INVESTIGATING LEARNER ERRORS AND MISCONCEPTIONS IN SOLVING LINEAR INEQUALITIES AT ORDINARY LEVEL: A CASE STUDY OF SECONDARY SCHOOL IN SANYATI DISTRICT.

BY

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DEDICATION

This study is dedicated with profound affection and gratitude to my beloved wife, Machacha Brenda, whose unwavering encouragement and unrelenting support empowered me to strive for excellence and reach unprecedented heights. Her selfless devotion and inspiration have been a constant source of motivation throughout this journey.

To my dear friends and colleagues, I express my sincere gratitude for their invaluable encouragement, support, and camaraderie throughout this endeavour.

Lastly, this project is lovingly dedicated to my cherished son, Acke Chirikusvesve, as a testament to the power of determination, perseverance and hard work. May this achievement serve as a beacon of inspiration, reminding him that with unwavering commitment and unrelenting passion, the boundaries of success are limitless.

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ABSTRACT

This study aimed to investigate the different errors and misconceptions made by students when dealing with linear inequalities. The goal was to uncover the nature and causes of these errors and misconceptions among students at Nyamatani High School in Sanyati District of Zimbabwe. A total of 12 form 3 students and 2 teachers participated in the study. The sample was selected using a random sampling technique, which yielded 12 students from 80 learners. Data collection encompassed results from students' tests on linear inequalities, interviews with students, and questionnaires given to both learners and mathematics teachers. The collected data was coded and analysed using descriptive statistics. The study's findings revealed common errors made by students, such as multiplying/dividing by a negative number, substituting inequality symbols with "equal to" symbols, performing operations on only one side or different numbers on the two sides of a compound inequality, as well as errors in algebraic operations, simplification~~,~~ and arithmetic. Misconceptions observed included confusion between equality and inequality, misconceptions when dividing or multiplying through an inequality by a negative number, and struggles with compound inequalities. Students' difficulties arose from an inadequate understanding of basic inequality concepts, overgeneralization, limited mastery of inequality rules, and insufficient exposure to compound inequalities. Translating word problems into algebraic symbols posed a significant challenge. The study also highlighted that mathematics teachers were aware of the errors made by students. Recommendations were given for teachers and learners. Implications were given for assessment and evaluation and curriculum development.

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CHAPTER 1: THE PROBLEM AND ITS SETTING

INTRODUCTION

This research serves to explore the errors and misconceptions exhibited by Ordinary School pupils in solving Linear Inequalities at Nyamatani Secondary School, situated in Sanyati District, Mashonaland West Province and a broader context of education's trans formative role in society. This introductory chapter gives an overview of the study's scope, the background, problem statement, research objectives, questions, assumptions, delimitation, limitations and definition of key terms. Ideally, this chapter depicts the study's parameters, elucidating the variables under examination, including "errors," "misconceptions," "Linear Inequalities," and "Ordinary Level learners." By clarifying these concepts, the study establishes a foundation for a comprehensive inspect of the research topic, eventually informing evidence-based instructional strategies to intensify Mathematics education at Nyamatani Secondary School.

1.1 BACKGROUND OF THE STUDY

Linear Inequalities, are a fundamental concept in mathematics education, particularly ordinary level where students are introduced to algebraic expressions and it pose significant challenges for learners worldwide. Understanding and solving inequalities is crucial for students as they form the basis for more advanced mathematical concepts. Regardless of their crucial role in mathematics, inequalities continue to exist as one of the least grasped areas, with learners struggling to aapprehend and apply them effectively. Research highlights the interrelation of inequalities with other mathematical concepts, such as algebra, trigonometry and analytical geometry (Bicer, Capraro, & Capraro, 2014). Moreover, inequalities play a vital role in cultivating a conceptual understanding of equality and equations, as they complement students' understanding of equality (Tsamir & Almog, 2001).

The examination of students' expertise in solving algebraic inequalities offers valuable insights into their comprehension of algebra. Learners are expected to accurately organize, interpret and present information in various formats including written, graphical and diagrammatically forms. However, evidence suggests that students struggle to accurately interpret and represent inequalities, both in written and graphical forms (West African Examinations Council, 2011).

Survey have consistently shown that students encounter difficulties and misconceptions related to linear inequalities, with challenges persisting from high school to university levels (Halmaghi, 2011). The research focuses on learner's grasping on inequality concept, particularly in Zimbabwe's Sanyati District

However, the existing research indicates that not only Ordinary Level Learners but also pre-service teachers exhibit a weak understanding of this concept (El-khateeb, 2016; Bicer, Capraro, & Capraro, 2014; Almog & Ilany, 2012; Halmaghi, 2011). This research aims to bridge the knowledge gap by investigating learners' errors and misconceptions regarding inequalities among Ordinary Level Learners in Sanyati District.

Ideally, this research focuses on Nyamatani Secondary School in Sanyati District, Mashonaland West Province, Zimbabwe, as a case study. By exploring the errors and misconceptions exhibited by learners in solving linear inequalities, this study seeks to identify common errors and misconceptions among Ordinary Level Learners, scrutinized the underlying causes of these errors and misconceptions and suggest possible strategies to reduce errors and misconceptions in solving linear inequalities

This research's findings will contribute to the development of targeted instructional strategies, enhancing mathematics education and improving learner outcomes in Zimbabwe.

1.2 STATEMENT OF THE PROBLEM

Despite the importance of linear inequalities in mathematics learners often exhibit significant errors when solving them. These errors can be attributed to various factors including lack of conceptual understanding, ineffective teaching methods and cognitive overload. Identifying the types of errors and their origins is essential for developing effective teaching strategies to improve learners' competencies. Msomi and Bansilal (2022) as well as Karthik (2023) have continually emphasized the struggle of learners in comprehending and employing the four primary inequality symbols ($<$, $>$, $\leq$, and $\geq$). They straightened that 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 The most familiar errors made by Learners include be using equations with inequalities, incorrect multiplication with negative coefficients and wrong representation of the number line as solutions. In all these circumstances, learners have consistently received lower marks, resulting in an overall mediocre performance in the subject. (Msomi and Bansilal 2022).

This therefore encourage the researcher to have an insight in learners' errors and misconceptions in solving Linear Inequalities.

1.4 RESEARCH OBJECTIVES

The research seeks to achieve the following objectives:

1. To identify the reasons why secondary school learners struggle to solve linear inequalities.

2. To investigate the common misconceptions and errors made by secondary school learners when solving linear inequalities.

3. To determine the most effective teaching strategies or methods for helping secondary school learners understand linear inequalities.

4. To propose recommendations for educators to address these errors and enhance student understanding.

1.4 RESEARCH QUESTIONS

The research seeks to answer the following questions:

1. Why do secondary school learners struggle to solve linear inequalities?

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

3. What misconceptions or misunderstandings contribute to these errors?

4. What teaching strategies are most effective in helping secondary school learners understand linear inequalities?

1.6 SIGNIFICANCE OF THE STUDY

This research is significant for educators, curriculum developers and policy makers. The study of errors and misconceptions in solving linear inequalities is very crucial in offering numerous benefits for mathematics education. By scrutinizing errors and misconceptions, researchers can recognize common patterns and areas of difficulty, informing the development of targeted instructional strategies. Understanding learners' errors and misconceptions enables teachers and educators to design more effective lessons, activities and assessments that address specific challenges. Addressing these issues leads to deeper understanding, improved academic performance and enhanced learning outcomes. This research contributes to the existing body of knowledge in mathematics education, providing valuable insights into the complexity of learning and teaching linear inequalities. Furthermore, it identifies areas where learners require additional support or review, enabling educators to provide targeted interventions. Ultimately, the findings can inform the development of mathematics curricula, ensuring linear inequalities are taught in a way that proactively addresses common errors and misconceptions, thereby optimizing student learning and success.

1.7ASSUMPTIONS OF THE STUDY

This study operates under several key assumptions that guide the research methodology and interpretation of findings. Initially, it is assumed that learners possess a foundational understanding of algebraic concepts, including variables, constants and mathematical operations and have prior exposure to linear equations and inequalities. Apparently, 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 generalization, expecting the findings to be applicable to other learners with similar backgrounds and experiences. In addition, 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 reveal learners' errors and misconceptions, providing a comprehensive understanding of their understanding of linear inequalities. By acknowledging and addressing these assumptions, the researcher strives to ensure a controlled, objective and rigorous investigation into learners' understanding of linear inequalities, ultimately informing evidence-based instructional strategies to enhance mathematics education.

1.8 DELIMITATIONS OF THE STUDY

In this study on learner errors and misconceptions in solving linear inequalities, several concepts are examined, including the basic understanding of inequality signs, graphical representation of solutions on number lines, and the solving of simple and multi-step inequalities. Particular attention is given to the critical rule of reversing the inequality sign when multiplying or dividing by a negative number, where many learners make errors, as well as misconceptions in handling compound inequalities involving “and” and “or” conditions. The study also explores learners’ difficulties in expressing solutions using set-builder or interval notation, interpreting word problems into algebraic inequalities, checking solutions for validity, and the common issue of “flapping inequalities,” where signs are reversed or misapplied during manipulation. Furthermore, challenges in transitioning between symbolic, graphical, and verbal representations of inequalities are investigated. However, the study is delimited in several ways: it focuses only on Ordinary Level learners, which restricts the applicability of findings to higher or lower grade levels; it uses a relatively small sample size, which may compromise the validity and authenticity of results; and it is geographically confined to Nyamatani Secondary School in Sanyati District, Zimbabwe, limiting the generalization of findings to broader educational contexts.

1.9 LIMITATIONS OF THE STUDY

This study has quite a number of limitations that may hinder its progress, validity and reliability. Financial constraints, in particular transport and stationery costs, pose a significant challenge that impede data collection and overall progress. In addition, as a continual teacher, the researcher's professional duties usually clash with research activities, compromising the study's timeline and quality. Time and resource constraints also limit the study's scope and depth, forcing prioritization of research objectives. Orchestrating the study in a restrained environment may not accurately reflect real-world learning settings, possibly limiting generalization to authentic educational contexts. Ethical considerations, such as minimizing learner exasperation and ensuring informed consent, impose boundaries on methodology and data gathering, probably restricting the study's design and implementation. Moreover, methodological limitations, including sampling skew, instrumentation constraints and researcher partiality, may impact the study's validity and reliability. The study's exploratory nature also means that findings may be preliminary and require further scrutiny. Other limitations include reliance on self-reported data, potential respondent fatigue and limited access to diverse participant populations. Therefore, by acknowledging these limitations, the

researcher recognizes potential vulnerabilities and encourages cautious interpretation of findings, highlighting areas for future research to address these gaps and enhance the study's contributions to understanding errors and misconceptions in solving linear inequalities.

1.10 DEFINITION OF KEY TERMS:
KEY TERMS:

MISCONCEPTION

Misconceptions are a fundamental aspect of learning, and they can significantly impact an individual's understanding of a concept or phenomenon. According to the National Science Education Standards (2014), "a misconception is a belief that is not supported by evidence or scientific evidence." Similarly, Anderson et al. (2015) define misconceptions as "ideas that are inconsistent with scientific principles or concepts." Novak (2017) also emphasizes that "a misconception is a misunderstanding or incorrect belief about a concept or phenomenon."

ERRORS

In contrast to misconceptions, errors are simply incorrect answers or actions. According to Krantz (2017), "an error is a deviation from the true value or correct result." Larsen (2019) also defines errors as "mistakes or inaccuracies in a mathematical calculation or measurement." Taylor (2020) notes that "an error is a deviation from the true value or a departure from the expected results." These definitions highlight the idea that errors are unintended departures from a desired outcome or standard of performance.

INEQUALITY

Inequality is a fundamental concept in mathematics and social sciences. According to Mydral (2019), "inequality refers to the unequal distribution of resources, opportunities, and privileges among individuals or groups." Hurst (2020) defines inequality as "a situation in which individuals or groups have unequal access to valued resources, services, and opportunities." Temkin (2022) notes that "inequality is a state of affairs in which people have unequal amounts of something, such as wealth, status, or power."

LINEAR INEQUALITIES

Linear inequalities are a specific type of mathematical expression that compares two expressions using inequality symbols. According to Lial (2019), "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." Sullivan (2020) defines linear inequalities as "inequalities in which the highest power of the variable is 1." Larson (2022) notes that "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."

1.11 SUMMARY OF THE CHAPTER

This chapter provided a comprehensive introduction to the research investigating errors and misconceptions in solving Linear Inequalities among Ordinary Level learners at Nyamatani Secondary School. The chapter began by establishing the background of the study, situating the research within the broader context of mathematics education and highlighting the significance of addressing learners' difficulties with Linear Inequalities. The statement of the problem succinctly outlined the specific challenges faced by learners, while the research questions guided the investigation. The chapter also articulated the study's objectives, clarifying the researcher's intentions and outcomes. Additionally, the chapter discussed the assumptions underlying the study, acknowledging potential influences on the findings. The significance of the study emphasized its importance and relevance, while the delimitation and limitations sections recognized potential constraints and vulnerabilities. Finally, key terms were defined to ensure clarity and precision throughout the research. By providing this foundational overview, this chapter established a solid framework for the subsequent chapters, which will delve into the literature review, methodology, data analysis and findings of the study

CHAPTER 2: LITERATURE REVIEW

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2.1 INTRODUCTION

Linear inequalities, a keystone of algebraic thinking, play a vital role in promote problem-solving skills and critical thinking in mathematics. Regardless of their importance, learners often encounter significant challenges when solving linear inequalities, leading to tenacious errors and misconceptions that can impede their mathematical progress and overall academic achievement. To approach these challenges, it is crucial to investigate the nature, frequency and underlying causes of these errors and misconceptions.

This segment aims to provide a comprehensive review of prevailing researches on errors and misconceptions in solving linear inequalities, examining the cognitive, linguistic and cultural factors that contribute to these errors. According to this review, the study provides a foundation for educators and researchers to develop effective instructional approaches, informed by empirical evidence, to enhance learner outcomes and promote mathematical proficiency.

2.2.1 ERRORS AND MISCONCEPTIONS SOLVING LINEAR INEQUALITIES

Research has consistently highlighted on the definitions of the terms which are error and misconceptions and differences. Mutambara and Chagwiza (2014) postulates that errors as the mistakes resulting from lake of understanding of mathematical concepts or procedures. These errors can indicate specific areas where learners need support. Chagwiza (2016) categorize errors as either procedural or conceptual, emphasizing how procedural errors arise from misapplication of techniques while conceptual errors stem from misunderstandings of fundamental ideas. Chagwiza (2016) viewed misconceptions as incorrect beliefs that learners cannot easily change. While Mutambara and Banslal (2022) defines misconceptions as entrenched beliefs that learners hold about mathematical concepts, which can lead to persistent incorrect reasoning and difficult in understanding new material. Mutambara and Bansilal (2014) says misconception are deeply rooted and reflect a misunderstanding of concepts while errors are typically surface-level mistakes that can occur even with a correct understanding. They go on saying misconceptions require deeper instructional intervention to address the underlying misunderstanding and can hinder future learning by creating flawed foundations

while can be corrected through practice and careful review of work and may temporarily affect performance but do not abstract overall comprehension if addressed.

2.2.2 FACTORS CONTRIBUTING TO ERRORS AND MISCONCEPTIONS IN SOLVING LINEAR INEQUALITIES

Mutambara and Chagwiza (2023) highlighted errors and misconceptions in solving linear inequalities stem from various factors, including lack conceptual understanding, procedural errors, and difficulties in interpreting inequality symbols. They emphasized that these issues can affect both in-service teachers and students.

LACK OFCONCEPUTUAL UNDERSTANDING

Some learners struggle to grasp the fundamental concepts underlying linear inequalities, such as the meaning of inequality symbols and the relationship between operations on both sides of the inequality. This lack of understanding can lead to inappropriate applications of rules, such multiplying or dividing both sides of the inequality by a negative number without changing the inequality sign Mutambara and Chagwiza, (2023).

PROCEDURAL ERRORS

Many learners face challenges with the steps involved in solving linear inequalities, particularly when dealing with multiple steps or operations. They might make mistakes in isolating the variable, performing operations in the correct order, or applying the correct rules for changing the inequality sign when multiplying or dividing by a negative number (Mutambara and Chagwiza, 2023).

DIFFICULTIES WITH INEQUALITY SYMBOLS

Some learners have difficulties interpreting the meaning of different inequality symbols for example $<$, $>$, $\geq$, $\leq$ and applying them correctly in solving inequalities. They may confuse the symbols or struggle to understand how they affect the direction of the inequality when solving (Chagwiza and Mutambara, 2023).

ADDRESSING ERRORS AND MISCONCEPTIONS

Mutambara and Bansilal (2022) suggest that educators should focus on developing a strong conceptual understanding of inequalities, providing sample opportunities for practice, and using strategic teaching methods to address learner's misconception

Numerous correlated factors contribute to the persistence of errors and misconceptions in solving linear inequalities. A prime factor is learners' inadequate understanding of underlying

Mathematical concepts, such as algebraic properties and inequality relationships (Kilpatrick, Swafford, & Findell, 2014). As stated by (Hativa 2020), 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, 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). Furthermore, 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. To approach these factors requires a comprehensive strategy that integrates effective instructional design, contextualized learning, and on-going support to promote 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 minimize errors and misconceptions in solving linear inequalities by adopting a range of evidence-based strategies that promote both procedural fluency and conceptual understanding. The use of visual aids and multiple representations, such as number lines, graphs, and verbal descriptions, enables learners to connect abstract concepts with concrete images, reducing reliance on rote memorization (Cai & Lester, 2010; Kilpatrick, Swafford, & Findell, 2014). Emphasizing conceptual understanding before procedures, for example explaining why inequalities reverse when multiplied by a negative number, helps prevent rule misapplication and strengthens reasoning (Sfard, 1991). Learners also benefit from error analysis and reflective practice, where they examine and correct incorrect solutions, fostering metacognitive awareness and deeper comprehension (Borasi, 1996; Hativa, 2020). Providing scaffolding and guided practice within the Zone of Proximal Development supports gradual mastery, while formative assessment and targeted feedback ensure misconceptions are identified and addressed early (Vygotsky, 1978; Black & Wiliam, 1998; Drijvers, 2018). Collaborative learning and peer discussions further enhance understanding by encouraging learners to articulate and justify their reasoning (Johnson & Johnson, 2009; Knuth, 2017). Technology integration, such as dynamic graphing tools like GeoGebra and Desmos, offers interactive exploration of inequalities and immediate feedback, enhancing visualization and engagement (Kaput, 1992). Embedding inequalities in real-life applications makes mathematics meaningful, motivating learners to connect classroom content with practical scenarios (Boaler, 1998). Additionally, clarifying the language and symbols of inequalities reduces ambiguity in interpreting terms such as “at least” or “at most” (Pimm, 1987; Siegler & Lortie-Forgues, 2015). Finally, fostering a growth mindset by normalizing mistakes and encouraging persistence helps learners build confidence and resilience in mathematics (Dweck, 2006). Collectively, these strategies promote accurate problem-solving, critical thinking, and mathematical literacy, equipping learners to overcome errors and misconceptions in solving linear inequalities.

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 considers 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 meta-cognitive 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.

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 assumptive evaluations, constructive feedback and peer review, influence learners' progress, confidence and persistence in overcoming errors and misconceptions in solving linear inequalities.

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.

OUTPUT

When solving linear inequalities, learners often exhibit specific process errors and misconceptions, including reversing the inequality sign, misunderstanding the direction of the inequality, 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.

2.4 SUMMARY OF THE CHAPTER

This literature review has provided a comprehensive examination of the prevalent errors and misconceptions that learners exhibit when solving linear inequalities, shedding light on the complexities of this fundamental mathematical concept. Through a critical analysis of existing research, the underlying sources of these errors and misconceptions have been identified, including inadequate understanding of mathematical concepts, linguistic and cultural barriers, and insufficient instructional strategies. Moreover, effective countermeasures have been discussed, encompassing the use of visual aids and real-world applications, implementation of evidence-based instructional approaches, targeted feedback and support, meta-cognitive thinking, and fostering deeper understanding of mathematical concepts. By recognizing the roots of errors and misconceptions and integrating these targeted strategies, educators can create an optimal learning environment that cultivates learners' problem-solving skills, enhance mathematical literacy, and ultimately bridge the gap between conceptual understanding and practical application of linear inequalities. This synthesis of research findings informs instructional design, diagnostic assessment, and remedial interventions, empowering educators to tailor their teaching practices to meet the diverse needs of learners and foster mathematical proficiency.

In addressing the first research question on the types of errors and misconceptions learners exhibit in solving linear inequalities, the chapter highlighted frequent mistakes such as failure to reverse the inequality sign when multiplying or dividing by a negative number, incorrect interpretation of compound inequalities, flapping inequalities, and confusion between equations and inequalities. It also underscored graphical errors, such as shading the wrong region or misusing solid and dashed lines in two-variable inequalities, as common learner difficulties documented in prior studies.

With respect to the second research question on the possible causes of these errors and misconceptions, the review revealed that limited conceptual understanding, over-reliance on procedural memorization, linguistic challenges in interpreting mathematical terminology, and gaps in instructional strategies were the dominant contributing factors. Cognitive overload and transfer of incorrect reasoning from solving equations to inequalities were also identified as significant sources of error.

Finally, in response to the third research question on strategies to reduce these errors and misconceptions, the literature suggested the integration of multiple representations, error analysis, scaffolding, technology-based tools, real-life applications, and formative assessments as key interventions. The role of collaborative learning, metacognitive strategies, and promoting a growth mindset was emphasized as vital in cultivating resilience and improving learners' confidence in handling inequalities.

Overall, this chapter establishes a clear link between the research questions and existing scholarly insights, offering both a diagnosis of learners' errors and misconceptions and evidence-based strategies to address them. This foundation paves the way for the next chapter, which will outline the research methodology adopted in investigating these challenges within the context of Ordinary Level learners at Nyamatani Secondary School in Sanyati District, Zimbabwe.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research methodology employed to investigate errors and misconceptions exhibited by Form 3 learners in solving linear inequalities at Nyamatani Secondary School in Sanyati District, Mashonaland West Province, Zimbabwe. A detailed methodology ensures the collection of accurate and relevant data, enhancing the study's reliability and validity. This study adopts a mixed-methods approach, combining both quantitative and qualitative case study design to provide a comprehensive understanding of the phenomenon. The chapter is arranged into several sections, which will discuss research paradigm, research design, sample and sampling procedure, data collection procedure, data presentation and analysis, ethical considerations, validity and reliability and summary.

Through a rigorous and systematic methodology, this research aims to provide valuable perception into the errors and misconceptions exhibited by Form 3 learners in solving linear inequalities, eventually informing instructional practices and improving learner outcomes.

3.2 RESEARCH PARADIGM

The research paradigm is a philosophical and theoretical framework that guides the researcher's approach to data collection and analysis. According to Kivunja and Kuyini (2017), a paradigm is a "worldview" that influences the methodology used by the researcher to interpret data. In the context of this study, a mixed-method paradigm was employed, combining both positivist and constructionist approaches to provide a comprehensive understanding of errors, misconceptions, and the learning process.

The positivist paradigm is characterized by a focus on objectivity, reliability, and validity, with an emphasis on quantitative methods and the pursuit of causal relationships and laws. As highlighted by Lincoln and Guba (2014), the positivist paradigm seeks to "identify and quantify errors and misconceptions" using methods such as surveys, tests, and interviews to collect data. This approach is useful for identifying patterns and trends in learners' errors and misconceptions.

In contrast, the constructionist paradigm emphasizes the role of the researcher in shaping the research findings, with a focus on qualitative methods and the exploration of meaning and interpretation. According to Crotty (2015), constructionist research "explores how learners

construct their understanding of linear inequalities, highlighting the role of prior knowledge, experiences, and social interactions in shaping their understanding." This approach provides a deeper understanding of the complex factors that influence learners' understanding of linear inequalities.

The mixed-method approach used in this study combines the strengths of both positivist and constructionist paradigms. Creswell (2018) alluded that, mixed-method researches "provides a more comprehensive understanding of the research problem" by combining quantitative and qualitative data. This approach enables researchers to identify patterns and trends in learners' errors and misconceptions, while also exploring the complex factors that influence their understanding of linear inequalities.

3.3 RESEARCH DESIGN

Research design is the conceptual blueprint within which research is conducted (Akhtar, 2016). Therefore, a research design is an exposition of the way the study conducted; that is, the plan that guides the undertaking of a research to meet the research objectives.

This study utilized the qualitative and quantitative research methods to examine the errors and misconceptions related to linear inequalities among Form 3 Learners in the field of mathematics.

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 (for example, text, video, or audio) to understand concepts, opinions or experiences. Qualitative research can also 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 emphasizes 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 analyzing 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 investigating in learners’ errors and misconceptions in solving Linear Inequalities and suggested interventions to reduce errors and misconceptions at Ordinary Level.

3.4 POPULATION

The population for this research consists of Form 3 students enrolled in Mathematics at Nyamatani Secondary School in Sanyati District, Mashonaland West Province, Zimbabwe, totaling 180 learners. Cohen and Manion (2003) and Bhattacherjee (2012) states that, a population refers to any group of individuals sharing common characteristics that are of interest to the researcher. In this context, the population encompasses all Form 3 students studying Mathematics. The selection of Form 3 students as the singled-out population was guided by several considerations, including comprehensive curriculum coverage of linear inequalities, cognitive maturity and familiarity with assessment formats. To ensure representatives and generalization, a random sampling method was employed to select a sub-sample of 15 learners from the larger population. This sampling approach helped to reduce bias and ensure that the selected participants accurately reflected the characteristics of the target population. The sampling frame consisted of all Form 3 Mathematics students enrolled at Nyamatani Secondary School during the academic year, 2024 of the study and the sample size of 15 learners was deemed sufficient for an in-depth exploration of errors and misconceptions in solving linear inequalities. Through focusing on this specific population, the study aimed to gain valuable insights into the comprehension and problem-solving skills of high school students in Mathematics, ultimately informing instructional practices and improving learner outcomes.

3.5 SAMPLE AND SAMPLING TECHNIQUE

3.5.1 SAMPLE

Leedy (2006) alluded that a sample refers to a subset of respondents or a group of individuals that accurately represents the larger population, possessing the most characteristic or typical attributes of the population being studied. Therefore, a sample is a carefully selected portion of the population, drawn to provide valuable insights into the phenomena under investigation. The sample serves as a representative subset of the population, showing similar qualities, traits and features that make it representative of the larger group. Through studying this subset, researchers can make inferences and draw conclusions about the entire population. In this

research, the sample consists of 15 Form 3 Mathematics students randomly selected from the total population of 180 learners at Nyamatani Secondary School. This sample size was regarded as sufficient to provide an in-depth understanding of errors and misconceptions in solving linear inequalities, while also ensuring manageability and feasibility. Through discrimination of this representative sample, the study aims to uncover trends, patterns and relationships that can be generalized to the broader population of Form 3 Mathematics students.

3.5.2 SAMPLING TECHNIQUE

The study employed random sampling as its sampling technique, targeting Mathematics Form 3 Learners, Mathematics teachers and the Head of the Mathematics Department at Nyamatani Secondary School in Sanyati District, Mashonaland west Province. Random sampling, a probability sampling method, ensures every member of the population has an equal chance of being selected, thereby minimizing bias and enhancing generalization. This approach allowed the researcher to draw a representative sample from the target population, providing a reliable and unbiased representation of the learners' and teachers' experiences, perceptions and understanding of linear inequalities. Through utilization of random sampling, the research aimed to increase validity and reliability, enabling the researcher to make assumption about the broader population. The sampling procedure involved selecting participants randomly from the school's Form 3 Mathematics classes, teacher roster and departmental leadership, ensuring a diverse and representative sample. This methodological choice facilitated an unbiased examination of errors and misconceptions in solving linear inequalities among learners and identifying effective instructional strategies to address these challenges.

3.5.3 RANDOM SAMPLING

A simple random sampling method was employed to ensure the reliability and generalization of the study's findings to select a subset of 25 Form 3 Mathematics students from the total population of 180 learners at Nyamatani Secondary School. This guaranteed that every student had an equal chance of being selected, thereby reducing the risk of sampling bias and selection bias. The random sampling process involved assigning a unique identifier to each of the 180 students, followed by the use of a random number generator to select the 15 participants. This method ensured that the selection was unbiased and free from researcher influence. The random process eliminated potential human error or prejudice, thereby enhancing the internal and external validity of the study. As a result, the findings derived from this randomly selected sample can be confidently generalized to the larger population of Form 3 Mathematics students at Nyamatani Secondary School. The simple random sampling method utilized in this study provides a vigorous foundation for drawing meaningful conclusions about the errors and misconceptions exhibited by students when solving linear inequalities.

In addition to the student sample, two teachers were also purposively selected to participate in the study. Purposive sampling was deemed most appropriate because the focus was on teachers who specifically handle Form 3 Mathematics at Nyamatani Secondary School. Unlike random sampling, which gives every individual in a population an equal chance of selection, purposive sampling allows the researcher to deliberately target participants who possess the relevant expertise and experience needed to provide meaningful insights into the research problem.

At Nyamatani Secondary School, there are three Mathematics teachers responsible for teaching Form 3 learners, and all of them were included in the study. This complete inclusion ensured that the perspectives of all relevant educators were captured, thereby enriching the findings with diverse professional viewpoints. The teachers' participation provided valuable data on common errors and misconceptions they observe among learners, their perceptions of underlying causes, and the strategies they employ to address these difficulties.

The purposive selection of teachers enhanced the study's credibility by ensuring that information was obtained from knowledgeable informants who directly interact with the learners under investigation. Consequently, their contributions complemented the learner data and provided a more holistic understanding of the challenges associated with solving linear inequalities.

3.6 RESEARCH INSTRUMENTS

Leedy and Ormrod (2012) define research instruments as data gathering methods. This study employed a multi-method approach to data collection, utilizing a combination of research instruments to gather comprehensive and nuanced insights into learners' understanding and teachers' instructional practices related to linear inequalities. Specifically, the research instruments included a knowledge test, questionnaires, and semi-structured interviews. The knowledge test assessed learners' mathematical proficiency and identified common errors and misconceptions in solving linear inequalities. Questionnaires, distributed to learners and teachers, gathered information on demographic characteristics, teaching methods and perceptions regarding linear inequalities. Semi-structured interviews with teachers and the Head of the Mathematics Department explored instructional strategies, curriculum implementation and assessment practices related to linear inequalities. These research

instruments enabled the collection of both quantitative and qualitative data, facilitating a rich and detailed understanding of the research phenomena.

3.6.1 QUESTIONNAIRES

This study utilized a questionnaire as a primary data collection tool to facilitate the research process, leveraging its effectiveness in gathering information from a large number of participants. A questionnaire, as described by Best and Khan (2000), is a document containing per-designed questions aimed at soliciting specific information. Mhlanga and Ncube (2003) further define it as a tool consisting of question items tailored to elicit relevant data for the research study. Essentially, a questionnaire is a standardized document containing a set of questions posed in a consistent order and manner to gather uniform information from respondents. Participants complete the questionnaire at their convenience, providing valuable

insights into their thoughts, experiences and perceptions. To maximize data collection, the questionnaire employed in this study incorporated both open-ended and close-ended responses. The open-ended questions allowed respondents to provide detailed qualitative answers, offering nuanced insights into their understanding and experiences with linear inequalities. Close-ended questions, on the other hand, enabled the collection of quantitative data, facilitating statistical analysis and identification of trends. By combining these two response formats, the questionnaire provided a comprehensive understanding of the research phenomena, yielding both depth and breadth of information.

3.6.2 INTERVIEWS

This study employed interviews as a qualitative data collection method to gather in-depth insights into learners' and teachers' thoughts, experiences, and understanding of linear inequalities. According to Creswell (2014), "interviews are a useful data collection method for exploring the thoughts, feelings, and experiences of individuals." Interviews involve oral or face-to-face conversations between the researcher and participants, allowing for flexibility and clarification of questions (Kvale & Brinkmann, 2015).

The face-to-face interview technique utilized in this study enabled the researcher to employ open-ended questions, explain concepts, observe nonverbal cues, and verify the accuracy of responses (Merriam & Tisdell, 2016). This approach also facilitated probing for additional

information to clarify ambiguous responses. As noted by Patton (2015), "interviews provide an opportunity for the researcher to probe for more information and to clarify any ambiguities in the responses."

To ensure transparency, the researcher explained the study's purpose to participants, mitigating potential misconceptions (Gubrium & Holstein, 2016). An interview guide consisting of six questions was prepared to elicit detailed insights into learners' thought processes, particularly regarding their test responses. Interviews complemented the test results, providing a richer understanding of learners' and teachers' experiences, challenges, and perceptions related to linear inequalities. As noted by Rubin and Rubin (2017), "interviews provide a unique opportunity for the researcher to gain a deeper understanding of the participants' perspectives and experiences."

3.6.3 TESTS

This study utilized standardized tests as a quantitative data collection method to assess learners' knowledge and skills in solving linear inequalities. Specifically, the researcher designed and administered a structured knowledge test to measure learners' proficiency and identify common error types. The test comprised two phases, a pretest and a post-test. The pretest, administered prior to the intervention, aimed to baseline learners' existing knowledge, attitudes and behaviors related to linear inequalities, providing a foundation for subsequent analysis. Conversely, the post-test, administered after the intervention, evaluated the effectiveness of the instructional strategies by comparing results to the pretest, thereby determining the degree of knowledge acquisition and error reduction. By employing this pretest/post-test design, the researcher could isolate the impact of the intervention, assess learners' progress and identify areas requiring further instructional support. The tests provided quantitative data, complementing the qualitative insights gathered through questionnaires, interviews and focus group discussions and enabling a comprehensive understanding of learners' understanding and challenges in solving linear inequalities.

3.7 DATA COLLECTION AND PROCEDURES

3.7.1 DATA COLLECTION

Data collection methods are the tools the researcher will use to gather information or data (Blaikie, 2010). Data collection, a crucial aspect of research, was meticulously executed in this study to gather comprehensive insights into Form 3 Learners' errors and misconceptions when solving linear inequalities. Employing a multi-method approach, the researcher utilized, individual interviews and questionnaires to ensure validity and reliability. Interviews, facilitated with an open-ended guide, enabled participants to share experiences and interact freely providing rich qualitative data on errors and misconceptions. This approach allowed participants to respond comfortably, fostering a supportive environment for meaningful discussions. Individual interviews offered the researcher opportunities to probe for additional information, clarifying inadequate responses and gathering deeper insights into participants' experiences. Detailed questions and follow-up probes enabled the researcher to uncover underlying issues and nuances. Questionnaires distributed personally by the researcher yielded varied responses, complementing the qualitative data with quantitative insights. By triangulating these data collection methods, the study ensured a robust and well-rounded understanding of learners' challenges and misconceptions in solving linear inequalities, ultimately informing effective instructional strategies.

3.7.2 DATA COLLECTION PROCEDURES

To ensure a rigorous and effective data collection process, the researcher meticulously followed a series of procedures. Initially, permission was sought from the Ministry of Primary and Secondary Education to access schools for data collection. Prior to administering the research instruments to the sample, a pilot study was conducted to validate and refine the methodology as advocated by Makore-Rukuni (2001). This preliminary testing enabled the researcher to modify and fine-tune the instruments, enhancing their reliability and validity. In collaboration with the school Head, appointments were scheduled for interviews with teachers and learners. The researcher designed flexible interview accommodating participants' convenience and availability. Face-to-face interviews were conducted at Nyamatani Secondary School with the researcher taking notes as necessary. Employing a flexible interview guide, the researcher tailored questions to align with the study's objectives, focusing on errors and misconceptions in solving Linear Inequalities. Probing techniques were extensively used to gather in-depth insights and clarify responses. This adaptive approach allowed for exploration of emerging themes and issues, ensuring comprehensive data collection. Through this systematic process,

the researcher ensured the collection of high-quality, relevant data to inform the study's findings and recommendations.

3.8 VALIDITY AND RELIABILITY

Ensuring the validity and reliability of research findings is crucial, and this study addressed these critical aspects by employing rigorous methods. Validity refers to the accuracy of data in reflecting the phenomena under study, also known as internal validity (Brewer, 2012). Reliability, as noted by Kothari (2004) and Best and Kahn (2006), encompasses dependability, consistency and stability of research tools. To achieve validity and reliability, this study utilized triangulation, a methodology that combines multiple research methods to offset the weaknesses of individual approaches (Cohen, Manion, & Morrison, 2010). Specifically, the researcher blended interviews, questionnaires and tests to yield authentic data on errors and misconceptions in solving Linear Inequalities. This multi-method approach enabled cross-validation of findings, enhancing the study's internal validity and reliability. By integrating diverse data sources and methods, the researcher mitigated potential biases and errors, increasing confidence in the findings. Triangulation also facilitated a comprehensive understanding of the research phenomenon, providing a rich and nuanced exploration of learners' challenges and misconceptions in solving Linear Inequalities.

3.9 ETHICAL CONSIDERATIONS

This study adhered to stringent ethical considerations, guided by principles of right and wrong that govern research practices, as outlined by Punch (2011). Recognizing the importance of ethical conduct throughout the data collection process, the researcher observed several key considerations. Informed consent was obtained from participants, ensuring they understood the study's purpose, potential risks and benefits, as well as their right to withdraw without penalty. Confidentiality and anonymity were guaranteed with all data collected and stored securely to protect participants' identities. Privacy was respected and participants' personal information was not disclosed without explicit permission. The researcher avoided harm or potential harm to participants, ensuring that the study's methods did not cause physical, emotional or psychological distress. Objectivity and bias were minimized through rigorous methodology and data analysis. The researcher declared no conflict of interest and maintained professional boundaries throughout the study. Furthermore, permission was obtained from relevant authorities including the Ministry of Primary and Secondary Education and school administrators to conduct the research. By upholding these ethical principles, the study ensured the dignity, rights and well-being of all participants were respected, fostering trust and credibility in the research process.

3.9.1 INFORMED CONSENT

In adherence to ethical standards, informed consent was obtained from all participants prior to data collection, ensuring they comprehensively understood the study's purpose, potential risks and benefits. As emphasized by Mungenda (2003), informed consent necessitates that participants grasp the research process and willingly provide their consent. In this study, participants were fully apprised of the academic nature of the research and their voluntary participation was stressed. As Neuman (2007) underscores, participation was entirely voluntary with no coercion or inducement. Participants were informed of their right to withdraw from the study at any point without penalty or consequence. The informed consent process ensured participants' autonomy and dignity were respected, fostering trust and openness in the research process. By providing clear, concise information, the researcher empowered participants to make informed decisions regarding their involvement, aligning with ethical principles of respect, beneficence and non-maleficence.

3.9.2 ANONYMITY AND CONFIDENTIALITY

In accordance with ethical principles, this study prioritized anonymity and confidentiality to safeguard participants' privacy and trust. Aligning with Makore's (2001) and Tuckman and Monette's (2011) guidelines, the researcher ensured participants' identities remained undisclosed, unless explicit consent was provided. To maintain anonymity, pseudonyms were used in place of actual names, preventing any identifiable information from being linked to individual participants. Furthermore, confidentiality was upheld by securing all collected data and storing it in a manner that protected participants' identities. The researcher refrained from collecting sensitive information without participants' consent, respecting their right to privacy. No personal or identifiable data was shared, published or disclosed without explicit permission. By adhering to these ethical standards, the researcher fostered a secure and trustworthy environment, encouraging open and honest responses from participants. This commitment to anonymity and confidentiality ensured participants' autonomy, dignity and privacy were respected throughout the research process.

3.9 DATA PRESENTATION AND ANALYSIS PROCEDURE

3.10.1 DATA ANALYSIS

This study employed a comprehensive data analysis plan, as outlined by Borg and Gall (2007), to systematically examine and interpret the collected data. The plan involved identifying patterns and themes, as described by Neuman (2003), to uncover recurrent behavior, objects or bodies of knowledge related to learners' understanding of linear inequalities. To achieve this, all learners' test results were assessed, focusing on errors and misconceptions evident is incorrect and partial answers. Attempt questions were excluded from analysis, as they did not provide insight into learners' understanding. Themes emerging from test data were validated through interviews with participants selected based on their error-prone or partially correct responses. Additional interviews were conducted with learners who skipped questions, aiming to gauge their conceptual knowledge and procedural fluency in solving linear inequalities. Data presentation took the form of narrative written reports, synthesizing findings from observations, questionnaires, tests and interviews. This integrated approach provided a rich, nuanced understanding of learners' challenges and misconceptions, informing recommendations for improved instructional strategies.

3.10.2 DATA PRESENTATION

Data presentation in this study involved a comprehensive process of analyzing, visualizing and interpreting the results to identify common errors and areas of difficulty faced by learners in solving linear inequalities. To achieve this, a multi-faceted approach was employed, incorporating various tools and techniques. Firstly, students' written scripts were meticulously examined to pinpoint specific errors and misconceptions. These scripts provided valuable insights into learners' thought processes, problem-solving strategies and mathematical reasoning. Notes were taken on recurring mistakes, such as sign errors, incorrect application of algebraic properties and misunderstanding of inequality concepts. Additionally, tables were constructed to categorize and quantify the frequency of errors, allowing for the identification of patterns and trends. Graphs, including bar charts and pie charts were also utilized to visually represent the data, facilitating the comparison of error rates across different question types and student demographics. By triangulating these data presentation methods, the study uncovered nuanced insights into learners' strengths and weaknesses, informing targeted interventions to enhance mathematics education.

3.12 SUMMARY OF THE CHAPTER

This chapter provided a comprehensive exposition of the research methodology underpinning the investigation into errors and misconceptions in solving linear inequalities among Form 3 Mathematics students at Nyamatani Secondary School. The chapter systematically outlined the research paradigm, blending quantitative and qualitative approaches and delineated the case study research design employed. The population, comprising 25 Form 3 Mathematics students was defined and the sampling procedure, involving random selection of 15 learners was explained. Ethical considerations, including informed consent, confidentiality and participant rights were meticulously addressed. A mixed-methods approach was adopted for data collection, incorporating questionnaires, interviews, observations and analysis of students' written scripts. Data presentation and analysis procedures involved note-taking, table construction, graph generation and error identification. By adopting a rigorous, systematic and transparent methodology, this study ensured reliability, validity and generalization of findings, contributing meaningfully to understanding learners' difficulties in solving linear inequalities and informing evidence-based instructional strategies to enhance mathematics education. Ultimately, this chapter provided a detailed road map of the research methodology, underscoring the study's credibility, trustworthiness and potential to inform impact educational interventions.

CHAPTER 4

4.0 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

This chapter presented the researcher's quantitative findings on statistical graphs like pie charts bar graphs and frequency distribution tables. The above statistical tables did not only make the researcher's data amenable for analysis, but also compacted the data, at the same time retaining original findings. The presented data was then analyzed 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. Qualitative data was analyzed narrative.

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	1	50%
Between 40 and 50 years	1	50%
Total	2	100%

Table 4.2.1 presents the demographic characteristics of the teacher respondents, specifically their age distribution. The data shows that there were only 2 teacher respondents who participated in the study. Both teacher respondents fall within the age range of 30-50 years. One teacher respondent (50%) falls within the age range of 30-40 years, while the other teacher respondent (50%) falls within the age range of 40-50 years. 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.

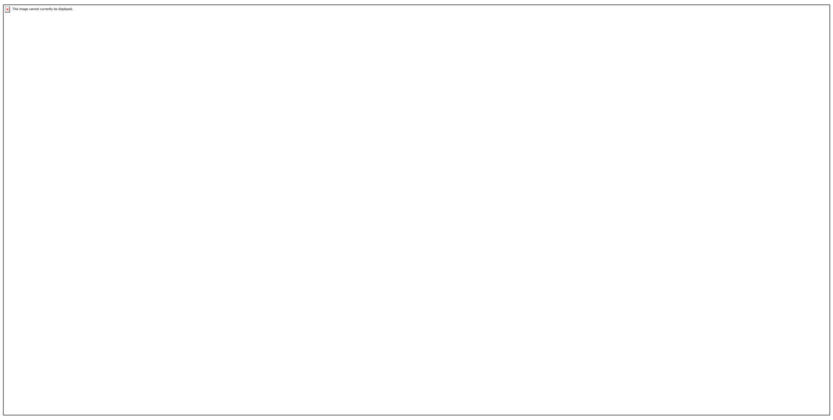
4.2.2 SEX FOR TEACHERS

Figure 4.2.1 Pie Chart Showing Sex of Teachers

Figure 4.2.1 presents a pie chart showing the sex of the teacher respondents. The data reveals that 50% of the teacher respondents are male and 50% of the teacher respondents are female. These results suggest that the teacher respondents are evenly distributed in terms of sex. This is consistent with the findings of other studies, which have shown that the teaching profession is generally evenly distributed 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.

4.2.3 TEACHER QUALIFICATIONS

Figure 4.2.3 Illustrates qualifications of the teachers



The data presented on figure 4.2.3 shows that all teacher respondents (100%) hold a 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. In addition, the qualifications of the teacher respondents may also influence their participation in professional development activities. As noted by Guskey (2000), "teachers who participate in professional development activities tend to have higher levels of educational qualification".

4.2.4 TEACHING EXPERIENCE FOR THE TEACHERS

Table 4.2.2 Frequency Table Showing Years of Teaching Experience

Working Experience	Frequency	Percentage
Between 10 and 15 years	1	50%

Above or equal to 15 years	1	50%
Total	2	100%

Table 4.2.2 presents a frequency table showing the years of teaching experience of the teacher respondents. The data reveals that 50% of the teacher respondents have between 10-15 years of teaching experience and the other 50% of the teacher respondents have 15 years or more of teaching experience. None of the teacher respondents have less than or equal to 5 years of teaching experience or between 5-10 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). According to Creswell (2014), "a frequency table is a useful way to display categorical data, such as the years of teaching experience of teacher respondents". 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	5	33%
16 years	7	47%
17 years	3	20%
Total	15	100%

Table 4.2.3 presents the demographic characteristics of learner respondents, specifically their ages. The frequency table shows that 47% of the learner respondents are 16 years old, 33% of the learner respondents are 15 years old and 20% of the learner respondents are 17 years old.

The results presented suggest that the majority of learner respondents (47%) are 16 years old. This suggests that the sample is predominantly composed of learners in the 16-year-old 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 SEXE

Figure 4.2.4 Pie Chart Showing Sexes of Learners

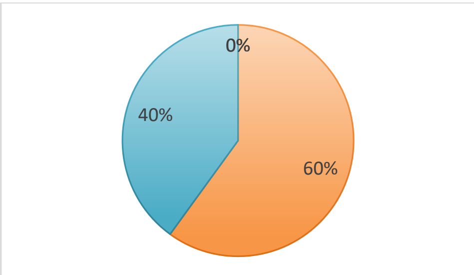
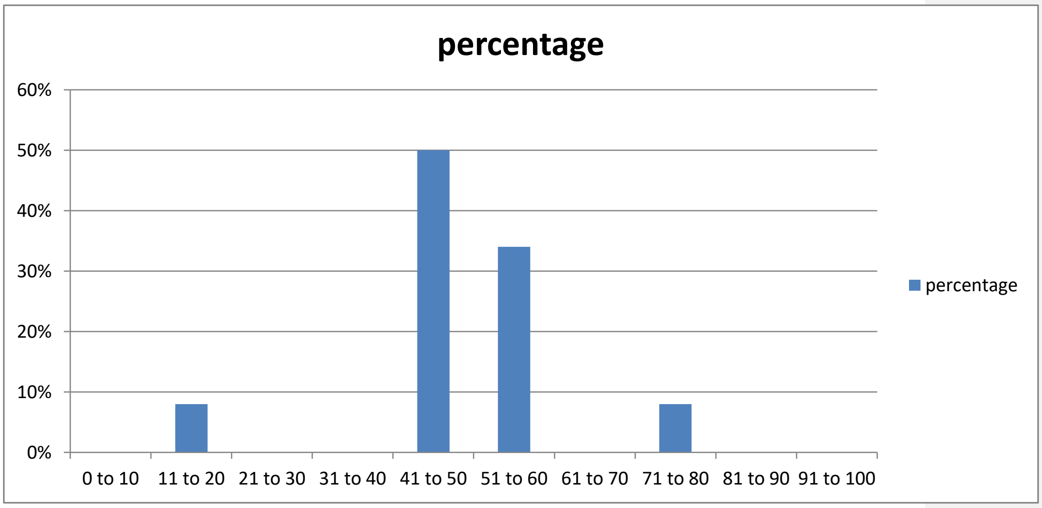


Figure 4.2.4 presents a pie chart showing the sexes of learners. The pie chart reveals that 60% of the learners are females and 40% of the learners are males. The results presented suggest that the majority of learners (60%) are females. This suggests that the sample is predominantly composed of female 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 OBTAINED THROUGH PRETEST

Figure 4.2.5 Bar graph showing results obtained from the pretest



The bar graph 4.2.5 presents the results obtained from the pretest, showing the mark obtained in percentage. The data reveals that 6 respondents scored between 41-50%, 4 respondents scored between 51-60%, 1 respondent scored between 11-20% and 71-80%. The results presented suggest that the majority of respondents (50%) scored between 41-50%. This suggests that the respondents may have a moderate level of understanding of solving linear inequalities.

ERRORS DISPLAYED IN THE PRETEST

The learners made various errors as they write the pretest. The scripts with the errors were evidenced by the written response shown on figure 4.2.6.

Figure 4.2.6 showing "sign error" or "incorrect handling of negative signs" done by the learner in solving linear inequalities.

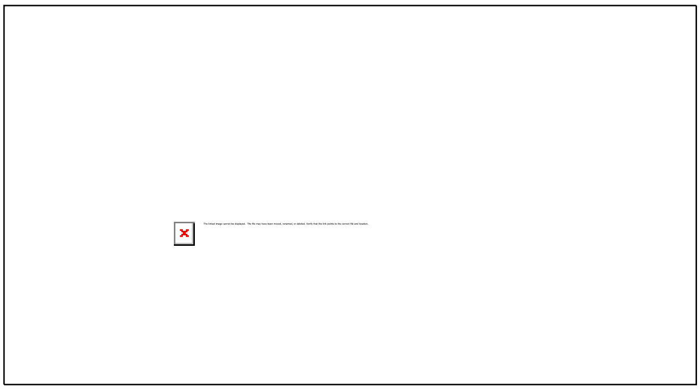


Figure 4.2.6: Learner A written response for sign error

The error shown on the written response above is called "sign error" or "incorrect handling of negative signs". The original inequality is $x \leq 5x + 2$. To solve for x, the child subtracted 3x from both sides, resulting in $-4x \leq 2$. Then, dividing both sides by -2 would require reversing the inequality sign, resulting in $x \geq -1/2$.However, the child incorrectly wrote $x \leq -1/2$, which is the opposite of the correct solution. This type of error can occur due to a misunderstanding of how to handle negative signs when solving inequalities, and can lead to incorrect solutions and misunderstandings of the inequality concept.

When writing the test, students also encounter difficulties due to various misunderstandings. Two prevalent errors are "misinterpretation of the problem" and "failure to understand the context of the inequality". These errors can lead to incorrect solutions and misconceptions about the nature of inequalities. Figure 4.2.7 illustrates these errors when learners were solving a problem that reads; a butchery sells a total of 250kgs of meat per day. They sell a combination of beef and pork. If they sell at least 30kgs of pork more than beef kg sold, write an inequality to represent the situation. The learner solution is given on the fig below

Figure 4.2.7 showing error of "misinterpretation of the problem" or "failure to understand the context of the inequality".

Figure 4.2.7 written response by Learner B. misinterpretation of the problem

The figure above shows an error called "misinterpretation of the problem" or "failure to understand the context of the inequality”. The child's solution, $250 < x < 30$, doesn't make sense in the context of the problem. The bakery sells a total of 250kgs per day, so the number of loaves can't be greater than 250. A correct inequality to represent the situation would be, let x be the number of pork kgs, then the number of pork kg would be $x + 30$ or more, and the total number of kgs would be $x + (x + 30) \leq 250$. The child's solution, $250 < x < 30$, demonstrates a lack of understanding of the problem and the correct way to represent the situation with an inequality.

Students also stumble upon frequent mistake like "incorrect simplification" or "arithmetic error". Such error can lead to wrong solutions and misunderstandings of the inequality principles. Figure 4.2.8 demonstrates this common error, pinpointing where learners typically go astray, to better guide their problem-solving accuracy.

Figure 4.2.8 showing error of "incorrect simplification" or "arithmetic error" done by the learner in solving linear inequalities.

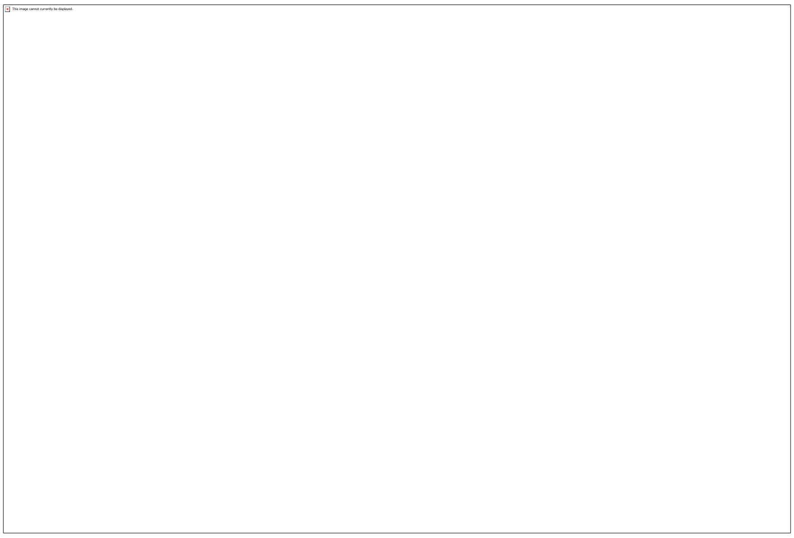
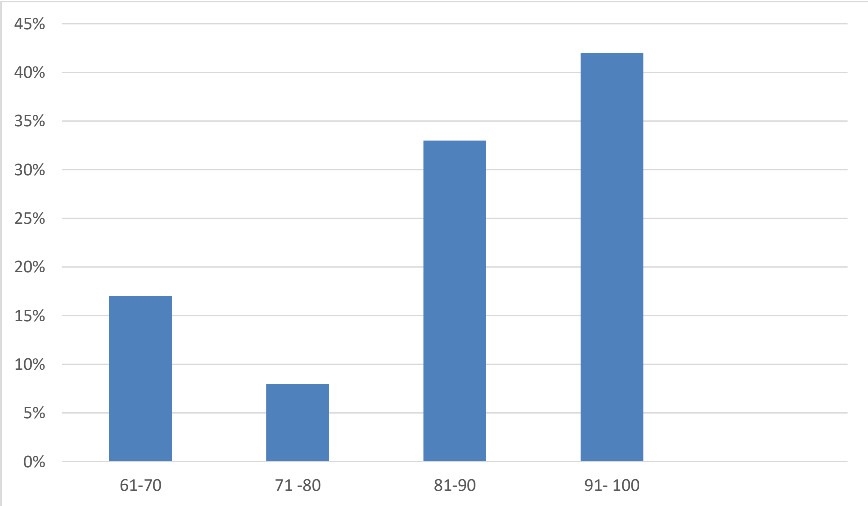


FIGURE 4.2.8: Written response by learner C. Arithmetic error

The picture above shows an error called "incorrect simplification" or "arithmetic error”. The child's mistake occurred when they divided the terms on both sides of the inequality. To solve the inequality $5x - 3 < 2x + 1$, the child should have first added 3 to both sides to get $5x < 2x + 4$, and then subtracted 2x from both sides to get $3x < 4$.Finally, to solve for x, the child should have divided both sides by 3, resulting in $x < 4/3$. However, the child incorrectly divided 3x by 3 on the LHS and 4 by 3 on the RHS, which led to an incorrect solution of $x < 1.5$ instead of $x < 1$ and 1/3 (or 4/3).This type of error can occur due to careless arithmetic or a lack of attention to detail, and can lead to incorrect solutions and misunderstandings of the inequality concept

4.2.8 RESULTS OBTAINED THROUGH POST-TEST

Figure 4.2.9 the graph below shows results obtained from the post-test



The graph presents the results obtained from the post-test, showing the mark obtained in percentage. The data reveals that 42% of the respondents scored between 91-100%, 33% of the respondents scored between 81-90%, 17% of the respondents scored between 61-70% and 8% of the respondents scored between 71-80%. The results presented suggest that the majority of respondents (42%) scored between 91-100%. This suggests that the respondents may have a high level of understanding of solving of linear inequalities. According to Tufte (2001), "bar graphs are useful for comparing the magnitudes of different categories, such as the post-test scores". The bar graph will provide a clear and concise visual representation of the data, allowing readers to easily compare the proportions of respondents in each score category.

In the post test, one of the errors manifested by the learners was "incorrectly splitting the inequality" as shown in Figure 4.2.10 below when asked to solve the inequality:

$2x + 5 < 3x - 2$.

Figure 4.2.10 showing error of splitting the inequality incorrectly done by the learner

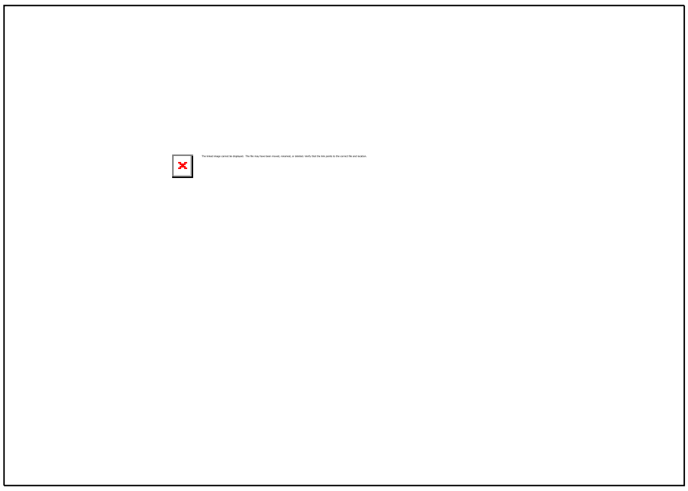


Figure 4.2.10 : Written response by learner D splitting the inequality incorrectly

The error in solving the linear inequality shown on the written response above is called "incomplete or partial analysis" or "splitting the inequality incorrectly”. When solving linear inequalities, it's essential to consider the entire inequality as a single unit, rather than breaking it down into separate parts. In this case, the child has incorrectly split the inequality into two separate parts:

1. $2x + 5 < 3x$ 2. $5 < 3x - 2$

This approach can lead to incorrect solutions, as the child is not considering the relationship between the two parts of the inequality. To solve the inequality correctly, the child should perform algebraic operations on both sides of the inequality, while keeping the inequality intact.

Another type of error revealed by the students was ‘incorrect use of the inequality sign’ as illustrated on Figure 4.2.11 below in trying to solve the inequality: $3x - 2 \leq 7$

Figure 4.2.11 showing error of incorrect use of the inequality sign done by the learner

Figure 4.2.11: Written response by learner E incorrect use of equal sign

This error is called "replacement of inequality sign with an equal sign" or "incorrect use of equality sign”. In an inequality, the inequality sign ($\leq$, $\geq$, $<$, or $>$) is used to indicate the relationship between two expressions. Replacing the inequality sign with an equal sign (=) changes the meaning of the statement and can lead to incorrect solutions.

For example, if the original inequality is $3x - 2 \leq 7$, writing $4x - 2 = 7$ is incorrect, as it implies that the two expressions are equal, rather than one being less than or equal to the other. This type of error can occur due to careless writing or a lack of understanding of the difference between equality and inequality.

Another error revealed by the learners was on, "failing to reverse the inequality sign" when necessary as shown on Figure 4.2.12 below when required to solve the inequality:

$2x + 5 < 3x - 2$

Figure 4.2.12 showing error of failing to reverse the inequality sign done by a learner

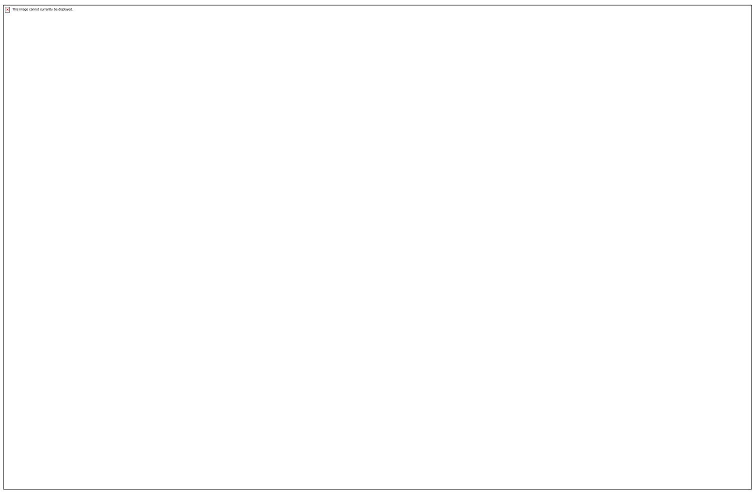


Figure 4.2.12: Written response by Learner E fail to reverse the inequality sign

The error in the child's solution is called "sign error" or "incorrect handling of negative signs" or “failure to reverse the inequality sign”. When multiplying or dividing both sides of an inequality by a negative number, the direction of the inequality sign must be reversed. To solve for x, the child should have divided both sides by -1, which would require reversing the inequality sign. The correct solution is $x > 7$.

The learners also showed an error on "incorrect application of inverse operations" as illustrated on Figure 4.2.13 below when asked to solve the inequality: $2x + 5 < 3x - 2$

Figure 4.2.13 showing error of incorrect application of inverse operations done by the learner

Figure 4.2.13: Written response by learner F incorrect application of inverse operation

This error is called "inconsistent operation" or "incorrect application of inverse operations”. When solving an equation or inequality, it's essential to perform the same operation on both sides to maintain the balance. In this case, the child should have subtracted 5 from both sides, but instead, the child subtracted 5 from the left-hand side and added 5 to the right-hand side. This type of error can lead to incorrect solutions and demonstrates a lack of understanding of the concept of inverse operations and the importance of maintaining the balance in equations and inequalities.

Another error encountered by learners was "failing to understand the context of the inequality". Figure 4.2.14 below illustrates this error in solving a word problem which reads, Proud has $90 to spend on a new cell phone. The cellphone costs x dollars and he wants to buy a box file that cost $12. Write an inequality to represent the situation and solve for x.

Figure 4.2.14 showing error of failing to understand the context of the inequality done by the learner

Figure 4.2.14: Written response by learner G fail to understand the context of the inequality

This error is called "misinterpretation of the problem" or "failure to understand the context of the inequality”. When solving inequality problems, it's essential to understand the context and interpret the problem correctly. If the child fails to do so, may set up the inequality incorrectly or solve for the wrong variable. This type of error can occur due to a lack of reading comprehension, failure to understand the mathematical concept, or inability to translate the word problem into a mathematical equation or inequality. In the case of number story questions on inequalities, the child needs to carefully read and understand the problem, identify the key elements, and set up the inequality correctly to solve for the unknown variable.

4.2.9 ERRORS DONE BY LEARNERS WHEN SOLVING LINEAR INEQUALITIES

4.2.9.1 Insights from educators

Educators have identified a range of errors and misconceptions that learners exhibit when solving linear inequalities. Their responses provide valuable insights into the challenges learners face and the areas where they need additional support.

According to Educator 1

Learners often struggle with reversing the direction of the inequality sign when multiplying or dividing both sides of the inequality by a negative number. For instance, when solving the inequality $-3x > 6$, learners may forget to reverse the inequality sign, resulting in an incorrect solution.

Educator 1also noted that learners often fail to consider the endpoint of the inequality. For example, when solving the inequality $3x > 6$, learners may forget to include the endpoint and they put an equal sign, thus obtaining $x = 2$, leading to an incomplete solution.

Educator 2

Educator 2 highlighted that learners often confuse the concepts of equality and inequality. For instance, when solving the inequality $x + 1 > 5$, learners may mistakenly subtract 1 from both sides and conclude that $x = 4$, without considering the direction of the inequality sign.

Educator 2 also emphasized that learners often fail to consider the context of the problem when solving linear inequalities. For example, when solving a linear inequality in the context of a real-world problem, learners may forget to consider the constraints of the problem, leading to an unrealistic or invalid solution.

4.2.9.2 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 A mentioned, "Sometimes I forget to reverse the inequality sign when multiplying or dividing both sides by a negative number."

Learner B stated, "I get confused between the greater than and less than symbols. I have to double-check my work to make sure I'm using the correct symbol."

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

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

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

Learner J mentioned, "I often get confused about the difference between 'or' and 'and' inequalities. I need to review the definitions of these types of inequalities."

Learner K stated, "I sometimes make mistakes when solving linear inequalities because I don't read the problem carefully. I need to practice reading problems more carefully."

Learner L 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."

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) say "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." (p. 239). National Council of Teachers of Mathematics (2014) states that "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." (p. 128).Carpenter, Franke, & Levi (2003) state 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 use incorrect notation, such as using the wrong symbol or notation for the inequality." (p. 239)

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) say that "Students may fail to simplify their solutions, which can lead to unnecessary complexity... This error can be attributed to a lack of understanding of the underlying algebraic concepts." (p. 240). National Council of Teachers of Mathematics (2014) outlines that "Students may struggle to simplify their solutions, which can result in unnecessary complexity... Teachers should provide opportunities for students to practice simplifying solutions and emphasize the importance of simplicity." (p. 129). Johnson (2017) says that "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." (p. 442)

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) stated that "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." (p. 240). National Council of Teachers of Mathematics (2014) said that "Students may struggle to connect the mathematical concepts to the context of the problem. Teachers should provide opportunities for students to practice solving linear inequalities in context and emphasize the importance of considering the context of the problem." (p. 129). Tirosh & Graeber (1990) states that "Students' difficulties with linear inequalities are often related to their lack of understanding of the concept of inequality and its application to real-world problems… One common error is to fail to consider the context of the problem, which can lead to incorrect or irrelevant solutions." (p. 129)

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) 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 use incorrect methods, such as using methods for solving linear equations instead of inequalities." (p. 240). Lester (2007) emphasized that "Using incorrect methods are a common error that students make when solving linear inequalities... Teachers should provide opportunities for students to practice solving linear inequalities using correct methods." (p. 150)

Siegler & Lortie-Forgues (2015) outlined 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 use incorrect methods, such as using methods for solving linear equations instead of inequalities." (p. 240)

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) said that "Making errors when solving linear inequalities with variables on both sides is a common mistake that students make... Teachers should provide opportunities for students to practice solving linear inequalities with variables on both sides." (p. 151).Siegler & Lortie-Forgues say that (2015)"Students' errors in solving linear inequalities are often related to their lack of understanding of the underlying algebraic concepts... One common error is to make mistakes when solving linear inequalities with variables on both sides." (p. 241)

According to Mayer (1985), "Solving linear inequalities with variables on both sides requires careful attention to detail... Students who make errors in this process may arrive at incorrect solutions." (p. 128)

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) state 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 reverse the direction of the inequality sign incorrectly when multiplying or dividing both sides by a negative number." (p. 234).Usiskin (1988) outlined that "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" (p. 145).According to Bell (1995), "Students often have difficulty with linear inequalities, particularly when it comes to reversing the direction of the inequality sign... This error can be addressed by providing students with opportunities to practice solving linear inequalities and by emphasizing the importance of checking solutions." (p. 201)

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) state that "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." (p. 235). National Council of Teachers of Mathematics (2014) outlined that "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." (p. 124). Johnson (2017) states that "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." (p. 437). Tirosh & Graeber (1990) said that "Students' difficulties with linear inequalities are often related to their lack of understanding of the concept of inequality... One common error is to forget to consider the endpoint of the inequality, which can lead to incorrect solutions." (p. 124)

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) 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 treat inequalities as if they were equations, which can lead to incorrect solutions." (p. 124). Lamon (2005) states that "Students may have difficulty distinguishing between equations and inequalities, which can lead to errors in solving linear inequalities... Teachers should use a variety of strategies to help students understand the differences between equations and inequalities." (p. 123). According to Siegler & Jenkins (1989), "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." (p. 234)

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) outlined that "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." (p. 237). National Council of Teachers of Mathematics (2014) states that "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." (p. 126). Johnson (2017) says that "Making calculation errors is a common mistake that students make when solving linear inequalities... Teachers can help students avoid this error by providing opportunities for students to practice calculations and check their solutions." (p. 439)

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) said 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." (p. 127). Carpenter, Franke, & Levi (2003) outlined 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." (p. 238). Lester (2007) states 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." (p. 148)

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" (p. 239). 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" (p. 150). 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. Siegler and Lortie-Forgues (2015) state that “students' errors in solving linear inequalities are often related to their lack of understanding of the notation and symbolism used in these equations" (p. 240). 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" (p. 123). 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" (p. 145). 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" (p. 123). 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" (p. 156). 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. Sweller (2018) outlined that “learners' working memory and cognitive load can influence their ability to process and understand mathematical information" (p. 189). 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. Black and Wiliam (2017) state that “inadequate assessment and evaluation methods can lead to learners developing misconceptions and errors in mathematical concepts" (p. 167). 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. Kilpatrick, Swafford and Findell (2014) outlined that “using real-world examples can help learners see the relevance and importance of linear inequalities" (p. 241). 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. 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, 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. Hernandez and González (2022) outlined that “technology can provide learners with interactive and engaging ways to explore linear inequalities" (p. 147). 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 understands linear inequalities. Johnson and Johnson (2017) 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.

The use of formative assessments is also an effective teaching strategy for helping secondary school learners understand linear inequalities. Black and Wiliam (2017) said that "formative assessments can help educators identify learners' misconceptions and errors and provide targeted support and feedback" (p.169). 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 understands linear inequalities. According to Tomlinson (2014), "differentiated instruction can help educators tailor their teaching to meet the diverse needs of their learners" (p.123). 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" (p. 145). 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" (p. 156). 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" (p. 167). 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" (p. 123). 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" (p. 156).

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" (p. 145). 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" (p. 167).

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" (p. 241). 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" (p. 242).

The findings also indicate that learners often get confused between linear inequalities and linear equations. This is consistent with the findings of Knuth (2017), who noted that "learners often struggle to distinguish between linear inequalities and linear equations" (p. 156). 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" (p. 145).

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" (p. 167). 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" (p. 241).

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" (p. 242). To address this challenge, educators can provide learners with additional practice and support, as noted by Drijvers (2018), who suggested that "learners need opportunities to practice solving linear inequalities with absolute value expressions in a variety of contexts" (p. 145).

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

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter serves as a comprehensive culmination of the research endeavour, providing a succinct summary of the research background, methodology, findings and conclusions. This study employed a mixed-methods approach, utilized interviews, questionnaires, pre-tests, and post-tests to gather data from secondary school learners. The primary objective of this research was to identify and examine the mathematical errors and misconceptions that learners exhibit when solving linear inequalities, give reasons on why secondary school learners struggle to solve linear inequalities and identify teaching strategies or methods that are most effective in helping secondary school learners understand linear inequalities.

5.2 SUMMARY OF THE STUDY

This research investigation focused on examining the errors and misconceptions exhibited by secondary school learners in solving linear inequalities. The study comprised five chapters, each contributing to the overall understanding of the research problem.

The inaugural chapter provided an overview of the research background, highlighting the motivation behind the study. The chapter delineated the research purpose, objectives, problems, assumptions, limitations, and delimitation. Furthermore, the chapter defined key terms and provided a summary of the research design.

Chapter 2 undertook a comprehensive review of existing literature pertinent to the study. The researcher examined the theories and empirical studies conducted by other scholars to gain a deeper understanding of the errors and misconceptions learners exhibit when solving linear inequalities. The chapter also presented research questions that guided the literature review.

Chapter 3 outlined the research methodology employed in the study. The chapter discussed the qualitative research approach, research design, population, sampling strategy, data collection instruments, and methods used to collect data. The chapter also described the interview protocol used to gather data from participants.

Chapter 4 presented the findings of the study, which were derived from the data collected through interviews, questionnaires, pretest, and post-tests. The data were presented in tables, graphs, and pie charts, and were interpreted based on the responses provided by the participants and observations made. The chapter also analyzed the data to identify patterns, trends, and relationships.

5.3 CONCLUSION

This study investigated the errors and misconceptions exhibited by learners when solving linear inequalities. The findings of the study revealed that learners made various errors and exhibited misconceptions when solving linear inequalities. These errors and misconceptions were attributed to a range of factors, including a lack of understanding of the underlying algebraic concepts, failure to consider the context of the problem, notation and symbolism confusion, prior knowledge and experiences, teaching methods and materials, lack of practice and feedback, mathematical anxiety and fear, cognitive load and working memory, and inadequate assessment and evaluation methods.

The study found that the most common errors made by learners when solving linear inequalities included reversing the direction of the inequality sign, failing to consider the endpoint of the inequality, making calculation errors, failing to consider the direction of the inequality, and confusing the concepts of equality and inequality. 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 and had experience solving linear equations were more likely to succeed in solving linear inequalities. On the other hand, learners who lacked a strong foundation in algebraic concepts and had limited experience solving linear equations struggled to solve linear inequalities. 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.

5.4 RECOMMENDATIONS

5.4.1 RECOMMENDATIONS FOR TEACHERS

Based on the findings of the study, here are some recommendations for teachers to help learners overcome errors and misconceptions when solving linear inequalities:

5.4.1.1 Emphasize Understanding of Underlying Algebraic Concepts

Provide opportunities for learners to develop a deep understanding of the underlying algebraic concepts, such as the concept of inequality and the rules for manipulating inequalities. Use a variety of teaching methods, including visual aids, real-world examples, and hands-on activities, to help learners understand these concepts.

5.4.1.2Provide Opportunities for Practice and Feedback

Provide learners with ample opportunities to practice solving linear inequalities, including those with variables on both sides and those that require simplification. Offer regular feedback on learners' work, highlighting common errors and misconceptions and providing guidance on how to improve.

5.4.1.3 Use Real-World Examples and Contexts

Use real-world examples and contexts to illustrate the relevance and importance of linear inequalities. Encourage learners to apply mathematical concepts to solve problems in a variety of contexts.

5.4.1.4Address Notation and Symbolism Confusion

Provide explicit instruction on the notation and symbolism used in linear inequalities, including the use of inequality signs and the rules for manipulating inequalities. Offer opportunities for learners to practice using correct notation and symbolism.

5.4.1.5 Foster a Growth Mind-set and Reduce Mathematical Anxiety

Encourage learners to view challenges and mistakes as opportunities for growth and learning. Provide a supportive and inclusive learning environment that reduces mathematical anxiety and fosters a love of learning.\5.4.1.6 Use Technology and Digital Tools

Utilize digital tools and technology, such as graphing calculators and online math software, to provide learners with interactive and engaging learning experiences. Encourage learners to use technology to explore and visualize linear inequalities.

5.4.1.7 Differentiate Instruction and Assessment

Provide differentiated instruction and assessment to meet the diverse needs of learners. Offer multiple forms of assessment, including formative, assumptive, and self-assessment, to provide learners with opportunities to demonstrate their understanding.

5.4.1.8 Provide Opportunities for Reflection and Self-Assessment

Encourage learners to reflect on their own learning and identify areas for improvement. Provide opportunities for learners to self-assess their understanding of linear inequalities and adjust their learning strategies accordingly.

5.4.1.9 Use Formative Assessment to Inform Instruction

Use formative assessment strategies, such as quizzes, class discussions, and observations, to inform instruction and adjust teaching strategies. Provide learners with feedback on their progress and understanding, and use this feedback to inform instruction.

5.4.1.10 Encourage Collaboration and Communication

Encourage learners to work collaboratively on tasks and projects, and to communicate their thinking and solutions to others. Provide opportunities for learners to share their understanding and solutions with the class, and to receive feedback from peers.

By implementing these recommendations, teachers can help learners overcome errors and misconceptions when solving linear inequalities and develop a deeper understanding of these important mathematical concepts.

5.4.2 RECOMMENDATIONS FOR LEARNERS

The following are some recommendations for learners to overcome common errors when solving linear inequalities:

5.4.2.1Read the problem carefully

Take your time to read the problem and understand what is being asked. Pay attention to the direction of the inequality sign and the endpoint of the inequality.

5.4.2.2 Check your notation and symbolism

Make sure you are using the correct notation and symbolism when solving linear inequalities. Pay attention to the use of inequality signs, parentheses, and other mathematical symbols.

5.4.2.3. Simplify your solutions

Always simplify your solutions to linear inequalities. This will help you avoid unnecessary complexity and ensure that your solutions are accurate.

5.4.2.4. Consider the context of the problem

When solving linear inequalities, consider the context of the problem. Think about the real-world application of the inequality and how it relates to the problem.

5.4.2.5. Practice, practice, practice

Practice is very essential when it comes to solving linear inequalities. The more you practice, the more confident you will become in your ability to solve these types of problems.

5.4.2.6. Check your work

Always check your work when solving linear inequalities. Go back and re-read the problem, and make sure your solution is accurate.

5.4.2.7 Don't be afraid to ask for help

If you're struggling with linear inequalities, don't be afraid to ask for help. Reach out to your teacher, tutor, or classmate for support.

5.4.2.8 Use visual aids

Visual aids such as graphs, charts, and diagrams can help you understand and solve linear inequalities. Use these tools to help you visualize the problem and find the solution.

5.4.2.9 Break down the problem

Break down the problem into smaller, more manageable parts. This will help you understand the problem better and make it easier to solve.

5.4.2.10 Stay organized

Stay organized and keep track of your work. Use a notebook or binder to keep your notes and work organized, and make sure you label your work clearly.

By following these recommendations, learners can overcome common errors and develop a deeper understanding of linear inequalities.

5.5.1 Implications for Assessment and Evaluation

5.5.1.1 Use Formative and Assumptive Assessments

Teachers should use both formative and assumptive assessments to evaluate learners' understanding of linear inequalities.

5.5.1.2 Provide Feedback on Errors and Misconceptions

Teachers should provide feedback on errors and misconceptions, highlighting common mistakes and areas where learners need additional support.

5.5.1.3 Use Technology to Support Assessment and Evaluation

Teachers should use technology to support assessment and evaluation, such as online quizzes and games.

5.5.1.4 Involve Learners in the Assessment Process

Teachers should involve learners in the assessment process, encouraging them to reflect on their learning and identify areas where they need additional support.

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APPENDIX I

TEACHER QUESTIONNAIRE

TOPIC: ERRORS AND MISCONCEPTIONS IN SOLVING LINEAR INEQUALITIES.

SECTION 1: DEMOGRAPHICS (TICK)

Gender: Male ☐ Female ☐

Age

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

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

Level taught: --

Education level: --

SECTION 2 (TICK)

How often do you teach linear inequalities in your mathematics?

Daily ☐ Weekly ☐ Monthly ☐ Termly ☐

2. Which 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) Do you often encounter these errors in your teaching?

Rarely ☐ b) occasionally ☐ c) almost always ☐ d) not sure ☐

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

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

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

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

Additional comments:

Anything else you would like to share about teaching linear inequalities or addressing errors and misconceptions in solving linear inequalities?--
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Thank you for taking the time to complete this questionnaire! Your input is valuable to us.

APPENDIX II

Questionnaire for learners

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

SECTION 1: DEMOGRAPHICS (TICK)

Gender: Male ☐ Female ☐

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 one 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?--
----

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

Do you have any suggestions for how teachers can better support learners in understanding and solving linear inequalities?---
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Thanks for taking the time to complete this questionnaire! Your input is valuable to us.

APPENDIX III

Pretest (35 minutes)

Section A:

Answer all questions in this section.

1. Solve the inequality: $2x + 3 > 11$

2. Which of the following is equivalent to $3x - 2 \leq 6$?

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

4. What is the solution to the inequality: $5x + 5 > 10$?

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: $2x - 4 \leq 6$

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) $2x > 2$ b) $-4x >8$

6. Peter has \$140 to spend on a new shop grocery. The groceries costs x dollars and he want to buy shelf materials that cost \$40. Write an inequality to represent the situation and solve for x.

7. A butchery sells a total of 250 kg of meat per day. They sell a combination of beef and pork. If they sell at least 30 kg of pork more than kg of beef sold, write an inequality to represent the situation.

8. A company offers a 30% discount on orders over $300. If q represents the original price, write an inequality to determine the prices eligible for the discount.

APPENDIX IV

Post-Test (35 minutes)

Section A.

Answer all questions.

1. Solve the inequality: $3x + 2 \leq 7$

2. Which of the following is equivalent to $- 2 > 1$?

3. Solve the inequality: $2x - 7 \geq 3$

4. What is the solution to the inequality: $+ 3 \leq 6$?

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

Section B: Open-Ended Questions.

Answer all questions

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

2. Solve the inequality$4x-6<10$

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) $3x>8$ b) $-3x>21$

6. John has $90 to spend on a new cellphone. The cellphone costs x dollars and he wants to buy a box file that cost $15. Write an inequality to represent the situation and solve for x.

7. A barker sells a total of 200 dozens of bread per day. He sells white and brown bread. If he sells at least 20 more white bread than brown bread, write an inequality to represent the situation.

8. A company offers a 20% discount on orders over $200. If x represents the original price, write an inequality to determine the prices eligible for the discount.

APPENDIX V

Interview scheduled for the teachers

1. Can you briefly describe your teaching experience with linear inequalities?

2. How do you assess students' understanding of linear inequalities in your classroom?

3. Which types of errors or misconceptions do you commonly observe when students solve linear inequalities?

3. How do you diagnose the root causes of these errors or misconceptions?

4. Which strategies do you use to address errors or misconceptions when teaching linear inequalities?

5. How do you stay current with research and best practices in teaching linear inequalities?

APPENDIX VI

Interview scheduled for the students

1. Can you tell me about your experience with linear inequalities in maths class?

2. How confident do you feel when solving linear inequalities?

3. Can you explain what a linear inequality is and how it is different from a linear equation?

3. What do you think are some common mistakes or misconceptions that students make when solving linear inequalities?

4. Which strategies do you use to check your work or ensure that your solution is correct?

5. Have you ever used visual aids, such as graphs or number lines, to help you solve linear inequalities?

6. Which resources or tools do you wish you had to help you better understand linear inequalities?