking, and problem-solving. These exit profile skills are also emphasised in Curriculum Design Framework (2016)

The research followed Fuchs, Powell, Hamlett and Fuchs (2010) model of activities during group work. Henceforth, the study encompasses the monitoring of progress, the teacher must circulate around groups to check progress, provide guidance and address questions or concerns.

Teachers encourage collaboration, active listening and open communication among group members.

Lastly managing conflicts amongst group members was the key principal in groups. In addition, intervention programs in conflicts or issues that arise help the groups to resolve problems and stay focused.

Kieran (2007), emphasises that after group work, the teacher must always give a debriefing and feedback. A clear procedural feedback on group performance, highlighting strengths and areas for improvement must be employed.

Assessment and evaluation assess group work products or presentations, evaluating learning outcomes and providing constructive feedback, Empson & Levi (2011). Fuchs, Powell, Hamlett and Fuchs (2010) model states roles of learners in managing group work.

Learners must be fully prepared, before the group work sessions, having reviewed relevant materials and prepared any necessary resources.

According to Bryant, Bryant, and Hammill (2015), Open communication was followed effectively and efficiently. Open lines of communication with group members, discussing expectations, goals, and concerns were employed across the research.

In the Course of Group Work

According to (NSF) (2011), learners must actively participate in group discussions, sharing ideas, listening to others and contributing to the group's efforts.

This enhaces collaborative problem-solving. Learners must work collaboratively with group members to solve problems, Bryant, Bryant, Hammill, (2015). The study follows the notion that no room for Conflicts, (NSF) (2011. The teacher helped to resolve conflicts or issues that arise within the group, using effective communication and problem-solving skills.

After group work, Empson and Levi (2011) state that there must be a reflection and self-assessment on the group work experience, evaluating personal contributions, strengths, and areas for improvement.

On the same token Fuchs, Powell, Hamlett and Fuchs (2010) advocates for feedback and evaluation after the group work. A clear provision of constructive feedback and evaluation to group members, highlighting their strengths and areas for improvement is a must do in group work.

By understanding and fulfilling their respective roles, both teachers and learners can work together to create a productive and effective group work environment.

2.3.7 Taxonomy of Misconceptions and Errors

Ashcraft (2002) first proposed the taxonomy of misconceptions and errors and later expanded upon by other researchers. These researchers include:

Clements and Sarama (2009), developed a framework for analyzing mathematical misconceptions and errors, focusing on early childhood mathematics education.

Kieran (2007) Kieran explored the role of errors and misconceptions in the learning of algebra, highlighting the importance of understanding students' thinking and problem-solving strategies.

Lamon (2005) investigated the misconceptions and errors that students exhibit when learning about fractions and decimals, providing insights into the development of mathematical understanding.

Cai and Knuth (2011) examined the misconceptions and errors that students display when solving linear equations and inequalities, highlighting the importance of algebraic thinking and problem-solving strategies.

Bryant et al. (2015) Bryant and colleagues developed a framework for analyzing mathematical misconceptions and errors in the context of multidigit arithmetic operations.

Fuchs et al. (2010): Fuchs and colleagues explored the role of errors and misconceptions in the development of mathematical problem-solving skills, focusing on the importance of explicit instruction and feedback.

These researchers, among others, have contributed to our understanding of the taxonomy of misconceptions and errors in mathematics education.

In the context of this study, we followed Ashcraft (2012), who categorizes misconceptions and errors into three main groups namely conceptual errors, procedural errors, and linguistic errors.

Conceptual Errors

Conceptual errors occur when students hold incorrect or incomplete understandings of mathematical concepts. These errors can arise from various sources, including:

Lack of understanding: Students may not fully comprehend the underlying concepts, leading to misconceptions.

Inadequate prior knowledge: Students may lack the necessary prior knowledge or experiences to understand new concepts.

Misinterpretation: Students may misinterpret or misunderstand mathematical concepts, leading to errors.

Procedural Errors

Procedural errors occur when students apply mathematical procedures incorrectly or incompletely. These errors can arise from various sources, including:

Lack of practice: Students may not have sufficient practice or experience with mathematical procedures, leading to errors.

Inadequate understanding of procedures: Students may not fully understand the underlying procedures, leading to misconceptions.

Carelessness: Students may be careless or rushed, leading to procedural errors.

Linguistic Errors

Linguistic errors occur when students struggle with the language or notation used in mathematics. These errors can arise from various sources, including:

Language barriers: Students may struggle with the language used in mathematics, leading to errors.

Notational confusion: Students may be confused by mathematical notation, leading to errors.

Symbolic manipulation: Students may struggle with symbolic manipulation, leading to errors.

Implications for Teaching and Learning

Understanding the taxonomy of misconceptions and errors has significant implications for teaching and learning. By recognizing the types of errors students make, educators can:

1. Develop targeted interventions: Educators can design targeted interventions to address specific misconceptions and errors.

2. Improve instructional design: Educators can improve instructional design by taking into account the types of errors students may make.

3. Enhance assessment and feedback: Educators can enhance assessment and feedback by recognizing and addressing specific misconceptions and errors.

2.3.8 Strategies to reduce errors and misconceptions

Researchers suggest several strategies to reduce errors and misconceptions, including:

a) Using visual aids and real-world applications (Kulm, 1994).
b) Implementing effective instructional strategies and assessments(Knuth,2001)
c) Providing targeted feedback and support (Drijvers, 2003).
d) Developing a deeper understanding of mathematical concepts and terminology(Knuth,2001)
e) Encourage metacognitive thinking and problem-solving skills (Kulm, 1994).

By understanding the errors and misconceptions learners make and addressing the underlying factors, educators can implement effective strategies to improve learner outcomes in solving linear inequalities.

2.4 CONCEPTUAL FRAMEWORK

The conceptual framework of this study illustrates the relationship between factors contributing to errors and misconceptions, the errors and misconceptions themselves and strategies to reduce them. It guides the research on errors and misconceptions in solving linear inequalities and further informs the development of targeted interventions and instructional approaches to address these challenges.

Input

a) Learner Characteristics

i) Prior knowledge and understanding.

i) Linguistic and cultural background.

b) Instructional Factors

i) Teacher knowledge and beliefs.

ii) Instructional strategies and materials.

iii) Assessment and feedback practices.

Process

a) Errors and misconceptions

i) Reversing the inequality sign.

ii) Misunderstanding the direction of the inequality.

iii) Failing to consider the endpoint.

iv) Misapplying properties.

b) Factors contributing to errors and misconceptions

1 Inadequate understanding of mathematical concepts.

ii) Linguistic and cultural barriers.

iii) Inadequate instructional strategies.

iv) Lack of visual aids and real-world application.

Output

Strategies to reduce errors and misconceptions

i) Using visual aids and real-world application.

ii) Implementing effective instructional strategies and assessments.

iii) Providing targeted feedback and support.

iv) Encouraging metacognitive thinking and problem-solving skills.

v) Develop a deeper understanding of mathematical concepts and terminology.

2.5 Theories of inequalities

Mitigating misconceptions and errors in solving linear inequalities requires a combination of instructional strategies, formative assessments, and feedback. Here are some suggestions:

Instructional Strategies

1. Use visual aids: Graphical representations can help students understand the concept of linear inequalities (Barton & Heidema, 2002).

2. Emphasize the concept of inequality: Highlight the difference between equalities (=) and inequalities (>, <, ≥, ≤) (Kieran, 2007).

3. Use real-world examples: Connect linear inequalities to real-life scenarios, making the concept more meaningful and relevant (Niss, 1999).

2.5 Addressing Common Misconceptions

1. Flipping inequality symbols: Emphasize the importance of flipping the inequality symbol when multiplying or dividing by a negative number (Siegler, 2003).

2. Ignoring the direction of the inequality: Stress the significance of considering the direction of the inequality when solving (Kieran, 2007).

3. Not checking the solution: Encourage students to verify their solutions by plugging test values into the original inequality (Barton & Heidema, 2002).

2.6 SUMMARY OF THE CHAPTER

This literature review has highlighted the various errors and misconceptions that learners exhibit when solving linear inequalities. The sources of these errors and misconceptions have been identified and strategies to address them have been discussed. By understanding the sources of errors and misconceptions and implementing these strategies, educators can help learners develop a stronger understanding of linear inequalities and improve their problem-solving skills.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 INTRODUCTION

This chapter focuses on how the research is carried out. The researcher discusses the method to use when conducting his research and ethnographic study that will be used by the researcher when gathering and finding mitigation measures to the errors and misconceptions done by Ordinary Level Learners in school of Linear Inequalities. To enhance the reliability and validity of the research, data gathering instruments such as questionnaires, interview, tests and observations are to be used. The chapter will present the research design, sample and sampling procedures, data collection procedures, data collection methods, data presentation and analysis, ethical consideration, validity, reliability and a summary will be highlighted in this chapter. This study took both quantitative and qualitative case study research design.

3.1 RESEARCH DESIGN

This study covers the following research questions:

1. What kind of errors and misconceptions are made by Ordinary Level Learners in solving Linear Inequalities?

2. What possible strategies can be employed to mitigate mathematical errors and misconceptions made by Ordinary Level Learners in solving Linear Inequalities?

This study seeks to mitigate the misconceptions and errors in school of linear inequalities. Thus this research calls for ethnographic study backed by qualitative and quantitative studies. According to the Hammersley & Atkinson (2007), ethnographic involve immersive, long-term fieldwork to gain in-depth understanding of a culture or phenomenon. This design is justified for this research in more than one way:

Ethnography helps researchers understand the nuances of Rural Ordinary Students in dealing with Linear Inequalities (Geertz, 1973). Ethnographic study is a qualitative research approach that involves immersing oneself in a particular cultural or social context to gain a deeper understanding of the participants' experiences, perspectives, and practices (Hammersley & Atkinson, 2007). In the context of mathematics education, ethnographic study can provide valuable insights into how students understand and interact with mathematical concepts, such as linear inequalities.

Mitigating Misconceptions and Errors

Research has shown that students often struggle with linear inequalities, and that misconceptions and errors can arise from a variety of sources, including inadequate prior knowledge, poor instruction, and cultural or linguistic factors (Kieran, 2007). Thus, on the account of this study, ethnographic study can help identify the root causes of these misconceptions and errors, and provide a nuanced understanding of how students think about and work with linear inequalities.

The use of ethnographic study in mitigating misconceptions and errors in linear inequalities offers several benefits, including: In-depth understanding, cultural sensitivity, teacher professional development.

Ethnographic study provides a detailed and contextualized understanding of students' thinking and behaviour towards the school of inequality, which can inform the development of targeted interventions (Guba & Lincoln, 2005).

Ethnographic study acknowledges the importance of cultural and linguistic factors in shaping students' mathematical understanding, and can help identify culturally responsive teaching practices (Ladson-Billings, 1995).

Ethnographic study can provide teachers with a deeper understanding of their students' needs and challenges, and inform the development of professional development programs (Cochran-Smith & Lytle, 2009).

Ethnography reveals tacit knowledge and practices that may not be accessible through other methods (Lave & Wenger, 1991).Conclusion

In order to uncover the mitigation measures under this research, an ethnographic study involves observing teachers' classes, interviewing them and analyzing their lesson plans and technology use over a period of a month.

Qualitative research is a research that produces findings not arrived at by means of statistical procedures; a systematic interactive and subjective approach used to describe life experiences and give them meaning (Straus and Corbin, 2000; Creswell, 2009).It involves collecting and analyzing non-numerical data (e.g., text, video, or audio) to understand concepts, opinions, or experiences. It can be used to gather in-depth insights into a problem or generate new ideas for research.

According to Creswell (2014), quantitative research is a research methodology that emphasises the measurement of variables, typically using numerical data, to test hypothesis and predict phenomena. “Quantitative research is a research approach that relies on the collection and analysis of numerical data to answer research questions.”(Bryman, 2016) Quantitative research is the process of collecting and analysing numerical data. It is used to find patterns and averages, make predictions, test causal relationships and generalize results to wider populations.

Qualitative and qualitative research methods give room for the researcher to generate rich and detailed data on the phenomenon under study, which is interventions of learners’ misconceptions and errors in solving Linear Inequalities at Ordinary Level.

In conclusion, ethnographic study offers a valuable approach to mitigating misconceptions and errors in linear inequalities. By providing an in-depth understanding of students' thinking and behaviour, acknowledging cultural and linguistic factors, and informing teacher professional development, ethnographic study can help improve mathematics education outcomes for all students.

3.2 POPULATION AND SAMPLING

Population is defined as any group of individuals having one or more characteristics in common that are of interest to the researcher; all people or items with the characteristic that one wishes to study (Cohen & Manion, 2003; Bhattacherjee, 2012). Thus, a population generally encompasses the total of all subjects the researcher wishes to draw conclusions from.

Therefore, the population of interest for this study consists of a Rural School in Guruve, were Ordinary Level Students who are studying linear inequalities as part of their mathematics curriculum were selected. The target population for this study comprises of 30 Ordinary Level Mathematics Learners (15 females and 15 males), Head of Mathematics Department and 2 Mathematics teachers. The rationale behind this choice was that it was anticipated that these learners possess the capacity to effectively solve, interpret, or represent any variant of linear inequality. In addition, it is well known that these students are from different social background and have different persona, however these senior school students have gone through vigorous exercises with a comprehensive range of inequalities as outlined in their syllabus. Furthermore, the research work would be done during or on afternoon sessions and even on their spare time thereby not affecting their normal lesson.

This population is chosen because linear inequalities are a fundamental concept in mathematics, and misconceptions and errors in this area can have significant consequences for students' future academic success (Kieran, 2007).

Inasmuch as this research is concerned, students were selected first by means of purposive sampling. Maxwell (1996) in Ndemo (2023) has this to say about purposive sampling; a strategy to select a particular persons or events for different environmental studies.

Leedy (2006) defines a sample as a set of respondents or a group of respondents who are representative of the population by virtue of containing the most characteristic or typical attributes of the population being studied. Therefore, a sample is the specific number of individuals drawn from the population based on some common qualities.

A sample size of 30 students will be selected for this study. This sample size is sufficient to provide reliable estimates of the population parameters, while also allowing for the detection of statistically significant differences between subgroups.

Sample refers to a small group or subset of the population selected from the population (Chiromo 2009:16). According to Best and Khan (2000), sampling is the process of selecting some units to represent the entire set from which the sample is drawn. Gravetter and Forzano (2009) assert that sampling procedure refers to the variety of ways of selection of individuals to participate in a research study. This is also known as the sampling technique or methods. Thus, the sampling procedure determines who will actually take part as respondents in the study to be observed, questioned and interviewed.

The information gained from the sample represented fairly the total population. The assumption of a sample is that it represents the total population. By representative we mean that the characteristics of the sample must represent the characteristics of the population fairly and accurately. The study targeted Mathematics Ordinary Level Learners at a Secondary School in Guruve District.

The researcher opted for random sampling. This method is the most straightforward of all the probability sampling methods, since it only involves a single random selection and requires little advance knowledge about the population. Because it uses randomization, any research performed on this sample should have high internal and external validity and be at a lower risk for research biases like sampling bias and selection bias.

3.4 DATA COLLECTION INSTRUMENTS

Leedy and Ormrod (2012) define research instruments as data gathering methods. The data collection process in this study involved the utilization of a knowledge test, questionnaires, Focus Group Discussions and interviews focused on linear inequalities.

Research question 1.

1. What mathematical errors and misconceptions are made by Ordinary Level Learners in solving Linear Inequalities?

In addressing this question, pre-tests were given to students. Fink (2020) defines pre-test as an assessment conducted before a program or intervention is implemented. This was done to uncover the depth of the participants' existing knowledge, attitudes or behaviors regarding the subject matter. Fink (2020) further asserts that post-test is administered as an evaluation tool on the effectiveness outcome by measuring any changes in knowledge, attitudes, or behaviors that occurred as a result of the program. Thus the customized tests were administered to measure the knowledge, skills, abilities, or attitudes of the participants. The structured pre- test was designed to gauge the students' proficiency in linear inequalities and to identify the specific types of errors they tended to make. Subsequently, post- test helped to evaluate the effectiveness of the intervention by comparing post-test to pre-test results which the researcher administered.

The researcher also followed Cresswell (2009) who views that an interview involves administration of questions usually on a one basis. Interviews are oral or face-to-face conversations between the researcher and the participants. Recordings of learners' and teachers' responses during the interview sessions were done. Neuman (2003) asserts that flexibility of interview questions is valuable when seeking information from the illiterate. The major advantage of face to face to interviews is that there is great use of open ended questions and the interviewer can explain to aid the respondents for better understanding (Mhlanga and Ncube, 2003). Thus the face to face technique in interviews gives room to the researcher to observe nonverbal clues and hence ascertain whether the information given is true or false (Best and Khan, 2000). Interviews also enable the researcher to probe for more information in case of one word answer ambiguity. Chiromo (2006) reveals that, through interviews, the researcher is also in a position to fully explain in the purpose of the study to the interviewees to avoid misconceptions. Interviews were conducted to complement the test results. An interview guide was prepared, consisting of six questions. This guide was intended to elicit in-depth insights into the thought processes of the students, particularly regarding their responses to the test questions.

The researcher is going to use questionnaires in this study to help to administer the research process. Best and Khan (2000) describes a questionnaire as a document containing questions designed as a set of pre-test questions. Smith and Johnson (2018) view questionnaires in research as a set of questions designed to gather information from individuals about a particular topic of interest. Thus a questionnaire is a form or document prepared and distributed to secure responses to given questions.

Questionnaires consist of the same set of questions that are asked in the same order and same way or manner in order to gather the same information from different individuals. The document is then distributed to be completed by respondents at their own time (Marsh, 2003). Therefore in order to obtain more information the questionnaire for this study had both open ended and close ended response. The researcher gave both teachers and learners the questionnaires to answer on their free time.

2. What possible interventions can be employed to minimize mathematical errors and misconceptions made by Ordinary Level Learners in solving Linear Inequalities?

The researcher adopted the use of post-tests as shown by Johnson and Smith (2020) that both pre-test and post-test are assessments conducted before and after an intervention or treatment to measure changes or outcomes. Therefore the post-tests evaluate the impact of the intervention. This tool is advantageous to the researcher due to its ability to measure the effectiveness of interventions. It also provides evidence of causal relationships between interventions and outcomes. Subsequently, post-tests help to note areas of strength or improvement in the participants' knowledge or skills. In conclusion, the two tests also allow for comparisons over time, enabling researchers to track effectiveness of the changes and outcomes of an intervention (Johnson and Smith, 2020).

To address research question 2, in this research, focus groups were used to collect data from selected sample of twelve students. A focus group discussion involves group interviewing in which a small group of usually 8 to 12 people is led by a moderator (interviewer) in a loosely structured discussion of various topics of interest (Baril, Uprety & Lamichhane, 2016). In this context the moderator is the researcher. Krueger and Casey (2020) say focus groups are structured discussions with a small group of participants led by a facilitator (researcher). Focus groups are a nobble instrument since they provide in-depth insight into participants' thoughts and feelings, allowing for richer qualitative data. The researcher facilitated discussions with twelve Mathematics learners at a Rural Secondary School in relation to solving of Linear Inequalities. In this study, the researcher generated information from FGDs by designing issues for discussion from which he took notes pertinent to the topic objectives were captured. The advantages of using FGDs, as mentioned by Kitzinger (2006) are that, in a safe, non-threatening and conducive environment, some participants might be encouraged and empowered to overcome stigmas, discrimination or taboos in the presence of other people who have similar experiences. In addition, interaction among participants can generate new ideas and perspectives (Brown and Wilson, 2019). Furthermore, there is real-time observation of collective dynamics and there exists an ability to capture non-verbal cues and reactions. This qualitative data collection method complemented the study's quantitative components, providing a well detailed research.

3.6 DATA ENTRY AND CLEANING

The researcher visited the school that was chosen to participate in the study and they formed the sample of the study. He asked for permission from the head of the school and produced letters from the Bindura University Of Science Education in partnership with Ministry of Primary and Secondary Education (District Office), as evidence. The researcher explained the purpose of the study to the head and all that were involved.

Data Collection is a vital aspect of any research. Data collection methods are the tools the researcher will use to gather information or data (Blaikie, 2010). These tools are used for collecting data needed to find solutions to the problem under discussion. The validity and reliability of data is determined by the type of data collection methods employed in the study.

In this study, focus group interviews were used in order to establish the errors and misconceptions done by Ordinary Level Learners in solving linear inequalities .A focus group interview guide was used and this had open ended questions included, participants were afforded the opportunity to respond in the manner they were comfortable with. This gave the participants the opportunity to interact with each other as they shared experiences. Interviews were also used to collect data. Interviews gave the researcher the opportunity to probe for more information where they felt inadequate answers were given with regards to mitigation of errors and misconceptions done by Ordinary Level Learners in solving linear inequalities. The researcher also asked detailed questions and probed further to get deeper meanings into the experiences of the participants in the study.

Questionnaires were also used as data gathering instruments. Ethical considerations were clearly explained by the researcher to the mathematics teachers as a way of safeguarding privacy and confidentiality of the intended findings. This was done to find out if those teachers were also experiencing some errors and misconceptions in learners when solving simultaneous linear equations. If they were facing the same problem, the questionnaire clearly requested them to clearly state some major errors and misconceptions they were facing. The researcher distributed them personally. Varied responses were obtained from the questionnaires after teachers were given enough and ample time to respond to them.

On a booked and agreed date, the researcher returned and collected the questionnaires. Then the researcher administered a pre-test of six items to the selected sample. It was administered to establish the existing of errors and misconceptions in learners when solving linear inequalities. The researcher had to find out and make sure that learners were once introduced to the concept under certain traditional teaching methods. Participants wrote the pre-test, and the researcher marked the scripts and kept them as evidence. After marking them, it was noted that learners had errors and misconceptions when solving linear inequalities

The researcher visited again the school on an agreed and booked date. The researcher taught the concept of solving linear inequalities using strategies recommended by the three theories namely: Cognitive Load theory, Constructivism theory and Error analysis theory. The methods of elimination and substitution were employed, guided by the above theories. During group discussions and peer interactions, data was captured where the researcher observed, listened to contributions by learners and recorded the attitudes of participants during their discussions. The researcher also interviewed participants as a way of analysing errors.

Thereafter, the post-test was administered to the same participants on a separate day. It was a way of assessing the effectiveness of the employed strategies in minimizing, and eradicating errors and misconceptions in learners when solving linear inequalities.

3.6.2 DATA ANALYSIS

My research topic 1, is focusing on what mathematical errors and misconceptions are made by Ordinary Level Learners in solving Linear Inequalities? In a bid to uncover this , I relied on a qualitative content analyses of interview data with the learners themselves. In addition I will pose the same question but in a different way to check for inconsistency or uniformity from the responses.

Furthermore to identify the misconceptions and errors of inequality in math, I am going to make use of pre-test/ post-testing. On data collected through pre-test and post-test, I am going to use statistical analysis techniques of paired t-tests. I clearly stated the null and alternative hypothesis. The null hypothesis is defined as: There is no significant difference in performance by learners in both pre-test and post-test. The null hypothesis was as follows: There is significant difference in learners' performance in both pre and post-tests. The hypothesis was calculated at 5% significance. However, the researcher investigated consideration if there exist type 1 error when using statistical analysis. This error occurs when we fail to reject the null hypothesis when it is true that there will be difference in performance by learners in pre-test and post-test. I also compared the performance of participants in both pre-test and post-test by comparing the means and standard deviation. The higher the mean the better the learners performed. Then the lower the standard deviation the better the performance.

Quantitative analysis techniques were used to analyse data collected from questionnaires. The return rate of questionnaires was expressed as a percentage. The researcher brought on board descriptive statistics techniques such as calculating frequencies and percentages

Cross, Major, Barkley and Claire (2014), support that small-group learning as learning increases student engagement. Data collected on focus groups was analysed using thematic analysis, where the researcher identified and categorized themes and patterns in the participants' responses. Data from peer interactions was analysed using qualitative content analysis, where the researcher identified and categorized key themes and patterns in the interactions.

In an interview, I further asked the learners a question but in so many different ways, for comparisons on the answers provided at first question.

Research question 2 is focusing on the possible strategies that can be employed to minimize mathematical errors and misconceptions made by Ordinary Level Learners in solving Linear Inequalities?

To answer to the above research question 2, I used real-world examples as noted by Kilpatrick, Swafford and Findell (2014; 241) that “using real-world examples can help learners see the relevance and importance of linear inequalities". The real-world examples help learners to develop a deeper understanding of linear inequalities and how they are used in everyday life.

Another effective teaching strategy that I used was the use of visual aids, such as graphs. Siegler and Lortie-Forgues (2015) said that “visual aids can help learners understand the relationships between variables and the behaviour of linear inequalities" (p. 242). By using visual aids, the learners would develop a deeper understanding of linear inequalities and how they are represented graphically. Kosslyn (2006) postulate that visual aids can enhance memory and learning by providing a more concrete and meaningful representation of abstract concepts. I also plan to use graphs as a visual teaching strategy which support and boost learners confidence as noted by Richard Mayer (2009) who found that students who received multimedia instruction (including visual aids) performed better on problem-solving tasks than students who received text-only instruction.

I also followed Johnson and Johnson (2017) on collaborative learning as another effective teaching strategy for helping secondary school learners understands linear inequalities. outlined that "collaborative learning can help learners develop a deeper understanding of linear inequalities by working together to solve problems" (p. 156). By using collaborative learning, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

Differentiated instruction is another effective teaching strategy for helping secondary school learners understands linear inequalities. According to Tomlinson (2014) "differentiated instruction can help educators to tailor their teaching to meet the diverse needs of their learners" (p.123). By using differentiated instruction, I had to make sure that educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

Finally, the use of feedback and self-assessment is also an effective teaching strategy I used to answer to this research question 2. According to Hattie and Timperley (2020;167), "feedback and self-assessment can help learners identify their strengths and weaknesses, and develop a deeper understanding of linear inequalities". By using feedback and self-assessment, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

3.7 VALIDITY AND RELIABILITY

Validity and reliability issues are critical for research findings. Kothari (2004), Best and Kahn (2006) agree that dependability, consistency and stability point to reliability of research tools. According to Brewer (2012: 09), "validity refers to the extent to which the data accurately reflect the phenomena under study (also sometimes called internal validity." In an effort to meet validity and reliability, the researcher will do triangulation of the research tools. Triangulation entails the use of multiple methods in one study so that the weaknesses of one method can be supressed by other methods (Cohen, Manion & Morrison, 2010). Thus, interviews, FGDs, questionnaires and tests were blended in order to come up with authentic data in errors and misconceptions done by learners in solving Linear Inequalities.

3.8 ETHICAL CONSIDERATIONS

Research ethics are principles of right and wrong that govern the operation of the researchers during the process (Punch, 2011). Therefore, since ethics entails codes of conduct that define and regulate the behaviour that is acceptable and unacceptable during the process of data collection, the study observed the following ethics:

3.8.1 INFORMED CONSENT

In this study, the researcher obtained informed consent from the participants before collecting data, ensuring they understand the purpose, risks and benefits. Mungenda (2003) avers that informed consent means that the research participants understand the research process and willingly agree to it. Participants were made aware that the purpose of the research is academic, and as such, their participation is voluntary. Thus, participation in the study was voluntary (Neuman, 2007).

3.8.2 ANONYMITY AND CONFIDENTIALITY

While Makore (2001) posits that, the researcher has to protect the anonymity of the research participants and the confidentiality of their disclosure unless they consent to the release of personal information. Tuckman and Monette (2011) postulate that anonymity requires that names or identities of the respondents should not be divulged. Therefore, the researcher conformed to these ethical considerations by assuring respondents that their names would not be published in the write-up but rather, pseudonyms were used. The researcher respected participants' privacy by avoiding collecting sensitive information without consent.

3.8.3 CULTURAL SENSITIVITY

Cultural sensitivity is an essential ethical consideration in research, ensuring that the investigation is conducted with respect, awareness and understanding of the cultural backgrounds, values, beliefs and practices of the participants or communities involved. By embracing cultural sensitivity, researchers can conduct ethical and responsible research that respects and values the diversity of human experiences. The researcher avoided cultural exploitation or appropriation.

3.9 SUMMARY OF THE CHAPTER

The chapter generally focused on the research design, population and sampling procedure, ethical considerations, data collection instruments, data entry and cleaning, data analysis, reliability and validity of data and ethical consideration.

Questionnaires focus groups and pre-test and post-test were used as research instruments to gather data. The researcher also put into consideration the ethical considerations where privacy and confidentiality were clearly communicated to the participants. No real names were used, instead the researcher used codes of letters. Under the data collection procedures, the researcher visited the selected schools and sought permission from the school's administrators as well as teachers. Thereafter the researcher administered questionnaires to mathematics teachers. Pre-test and post-test were administered to thirty learners who were selected under simple random sampling. Data collected was then analysed to ascertain the accuracy and effectiveness of research instruments. Descriptive statistics, quantitative analysis, and qualitative analysis were also part of data analysis techniques used to analyse data. Next chapter will deal with data analysis, presentation and interpretation

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

The chapter is going to present and analyse researcher's quantitative findings collected using questionnaires, pre-tests, post-tests and focus groups. Tables, pictures, figures and graphs were used to present data. The statistical tables did make the researcher's data amenable for analysis and at the same time retaining original findings. The presented data was then analysed and interpreted with the aim of answering the study's research questions. The analysis and interpretation also sought to reveal any correlations between the researcher's current findings and findings of other earlier authorities. Narration of qualitative data was covered as part of the research analysis.

These are the key data analysis techniques employed in this research. It will begin by presenting the quantitative data derived from questionnaires, pre-test and post-test providing statistical insights into learner performance before and after intervention. A comprehensive summary will be outlined at the end of this chapter.

4.2 DATA PRESENTATION

4.2.1 Demographic Characteristics of Teacher Respondents gathered through questionnaires

Table 4.2.1 Frequency Table Showing Ages of Teacher Respondents

Age (Years)	Frequency	Percentage
Between 30 and 40 years	2	40%
Between 40 and 50 years	3	60%
Total	10	100%

Table 4.2.1 presents the demographic characteristics of the teacher respondents, specifically their age distribution. The data shows that there were only 5 teacher respondents who participated in the study in between 30-50 years range. The age range of 30-40years contributed to 40% and 40-50years contributed to 60%. The age distribution of the teacher respondents suggests that they are experienced educators, which may influence their perspectives and practices hence the researcher assumed that he gathered reliable and valid data from the sampled teacher respondents.

4.2.2 SEXES FOR TEACHERS

Figure 4.2.1 Pie Chart Showing Sexes of Teachers

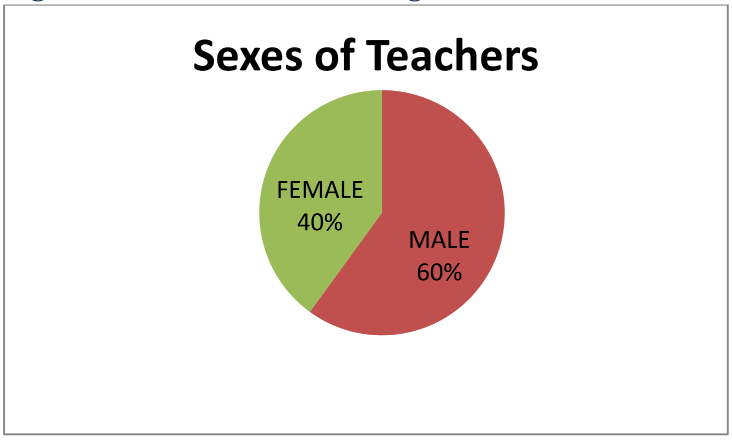

Figure 4.2.2 presents a pie chart showing the sex of the teacher respondents. The data reveals that 60% of the teacher respondents are males and 40% of the teacher respondents are females. These results suggest that the teacher respondents are skewed in distribution in terms of sex. This is consistent with the findings of other studies, which have shown that the teaching profession is generally skewed in distribution in terms of sex (OECD, 2019). The inclusion of both sex groups in the study indicates that the researcher obtained authentic data from both male and female respondents. This ensured credibility to the information gathered and the researcher was assured that his findings were generalizable.

4.2.3 TEACHER QUALIFICATIONS

Figure 4.2.3 Illustrates qualifications of the teachers

Qualification	**Number**
Diploma in education	5
Degree in education	0
TOTAL	5

The data presented on figure 4.2.3 shows that all teacher respondents (100%) are professionals with Diploma as their highest educational qualification. This suggests that the teacher respondents have a relatively high level of educational qualification. Research has shown that teachers with higher levels of educational qualification tend to be more effective in the classroom (Hanushek & Woessmann, 2015). The qualifications of the teacher respondents may also reflect the overall quality of the teaching workforce. As noted by Darling-Hammond (2010), "teacher quality is the most important factor in determining student achievement. This was also a factor to consider since there was no degree holder at the station.

4.2.4 TEACHING EXPERIENCE FOR THE TEACHERS

Table 4.2.2 Frequency Column Table Showing Years of Teaching Experience

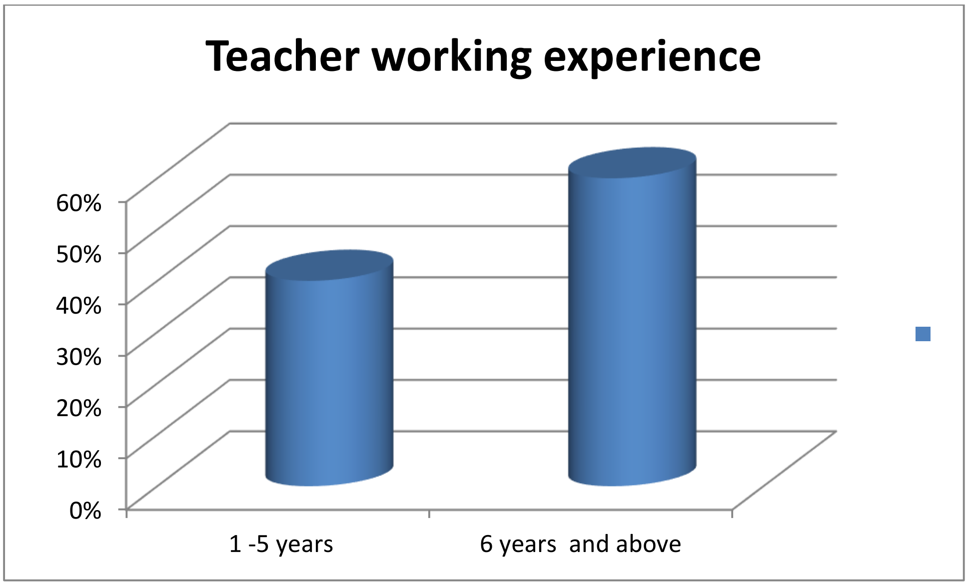

Table 4.2.2 presents a column table showing the years of teaching experience of the teacher respondents. The data reveals that 40% of the teacher respondents have between 1-5 years of teaching experience and the other 60% of the teacher respondents have more of teaching experience of above five years. None of the teacher respondents have less than or equal to 5 years of teaching experience. The results presented suggest that the teacher respondents have a significant amount of teaching experience, with 100% of respondents having 10 years or more of teaching experience. This is consistent with the findings of other studies, which have shown that experienced teachers tend to be more effective in the classroom (Hanushek & Woessmann, 2015). The use of a frequency table provides a clear and concise visual representation of the data.

4.2.5 Demographic Characteristics of Learner Respondents

Table 4.2.3 Frequency Table Showing Ages of Learner Respondents

Age (Years)	Frequency	Percentage
15 years	3	10%
16 years	12	40%
17 years	15	50%
Total	**30**	**100%**

Table 4.2.3 presents the demographic characteristics of learner respondents, specifically their ages. The frequency table shows that 10% of the learner respondents are 15years old, 40% of the learner respondents are 16 years old and 50% of the learner respondents are 17 years old. The results presented suggest that the majority of learner respondents (50%) are 17 years old. Ultimately, this is a predominant age group. According to Creswell (2014), "frequency tables are useful for displaying the distribution of a single variable, such as age". The frequency table will provide a clear and concise visual representation of the data, allowing readers to easily compare the proportions of learner respondents in each age category.

4.2.6 DEMOGRAPHIC CHARACHERISTIC OF LEARNER SEXES

Figure 4.2.4 Pie Chart Showing Sexes of Learners

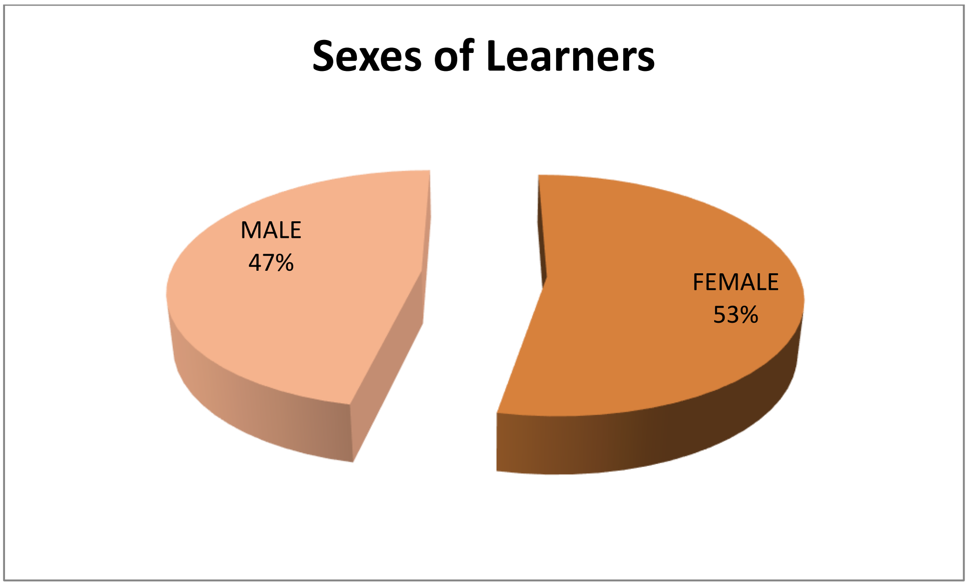

Figure 4.2. 6 presents a pie chart showing the sexes of learners. The pie chart reveals that 53% of the learners are females and 47% of the learners are males. The results presented suggest that the majority of learners (53%) are females. This suggests that the sample is predominantly composed of female learners. According to Tufte (2001), "pie charts are useful for displaying proportional data, such as the sexes of learners". Pie charts provide a clear and concise visual representation of the data, allowing readers to easily compare the proportions of males and females.

4.2.7 RESULTS OF ERRORS OBTAINED THROUGH PRE-TEST AND POST -TEST

Figure 4.2.5

	Error Type	**PRE-TEST Frequency**	**POST-TEST Frequency**
PROCEDURAL ERRORS	reversing the inequality sign when multiplying or dividing by negative numbers	14	2
	failing to consider the endpoint (failure Check to the solution)	10	3
	Using incorrect notation when solving linear inequalities	8	2
CONCEPTUAL ERRORS	Making calculation errors when solving linear inequalities	5	2
	Failing to consider the context of the problem when solving linear inequalities	14	3
	Failing to simplify solutions when solving linear inequalities	5	1
LINGUISTIC ERRORS	Making errors when solving linear inequalities with variables on both sides	20	4

4.2.9 ERRORS DONE BY LEARNERS WHEN SOLVING LINEAR INEQUALITIES

4.2.9.1 Interview and questionnaire responses from learners

Learners were asked to share their experiences and challenges when solving linear inequalities. Their responses revealed a range of common errors and misconceptions. Below are some quotes from the learners:

Learner 1 mentioned, *" Eishy !!!!!! Sometimes I forget to reverse the inequality sign when multiplying or dividing both sides by a negative number."*

Imposed with the question how best can this error be corrected:

He quickly pointed ummmmhh for the mean time learners practise keep practising on daily basis.

Learner 2 stated, "*I get confused between the greater than and less than symbols. Today seems I now know the signs, come tomorrow I can't even recall them , I don't know may be its too much content teachers give us."*

Too much content , what do you mean , are you saying teachers give you more maths work

" *aiwa, no I mean the subjects we do at secondary school are too many, how can I balance myself now, I don't even know that we are doing which subject if am not told.*

Learner 3 said, "*I often struggle with solving linear inequalities that have variables on both sides. I get confused about how to isolate the variable."*

Learner 4 mentioned, "*I sometimes forget to check my solutions to make sure they are valid. I need to remember to plug my solutions back into the original inequality."*

Learner 5 stated, "*I get confused between linear inequalities and linear equations. I have to remind myself that inequalities have a range of solutions, while equations have only one solution."*

Learner 6 said, "*I sometimes struggle with solving linear inequalities that have fractions or decimals. I need to practice working with these types of numbers."*

Learner 7 mentioned, "*I often make careless mistakes when solving linear inequalities, such as forgetting to distribute a negative sign or forgetting to simplify my answer."*

Learner 8 stated, "*I often get confused about how to graph linear inequalities on a number line. I need to practice graphing different types of inequalities."*

Learner 9 said, "*I sometimes struggle with solving linear inequalities that have multiple variables. I need to practice working with systems of inequalities."*

Learner 10 Asked of the areas he finds difficult : *he pointed out aaahhhhhh it would be very very difficult to follow the type of the problems.*

Teacher: how long do you need to fully grasp the concept taught?

Learner 11 She: *one week ... is enough*

Teacher: are sure

She: *yes ..very*

Learner 12 said, "*I get confused about how to solve linear inequalities that have absolute value expressions. I need to review the rules for working with absolute value expressions."*

Learner 13 *ummmmhh I need help on extra time , coz the teacher is very fast.*

1. **Learner 14** *I don't know much but if given the time to practice, I can do better. I mostly forget to change to the + sign when dividing by negative*.

Teacher: is it that you always change to the + sign when dividing by negative.

ummmhhhhh yes….Sir.

Learner 15 *I can plot the graph, but I mostly confuse the nature of my signs. Asked of any inequality question in end of year examination.*

Learner 16 Kubo: *he could not even write any example of an inequality. He pointed that he last did the concept in Form one level.*

nodded his head in disapproving.

Learner 17 *we started to learn inequality in form 2, but from there I did not practise . So I don't now even know if a question is an inequality, if given one real life problem.*

Learner 18 *I always make silly mistakes, like incorrect adding or subtracting*

Learner 19 *ummmmh,, this is difficult for me. Working with negative numbers is a non-starter, Sir.*

Learner 20 *last did inequality in form 2, I last practised the topic long back. But I remember the questions coming in an examination*

Learner 21 *gave an example of inequality sign, as 10>35*

Imposed with the question: Are you sure about your answer? Take a look again.

Mouth apart: aaaahh Sir, it's the opposite.

Learner 22 *inequality with index form is difficulty to work with.*

Can you give me an example of such inequality?

$3x^2-4x+45=0$

Learner 23 *I last practised this term. But I need more practise on graphs.*

Learner 24 *when diving with negative sign, the sign must change. Learners must do maths with negative signs.*

Learner 25 *our teacher did not cover us to graphs. We haven't done So many of them*

Learner 26 *I need more time, even extra lessons for me to master this animal. Shading unwanted region is a challenge to me.*

Learner 27 *all along I thought equations are inequality only till I got the answer wrong last term in an examination. I was demotivated.*

Learner 28 *I always get one mark on all inequality questions that demand 2marks.*

Learner *29 2>4, can you give me one more example, uuuuummhh I can't because I did not do that. Most of the time I will be at home helping elders to do some work.*

Imposed with a question: how do you want to learn so that you can internalise the topic clearly: *I need someone to teach me for an hour rigorously!!!*

Learner 30

he could write an example of an inequality so well, when asked of shading the unwanted region of the inequality. She said that she can but had forgotten. She also pointed out that there were inequality questions in the examination.

4.3 DATA ANALYSIS

4.3.1 Mathematical errors and misconceptions exhibited by Learners when solving Linear Inequalities

4.3.1.1 Using incorrect notation when solving linear inequalities

This error was noted from participants and from given tests. Kilpatrick, Swafford, & Findell (2001) "Students may use incorrect notation, such as using a greater than symbol instead of a less than symbol, when solving linear inequalities. This error can be attributed to a lack of understanding of the underlying algebraic concepts." National Council of Teachers of Mathematics (2014:128) "Students may struggle with notation, such as using the wrong symbol or notation for the inequality. Teachers should provide opportunities for students to practice using correct notation and emphasize the importance of accurate notation." Carpenter, Franke, & Levi (2003) have this to say, students errors in solving linear inequalities are often related to their understanding of the underlying algebraic concepts. Incorrect notation is one common error which involves using the wrong symbol or notation for the inequality.

4.3.1.2 Failing to simplify solutions when solving linear inequalities

This error was noted from participants and from given tests. Kilpatrick, Swafford, & Findell (2001) students may fail to simplify their solutions, Johnson (2017:442) "Failing to simplify solutions is a common error that students make when solving linear inequalities. Teachers can help students avoid this error by providing opportunities for students to practice simplifying solutions and emphasizing the importance of simplicity.

4.3.1.3 Failing to consider the context of the problem when solving linear inequalities

This error was noted from participants and from given tests. Kilpatrick, Swafford, & Findell (2001: 240) "Students may fail to consider the context of the problem, which can lead to incorrect or irrelevant solutions... This error can be attributed to a lack of understanding of the underlying algebraic concepts and their application to real-world problems." Teachers should provide opportunities for students to practice solving linear inequalities in context and emphasize the importance of considering the context of the problem. One common error is to fail to consider the context of the problem, which can lead to incorrect or irrelevant solutions.

4.3.1.4 Error of using incorrect methods for solving linear inequalities

This error was noted from participants and from given tests. Carpenter, Franke, & Levi (2003:240) "Students' errors in solving linear inequalities are often related to their lack of understanding of the underlying algebraic concepts... One common error is to use incorrect methods, such as using methods for solving linear equations instead of inequalities."

Siegler & Lortie-Forgues (2015:240) "Students' errors in solving linear inequalities are often related to their lack of understanding of the underlying algebraic concepts. One common error is to use incorrect methods, such as using methods for solving linear equations instead of inequalities."

4.3.1.5 Making errors when solving linear inequalities with variables on both sides

This error was noted from participants and from given tests. Lester (2007:151) "Making errors when solving linear inequalities with variables on both sides is a common mistake that students make. One common error is to make mistakes when solving linear inequalities with variables on both sides."

4.3.1.6 Error of reversing the direction of the inequality sign

This error was noted from participants and from given tests. These scholars support the idea that reversing the direction of the inequality sign as a common error that students make when solving linear inequalities. Carpenter, Franke, & Levi (2003:234) "Students' errors in solving linear inequalities are often related to their lack of understanding of the underlying algebraic concepts... One common error is to reverse the direction of the inequality sign incorrectly when multiplying or dividing both sides by a negative number." Usiskin (1988:145) "One of the most common errors in solving linear inequalities is to forget to reverse the direction of the inequality sign when multiplying or dividing both sides by a negative number. Eemphasizing the importance of checking solutions."

4.3.1.7 Forgetting to consider the endpoint when solving linear inequalities

This error was noted from participants and from given tests. These scholars support the idea that forgetting to consider the endpoint as a common error that students make when solving linear inequalities. Kilpatrick, Swafford, & Findell (2001:235) "Students often forget to consider the endpoint of the inequality, which can lead to incorrect solutions. This error can be attributed to a lack of understanding of the underlying algebraic concepts." .National Council of Teachers of Mathematics (2014:124) "Students may forget to consider the endpoint of the inequality, which can result in an incomplete or incorrect solution. Teachers should emphasize the importance of considering the endpoint when solving linear inequalities." Johnson (2017:134) "Forgetting to consider the endpoint of the inequality is a common error that students make when solving linear inequalities... This error can be addressed by providing students with opportunities to practice solving linear inequalities and by emphasizing the importance of checking solutions." One common error is to forget to consider the endpoint of the inequality, which can lead to incorrect solutions."

4.3.1.7 Confuse the concept of equality and inequality

This error was noted from participants and from given tests. These scholars support the idea that learners often confuse the concept of equality and inequality, which can lead to errors in solving linear inequalities. Tirosh & Graeber (1990) "Students' difficulties with linear inequalities are often related to their lack of understanding of the concept of inequality. One common error is to treat inequalities as if they were equations, which can lead to incorrect solutions." (p. 124).Lamon (2005) "Students may have difficulty distinguishing between equations and inequalities, which can lead to errors in solving linear inequalities, Siegler & Jenkins (1989:234) say that "Students' understanding of linear inequalities is often limited by their lack of understanding of the concept of Inequality One common error is to confuse the concepts of equality and inequality, which can lead to incorrect solutions." Rain coat

4.3.1.8 Making calculation errors when solving linear inequalities

This error was noted from participants and from given tests. These scholars support the idea that making calculation errors is a common mistake that students make when solving linear inequalities. Kilpatrick, Swafford, & Findell (2001:237)"Students may make calculation errors, such as adding or subtracting incorrectly, when solving linear inequalities... These errors can be attributed to a lack of fluency with basic arithmetic operations. National Council of Teachers of Mathematics (2014:126) has this view "Students may struggle with calculations, such as multiplying or dividing both sides of an inequality by a negative number... Teachers should provide opportunities for students to practice calculations and check their solutions.

4.3.1.9 Failing to consider the direction of the inequality when solving linear inequalities

This error was noted from participants and from given tests. These scholars support the idea that failing to consider the direction of the inequality is a common error that students make when solving linear inequalities. Tirosh & Graeber (1990) outlined that "Students' difficulties with linear inequalities are often related to their lack of understanding of the concept of inequality. One common error is to fail to consider the direction of the inequality, which can lead to incorrect solutions." Carpenter, Franke, & Levi (2003) said that "Students' errors in solving linear inequalities are often related to their lack of understanding of the underlying algebraic concepts. One common error is to fail to consider the direction of the inequality, which can lead to incorrect solutions." .Lester (2007) outlined that "Failing to consider the direction of the inequality is a common error that students make when solving linear inequalities... Teachers should provide opportunities for students to practice solving linear inequalities and emphasize the importance of considering the direction of the inequality."

4.3.2 Causes of errors and misconception in solving linear inequalities.

One of the primary causes of errors and misconceptions in solving linear inequalities is a lack of understanding of the underlying algebraic concepts. According to Kilpatrick, Swafford, and Findell (2014), "students' difficulties with linear inequalities are often related to their lack of understanding of the underlying algebraic concepts" This lack of understanding can lead to errors in solving linear inequalities, as learners may struggle to apply mathematical concepts to solve problems.

Another cause of errors and misconceptions is the failure to consider the context of the problem. As noted by Lester (2017), "students may struggle to connect the mathematical concepts to the context of the problem". This can lead to learners solving linear inequalities in a mechanical manner, without considering the underlying mathematical concepts. By failing to consider the context of the problem, learners may also struggle to interpret the results of their calculations.

Notation and symbolism confusion is another common cause of errors and misconceptions in solving linear inequalities. According to Siegler and Lortie-Forgues (2015), "students' errors in solving linear inequalities are often related to their lack of understanding of the notation and symbolism used in these equations". This can lead to errors in solving linear inequalities, particularly when learners are required to manipulate the notation and symbolism.

Prior knowledge and experiences can also contribute to errors and misconceptions in solving linear inequalities. As noted by Ramirez and Soto (2020), "learners' prior knowledge and experiences can influence their understanding of linear inequalities and lead to errors and misconceptions". Learners' prior knowledge and experiences can shape their understanding of mathematical concepts and influence their ability to apply these concepts to solve problems.

The teaching methods and materials used in the classroom can also contribute to errors and misconceptions in solving linear inequalities. According to Hernández and González (2022), "the teaching methods and materials used in the classroom can influence learners' understanding of linear inequalities and lead to errors and misconceptions". Effective teaching methods and materials can help learners develop a deep understanding of mathematical concepts, while ineffective methods and materials can contribute to errors and misconceptions.

A lack of practice and feedback is another common cause of errors and misconceptions in solving linear inequalities. As noted by Wiggins and McTighe (2014), "learners need opportunities to practice and receive feedback on their understanding of mathematical concepts”. Without adequate practice and feedback, learners may struggle to develop a deep understanding of linear inequalities, leading to errors and misconceptions.

Mathematical anxiety and fear can also contribute to errors and misconceptions in solving linear inequalities. According to Ashcraft (2018), "mathematical anxiety and fear can impede learners' ability to understand and apply mathematical concepts". Mathematical anxiety and fear can lead to learners avoiding mathematical tasks or struggling to focus on mathematical concepts, ultimately contributing to errors and misconceptions.

Cognitive load and working memory can also contribute to errors and misconceptions in solving linear inequalities. According to Sweller (2018), “learners' working memory and cognitive load can influence their ability to process and understand mathematical information". When learners' working memory and cognitive load are overwhelmed, they may struggle to process and understand mathematical information, leading to errors and misconceptions.

Finally, inadequate assessment and evaluation methods can also contribute to errors and misconceptions in solving linear inequalities. According to Black and Wiliam (2017), “inadequate assessment and evaluation methods can lead to learners developing misconceptions and errors in mathematical concepts". Effective assessment and evaluation methods can help identify learners' misconceptions and errors, allowing educators to provide targeted support and feedback.

4.3.3 Teaching strategies or methods that are most effective in helping secondary school learners understand linear inequalities.

One of the most effective teaching strategies for helping secondary school learners understand linear inequalities is the use of real-world examples. According to Kilpatrick, Swafford and Findell (2014), "using real-world examples can help learners see the relevance and importance of linear inequalities". By using real-world examples, educators can help learners develop a deeper understanding of linear inequalities and how they are used in everyday life.

Another effective teaching strategy is the use of visual aids, such as graphs and charts. According to Siegler and Lortie-Forgues (2015), "visual aids can help learners understand the relationships between variables and the behaviour of linear inequalities". By using visual aids, educators can help learners develop a deeper understanding of linear inequalities and how they are represented graphically.

The use of technology, such as computer software and online tools, is also an effective teaching strategy for helping secondary school learners understand linear inequalities. According to Hernández and González (2022), "technology can provide learners with interactive and engaging ways to explore linear inequalities". By using technology, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

Collaborative learning is another effective teaching strategy for helping secondary school learners to understand linear inequalities. According to Johnson and Johnson (2017), "collaborative learning can help learners develop a deeper understanding of linear inequalities by working together to solve problems". By using collaborative learning, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

The use of formative assessments is also an effective teaching strategy for helping secondary school learners understand linear inequalities. According to Black and Wiliam (2017), "formative assessments can help educators identify learners' misconceptions and errors and provide targeted support and feedback". By using formative assessments, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

Differentiated instruction is another effective teaching strategy for helping secondary school learners understand linear inequalities. According to Tomlinson (2014), "differentiated instruction can help educators tailor their teaching to meet the diverse needs of their learners". By using differentiated instruction, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

The use of games and simulations is also an effective teaching strategy for helping secondary school learners understand linear inequalities. According to Shute (2018), "games and simulations can provide learners with interactive and engaging ways to explore linear inequalities". By using games and simulations, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

Another effective teaching strategy is the use of problem-solving approaches. According to Schoenfeld (2019), "problem-solving approaches can help learners develop a deeper understanding of linear inequalities by encouraging them to think critically and solve problems". By using problem-solving approaches, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

Finally, the use of feedback and self-assessment is also an effective teaching strategy for helping secondary school learners understand linear inequalities. According to Hattie and Timperley (2020), "feedback and self-assessment can help learners identify their strengths and weaknesses, and develop a deeper understanding of linear inequalities". By using feedback and self-assessment, educators can help learners develop a deeper understanding of linear inequalities and how they are used in real-world applications.

4.4 DISCUSSIONS OF FINDINGS

The research findings indicate that learners encounter a range of errors and misconceptions when solving linear inequalities. These findings are consistent with those reported by other researchers. For instance, Kulm (2014) noted that "learners often struggle with linear inequalities due to a lack of understanding of the underlying algebraic concepts". Similarly, Knuth (2017) found that "learners' difficulties with linear inequalities are often related to their lack of understanding of the notation and symbolism used in these equations".

The findings also indicate that learners often make careless mistakes when solving linear inequalities, such as forgetting to distribute a negative sign or forgetting to simplify their answer. This is consistent with the findings of Drijvers (2018), who noted that "learners' errors in solving linear inequalities are often related to their lack of attention to detail and their failure to check their work". These careless mistakes can be addressed through targeted feedback and support, as noted by Hativa (2020), who suggested that "educators can help learners develop a deeper understanding of linear inequalities by providing feedback that focuses on the process of solving, rather than just the answer".

Furthermore, the findings suggest that learners often struggle with solving linear inequalities that have variables on both sides. This is consistent with the findings of Kilpatrick, Swafford, and Findell (2014), who noted that "learners often find it challenging to isolate the variable when solving linear inequalities". To address this challenge, educators can provide learners with additional practice and support, as noted by Siegler and Lortie-Forgues (2015), who suggested that "learners need opportunities to practice solving linear inequalities in a variety of contexts".

The findings also indicate that learners often get confused between linear inequalities and linear equations. This is consistent with the findings of Knuth (2017:156).), who noted that "learners often struggle to distinguish between linear inequalities and linear equations". To address this confusion, educators can provide learners with explicit instruction and feedback, as noted by Drijvers (2018), who suggested that "educators can help learners develop a deeper understanding of linear inequalities by providing explicit instruction and feedback on the differences between linear inequalities and linear equations".

In addition, the findings suggest that learners often make mistakes when solving linear inequalities because they don't read the problem carefully. This is consistent with the findings of Hativa (2020), who noted that "learners' errors in solving linear inequalities are often related to their failure to read the problem carefully and understand the context". To address this issue, educators can encourage learners to read problems carefully and ask questions to clarify their understanding, as noted by Kilpatrick, Swafford, and Findell (2014), who suggested that educators can help learners develop a deeper understanding of linear inequalities by encouraging them to ask questions and seek clarification when they are unsure.

Finally, the findings indicate that learners often get confused about how to solve linear inequalities that have absolute value expressions. This is consistent with the findings of Siegler and Lortie-Forgues (2015), who noted that "learners often struggle to understand the rules for working with absolute value expressions in linear inequalities". To address this challenge, educators can provide learners with additional practice and support, as noted by Drijvers

(2018:145), who suggested that "learners need opportunities to practice solving linear inequalities with absolute value expressions in a variety of contexts".

4.5 CHAPTER SUMMARY

This chapter presents a comprehensive analysis of the data collected through questionnaires, oral interviews, pre-tests, and post-tests. The researcher employed statistical graphs, including frequency distribution tables, bar graphs, and pie charts, to succinctly display the findings. These visual aids facilitated the compacting of data, rendering it more suitable for in-depth analysis.

The researcher provided a meticulous explanation of the displayed data, followed by a thorough analysis and interpretation of the findings in relation to the research questions. This involved examining the correlations between the researcher's data and existing literature cited in the literature review. By doing so, the researcher aimed to identify patterns, trends, and relationships that could inform the research questions and contribute to the existing body of knowledge.

Through this rigorous analysis and interpretation process, the researcher was able to uncover meaningful insights and draw conclusions that address the research questions. The findings of this study provide a valuable contribution to the existing literature on the topic, offering implications for future research and practice.

CHAPTER 5

5.1 Summary, Discussions, Recommendations and Conclusion

In this chapter, the researcher presents a blueprint overview of the research conducted on mitigating the misconceptions and errors learners experience when solving linear inequalities at a rural secondary school at Ordinary level. The summary of findings from this investigation will go a long way in improving the way teachers teach mathematics, and curriculum planners handle mathematics.

In chapter one, the researcher outlined the research Problem and its setting. Unsatisfactory performance at Ordinary Level and reports from parents prompted this research. There are two research questions on this research to address the topic given following the research objectives. This study is significant as it provides insights to teachers, parents and curriculum planners on effectiveness of conceptual teaching approach not only in solving inequalities but teaching of maths. Quantitative data was collected through questionnaires, interview guides and tests and Pre-tests and post-tests scores were collected for analysis and discussion. Qualitative data was collected from the interview guide and questionnaires.

The researcher will also provide recommendations for educators and future researchers, suggesting strategies to enhance teaching practices and further areas of study that could build upon the research findings.

Finally, this chapter will include a list of references cited throughout the research, along with appendices that contain supplementary materials, such as the instruments used and additional data analyses. This structured approach aims to ensure that the insights gained from this research are both actionable and informative for stakeholders in mathematics education.

Also, the research aligns with the social constructivism theory which emphasizes collaborative learning, active participation and the construction of knowledge through interactions with others. In problem-centred learning, students work together, share ideas and build their understanding collectively, reinforcing the principle of social constructivism.

The two main research questions were covered which are:

1. What mathematical errors and misconceptions are made by Ordinary Level Learners in solving Linear Inequalities?

2. What possible strategies can be employed to minimize mathematical errors and misconceptions made by Ordinary Level Learners in solving Linear Inequalities?

In Chapter 2 the research covered literature review on the errors and misconceptions done by Ordinary Level Learners in solving linear inequalities. Objectives were followed to give an insight to the study. A discussion on the teaching and learning of Mathematics in tandem with the research topic was critically done.

The research followed Ashcraft (2002), who categorizes misconceptions and errors into three main groups namely conceptual errors, procedural errors, and linguistic errors.

In chapter 3 the research covered the research design, methodology, population and sampling, data collection instruments and data analysis. The researcher obtained informed consent from the participants and followed ethical considerations in carrying the research.

In Chapter 5, the quantitative findings, presentation and analysis of data in forms of tables, pie chart, pictures and graphs was done. The statistical tables did make the researcher's data amenable for analysis.

The research findings indicate that learners encounter a range of errors and misconceptions when solving linear inequalities. Teaching strategies or methods that are most effective in helping secondary school learners understand linear inequalities were unpacked during the research. Focus group and constructivism proved to be the best approach as a mitigation strategy.

5.2 DISCUSSION

In this chapter 5, the researcher is presenting a discussion of results according to the research questions as follows.

Research question 1.

What mathematical errors and misconceptions are made by Ordinary Level Learners in solving Linear Inequalities?

The research found out that the main errors and conceptions in solving the inequalities made by Ordinary level learners was: reversing the inequality sign when multiplying or dividing by negative numbers.

46 % of the learners had a challenge on reversing the inequality sign when dealing with inequality.

33% failing to consider the endpoint whereas those who failed to check their solution covered .

27% Using incorrect notation when solving linear inequalities. 16.6%Making calculation errors when solving linear inequalities. 46%Failing to consider the context of the problem when solving linear inequalities

1% Failing to simplify solutions when solving linear inequalities

16 % Making errors when solving linear inequalities with variables on both sides

These errors and misconceptions were consistent with the findings of previous studies (Kilpatrick, Swafford, & Findell, 2014; Lester, 2017; Siegler & Lortie-Forgues, 2015).

The study also found that learners' prior knowledge and experiences played a significant role in shaping their understanding of linear inequalities. Learners who had a strong foundation in algebraic concepts had little or no challenges in solving linear equations. The findings of this study have implications for teaching and learning linear inequalities.

In conclusion, this study highlights the importance of understanding the errors and misconceptions that learners exhibit when solving linear inequalities. By identifying the causes of these errors and misconceptions, educators can provide targeted support and feedback to help learners overcome these challenges and develop a deeper understanding of linear inequalities.

2. What possible strategies can be employed to minimize mathematical errors and misconceptions made by Ordinary Level Learners in solving Linear Inequalities?

From the the teachers indicated that group work, lecture method, dramatization and gaming can be very effective . The contextual approach and Group focus that was employed to teach the learners had an impact on their performance and grasping of the concepts. Visual media, such as graphs and numberline. It was observed that learners

The research findings from research question 2 above, after considering insights from interviews and questionnaires in conceptual teaching strategies yielded a deeper understanding in learners about the concept of inequality and its algebraic properties. Thus there was a remarkable conceptual understanding, 70% of the learners. Learners also demonstrated improved accuracy in solving linear inequalities demonstrated by their participation and few errors made on given exercises after lessons. Moreso, fewer endpoint errors were noted. :

Students were more accurate in determining whether endpoints were included or excluded from the solution set. Although everyone had a question or two missed from the exercise. Noone got 100%. Just 30% of the students made fewer sign errors when multiplying or dividing both sides of an inequality by a negative number.

Outcome Aspects that were observed from learners also include, improved self efficacy and motivation in solving Linear Inequalities.

The data collected during the study indicated that students demonstrated a marked increase in their understanding and application of linear equations after engaging in targeted instructional strategies. The pre-test results highlighted prevalent misconceptions and errors, which were effectively addressed through the implementation of learner-centered methodologies. The post-test results showed that students not only retained the information better but also applied it more accurately in problem-solving scenarios

5.3 CONCLUSION

In conclusion, the mitigation of errors and misconceptions in solving linear inequalities is crucial for students to grasp this fundamental concept in mathematics. By acknowledging the common pitfalls, such as neglecting to flip the inequality sign when multiplying or dividing by a negative number, and proactively addressing them through targeted instruction and practice, educators can empower students to overcome these obstacles.

Moreover, by fostering a growth mindset and encouraging students to view mistakes as opportunities for growth and learning, we can help build their confidence and resilience in tackling complex mathematical problems.

As we have seen, even the slightest mistake in solving linear inequalities can lead to significant consequences. Therefore, it is imperative that we adopt a proactive approach to identifying and mitigating errors. By doing so, we not only improve our mathematical proficiency but also cultivate a culture of attention to detail and critical thinking.

5.4 RECOMMENDATIONS

Based on the outcomes of this research, the researcher can make the following recommendations:

5.4.1 Adoption of conceptual teaching techniques

Educators should implement conceptual teaching strategies, such as understanding the concept of inequality and collaborative problem-solving to enhance students' understanding of linear inequalities. These methods encourage active participation and facilitate deeper conceptual graspe across all learning areas.

5.4.2 Utilize Technology and Interactive Tools

Since this research was carried out in rural areas where technological tools for supporting learning are scarce resources, the researcher therefore recommends employment of educational technologies and interactive resources that allow students to visualize and manipulate inequalities.

5.5 SUGGESTIONS FOR FURTHER STUDIES

When solving linear inequalities, it's essential to mitigate misconceptions and errors to ensure accurate solutions. One key recommendation is to carefully handle the direction of the inequality sign when multiplying or dividing by a negative number, as this can reverse the inequality. Additionally, students should be cautious when dealing with compound inequalities, ensuring that they consider both endpoints and the direction of the inequality. It's also crucial to check solutions by plugging them back into the original inequality to verify validity. Furthermore, visual aids like number lines can help students better understand the relationships between the inequality, the solution set, and the direction of the inequality sign. By being mindful of these potential pitfalls and taking steps to address them, students can develop a stronger grasp of linear inequalities and improve their problem-solving skills. Subsequently, the researcher recommends further studies on mitigation of the misconceptions and errors in solving Linear Inequalities at Ordinary Level in the same district so as to have conclusive and broad data..

5.6 CONCLUSIONS

When solving linear inequalities, it's essential to mitigate misconceptions and errors to ensure accurate solutions. One key recommendation is to carefully handle the direction of the inequality sign when multiplying or dividing by a negative number, as this can reverse the inequality. Additionally, students should be cautious when dealing with compound inequalities, ensuring that they consider both endpoints and the direction of the inequality. It's also crucial to check solutions by plugging them back into the original inequality to verify validity. Furthermore, visual aids like number lines can help students better understand the relationships between the inequality, the solution set, and the direction of the inequality sign. By being mindful of these potential pitfalls and taking steps to address them, students can develop a stronger grasp of linear inequalities and improve their problem-solving skills.

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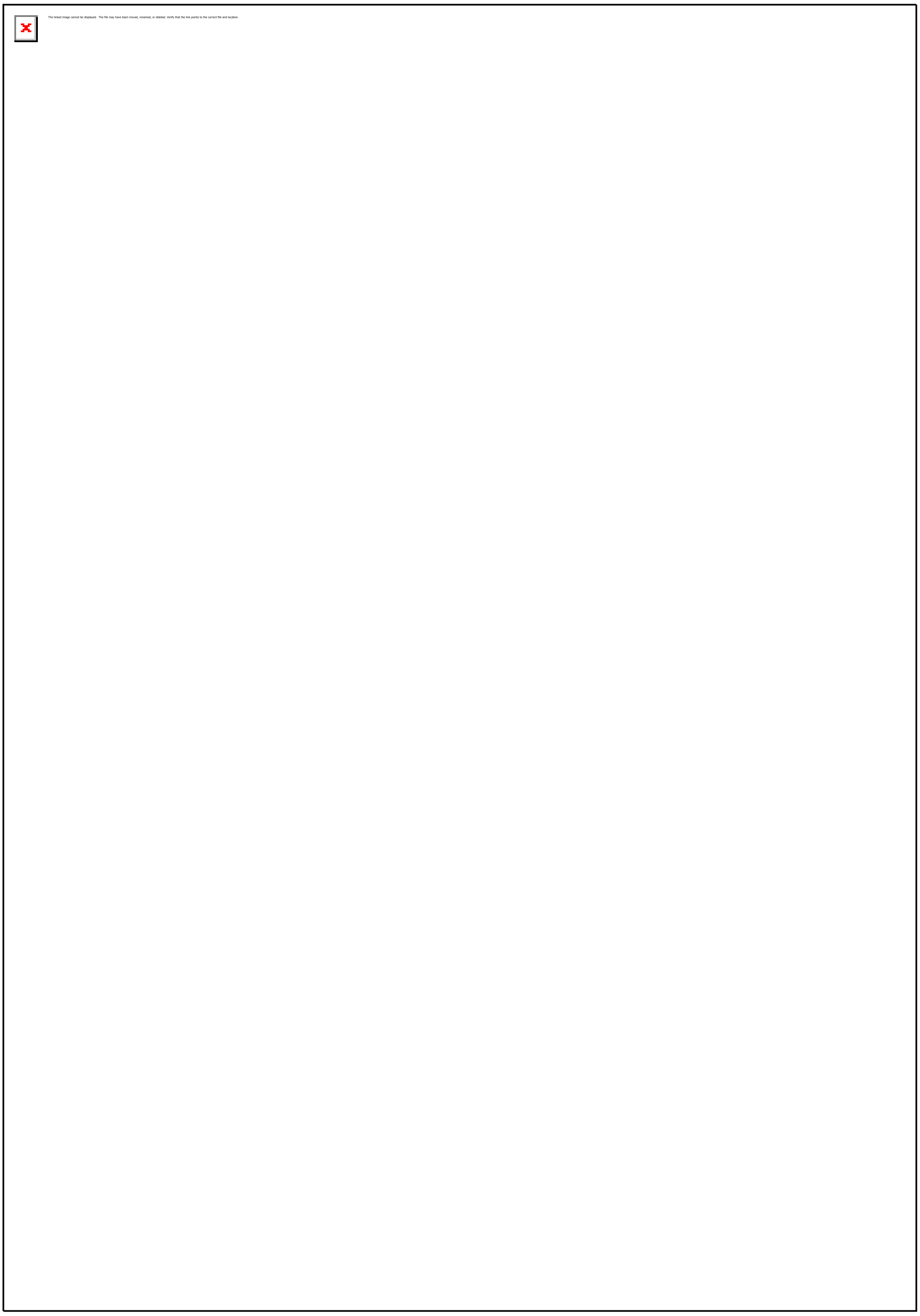
APPENDICES

A . Letters of correspondence



B. Research Instruments

TEACHER QUESTIONNAIRE

TOPIC: ERRORS AND MISCONCEPTIONS IN SOLVING LINEAR INEQUALITIES.

SECTION 1: DEMOGRAPHICS (TICK)

Gender: Male ☐ Female ☐

Age------------------Years

Teaching experience: --------------- years.

Subject taught: -------------------------------------

Grade taught: ---------------------------------------

Education level: --

SECTION 2 (TICK)

1. How often do you teach linear inequalities in your mathematic?

Daily ☐ Weekly ☐ Monthly ☐ Termly ☐

2. What common errors learners make when solving linear inequalities?

a) Reversing the inequality sign ☐

b) Misunderstanding the direction of the inequality ☐

c) Failing to consider the endpoint ☐

Other (please specify) ---

----

3) How often do you encounter these errors in your teaching?

a) Rarely ☐ b) occasionally ☐ c) almost alway☐ d) not sure ☐

4) How confident are you in ability to address errors and misconceptions in solving linear inequalities?

a) Very confident ☐ b) not very confident ☐ c) not at all confident ☐

5) What strategies do you currently use to address errors and misconceptions in solving linear inequalities?

----

6) What resources or support you need to better address errors and misconceptions in solving linear inequalities?

Additional comments:

Is there anything else you would like to share about teaching linear inequalities or addressing errors and misconceptions in solving linear inequalities?-------------------------------
----

Thanks for taking the time to complete this questionnaire! Your input is valuable to us.

Questionnaire for learners

Topic: Errors and misconceptions done by learners in solving linear inequalities.

SECTION 1: DEMOGRAPHICS (TICK)

Gender: Male ☐ Female ☐

Age------------------Years

Level (FORM)…………………………

SECTION 2

1) Which of the following is a common error in solving linear inequalities? (TICK)

a) Reversing the inequality sign when multiplying or dividing by a negative number. ☐

b) Forgetting to flip the inequality sign when changing direction. ☐

2) Which of the following statements is true about solving linear inequalities? (TICK)

a) You always flip the inequality sign when dividing or multiplying by a negative number. ☐

b) You never flip the inequality sign when changing direction. ☐

3) What is the most common reason for errors in solving linear inequalities? **(Tick one).**

a) Careless mistake ☐

b) Lack of understanding of inequality properties. ☐

4) How often do you review and practice solving linear inequalities to reinforce your understanding**. (Tick one)**

Daily ☐ Weekly ☐ Monthly ☐ Rarely ☐

5) How do you think learners can do to improve their understanding and skills in solving linear inequalities?--

----

----

6) What resources or support would you need in learning linear inequalities?------------------
----

Additional information:

Do you have any suggestions for how teachers can better support learners in understanding and solving linear inequalities?---
----

Thanks for taking the time to complete this questionnaire! Your input is valuable to us.

Pre-Test (35 minutes)

Section A: Multiple Choice Questions

Answer all questions in this section.

1. Solve the inequality: $2x + 5 > 11$

A) $x > 3$ C.

B) $x < 3$

C) $x \geq 3$

D) $x \leq 3$

2. Which of the following is equivalent to $3x - 2 \leq 5$?

A) $3x \leq 7$

B) $3x \geq 7$

C) $x \leq 7/3$

D) $x \geq 7/3$

3. Solve the inequality: $x/2 - 3 < 2$

A) $x < 10$

B) $x > 10$

C) $x \leq 10$

D) $x \geq 10$

4. What is the solution to the inequality: $4x + 2 > 10$?

A) $x > 2$

B) $x < 2$

C) $x \geq 2$

D) $x \leq 2$

5. Draw a number line that represents the solution to the inequality: $y > 2x - 1$ for $x \geq 0$.

Section B: Open-Ended Questions.

Answer all questions.

1. Solve the inequality: $2x - 4 \leq 8$

2. Find the solution to the inequality: $x/3 + 2 > 5$

3. Draw a number line that represents the solution to the inequality: $x \leq 3x + 2$ for $x \geq 0$.

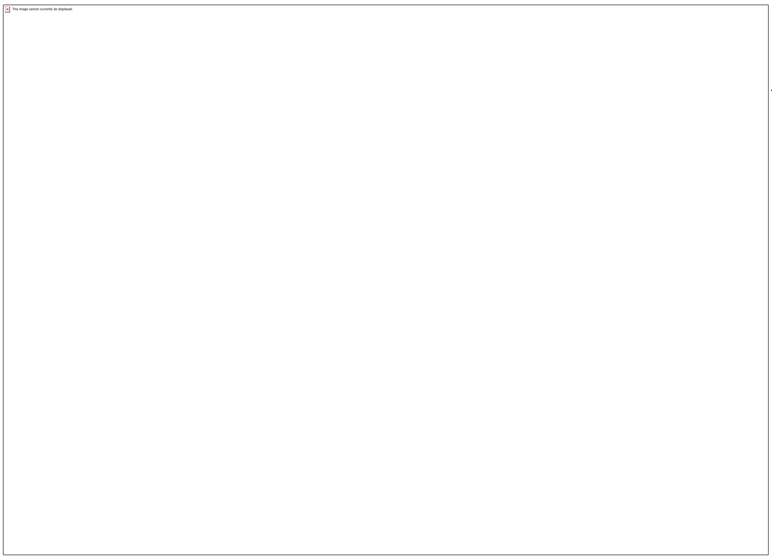
4. Solve the inequality: $5x - 3 > 2x + 1$

5. Solve

a) $4-2x \leq 8$ b) $-2x >6$

6. Tom has \$120 to spend on a new video game. The game costs x dollars and he wants to buy snacks that cost \$20. Write an inequality to represent the situation and solve for x.

7. A bakery sells a total of 250 loaves of bread per day. They sell a combination of whole wheat and white bread. If they sell at least 30 more whole wheat loaves than white bread loaves sold, write an inequality to represent the situation.



Write the three equation shown in fig 27.12 ?

Post-Test (35 minutes)

Section A: Multiple Choice Questions.

Answer all questions.

1. Solve the inequality: $3x + 2 \leq 14$

A) $x \leq 4$

B) $x \geq 4$

C) $x < 4$

D) $x > 4$

2. Which of the following is equivalent to $\frac{x}{4} - 2 > 1$?

A) $x > 12$

B) $x < 12$

C) $x \geq 12$

D) $x \leq 12$

3. Solve the inequality: $2x - 5 \geq 3$

A) $x \geq 4$

B) $x \leq 4$

C) $x > 4$

D) $x < 4$

4. What is the solution to the inequality: $\frac{x}{2} + 3 < 6$?

A) $x < 6$

B) $x > 6$

C) $x \leq 6$

D) $x \geq 6$

5. Draw a number line that represents the solution to the inequality: $y < 2x + 3$, $x \geq 0$, $x \geq 0$.

Section B: Open-Ended Questions.

Answer all questions

1. Solve the inequality: $4x - 2 \leq 10$

2. Find the solution to the inequality: $3x/2 + 1 > 4$

3. Draw a number line showing the solution to the inequality: $y \geq 2x - 3$ for $x \geq 0$.

4. Solve the inequality: $2x + 5 < 3x - 2$

5. Solve

a) $3x>27$ b) $-3x>24$

6. Proud has $80 to spend on a new calculator. The calculator costs x dollars and he wants to buy a flat file that cost $15. Write an inequality to represent the situation and solve for x.

7.

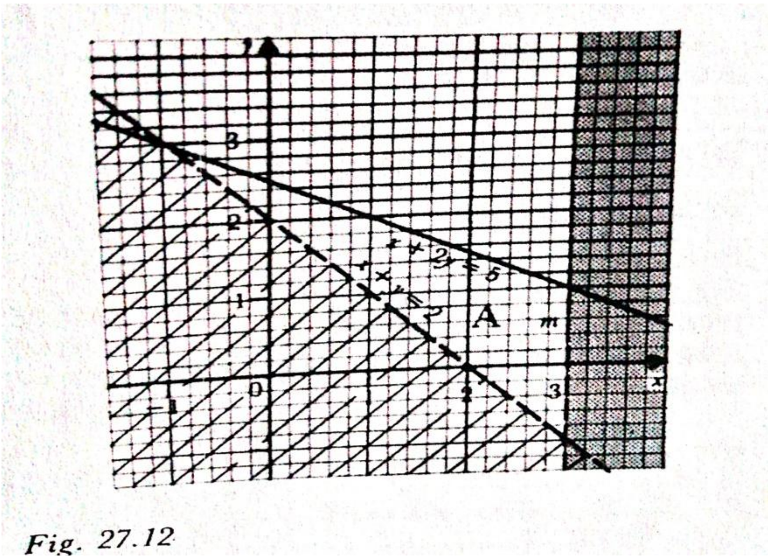
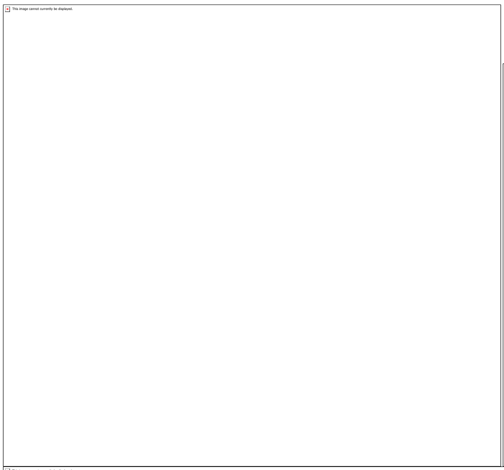
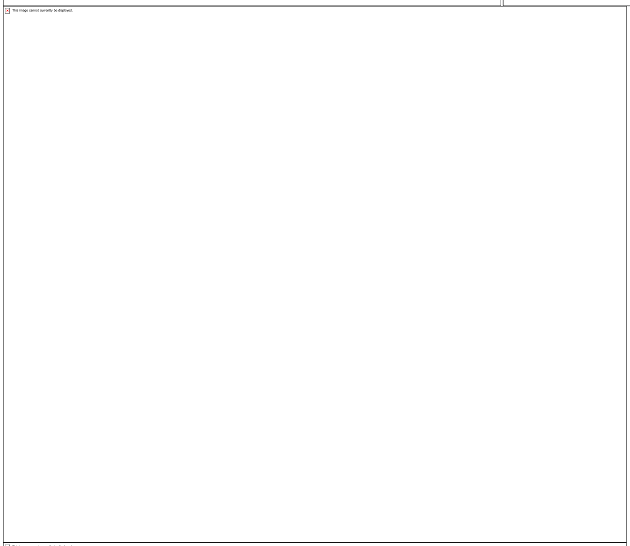


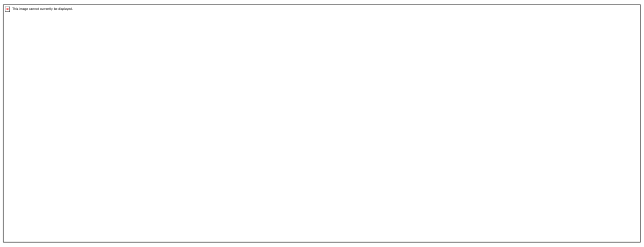
Fig. 27.12

Shade the unwanted region in this graph.

Sample of responses



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Questionnaire for learners

Topic: Errors and misconceptions done by learners in solving linear inequalities.

SECTION 1: DEMOGRAPHICS

(TICK)

Gender: Male [✓] Female [ ]

Level (FORM)..............................

1) Which of the following is a common error in solving linear inequalities? (TICK)

a) Reversing the inequality sign when multiplying or dividing by a negative number. [✓]

b) Forgetting to flip the inequality sign when changing direction. [ ]

2) Which of the following statements is true about solving linear inequalities? (TICK)

a) You always flip the inequality sign when dividing or multiplying by a negative number. [✓]

b) You never flip the inequality sign when changing direction. [ ]

3) What is the most common reason for errors in solving linear inequalities? **(Tick one).**

a) Careless mistake [ ]

b) Lack of understanding of inequality properties. [✓]

4) How often do you review and practice solving linear inequalities to reinforce your understanding. **(Tick one)**

Daily [ ] Weekly [✓] Monthly [ ] Rarely [ ]

5) How do you think learners can do to improve their understanding and skills in solving linear inequalities? The leaners should be practise at home. Leaner should be have a time table at a school. The leaners should. be practise extra lessons on holidays. Leame should be practise carefully every day night or ~~the~~ morning.

6) What resources or support would you need in learning linear inequalities?

- ~~Rutors~~ More Test book ~~should~~ would support to learning
- ~~Textbooks~~ on ~~Qu~~ linear inequalities.

Additional information:

Do you have any suggestions for how teachers can better support learners in understanding and solving linear inequalities? -

\# Ever time table their should have remidial time table.

\# Maths teacher you have come to lesson every day

\# Teacher should have a [illegible] phone to creat a group on online earners.

Thanks for taking the time to complete this questionnaire! Your input is valuable to us.