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AN EXPLORATION OF FORM ONE PUPILS' ERRORS AND MISCONCEPTIONS IN DIRECTED NUMBERS: A CASE OF MUTOKO DISTRICT

BY

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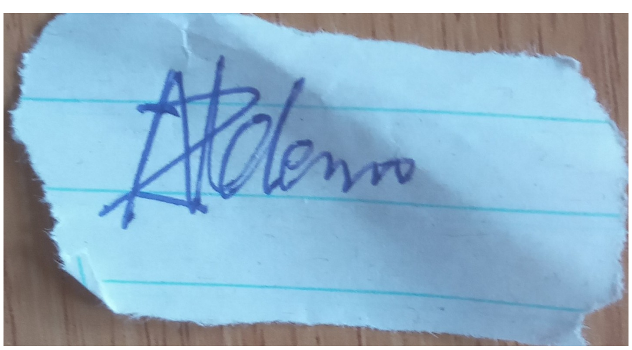

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DEDICATION

This study is dedicated to my caring husband Pasirari Collin who encouraged me through all circumstances to reach beyond the stars. To my daughter Praise, you are the reason I have so much courage to move on when the road gets tough. To Mr Matienga and Mrs Musiyiwa, I am thankful for all the encouragement and support you have given me.

ABREVIATIONS/ACCRONYMS

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Abstract

This study aimed to identify the errors and misconceptions in solving the operation of integers among the form one learners of Chimoyo Secondary School. This study aimed to identify the sources and causes of learners' errors and misconceptions when solving problems involving integer addition, subtraction, multiplication, and division. The study employed a mixed-methods approach, incorporating both quantitative analysis of student test scores and qualitative interviews with teachers. The qualitative phase of the study was designed to identify the errors and misconceptions in solving the operation of integers. The findings concluded that: the common error of the students in solving addition and subtraction of integers is procedural errors, common error in solving multiplication and division of integers is careless error. A common misconception of the respondents in solving addition and subtraction of integers were that learners could not assimilate concepts and had poor knowledge directed numbers, a common misconception in solving multiplication and division of integers was that of signed rules misconception. The following recommendations were made: Teacher should teach the students that when two negatives were right next to each other with nothing except maybe a parenthesis in between, they become positive. – (-) = +. Teachers should have learners' portfolios to help them reflect on the wrong answers they got and for them to figure out where they had made some mistakes and the areas that needed improvements. Teachers need to develop contextualized strategic materials about the operations of integers with application in real-life situations in order to understand more about the operation of integers. Teachers should provide a daily activity on the operations of integers to enhance and develop the skills and knowledge of the students.

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CHAPTER 1

1.0 Chapter Introduction

This chapter focused on background of study, statement of the problem, purpose of the study, research questions, significance of the study, delimitations, limitations and definition of key terms.

1.1 Introduction

This study aimed at investigating the misconceptions and errors made by form one students at Chimoyo Secondary School when simplifying directed numbers. The school is located in Mutoko District in Zimbabwe. According to Juaban, (2022), a directed number is a number that can either be positive or negative, depending on its position on the number line. Negative numbers are to the left of zero, and positive numbers are to the right of zero. Since zero is neither positive nor negative, it is regarded as a neutral number. Directed numbers are signed numbers that can be either positive or negative, according to the researcher. Like any other numbers, they can be multiplied, divided, added, and subtracted for example, $-2-6=-8$, $-8+10=+2$, $(-7)-(-12)=+5$, $-3\times(-4)=12$, $-9\div-3=3$. Directed numbers are essential to many mathematical ideas and practical applications. However, because of frequent errors and misconceptions, a lot of pupils have trouble in manipulating directed numbers accurately and fluently. These difficulties impeded not just their development in numerical operations but also their capacity to use this foundational mathematical idea to solve problems in other academic areas. Booth and Davenport (2020) argued that, one mistake that students frequently make is the "rule of signs" misunderstanding, which holds that the rule "minus times minus is plus" determines the sign of the result when multiplying or dividing directed numbers. This resulted in mistakes such as assuming that $(-3)\times(-5)=-15$ instead of the accurate number of 15. It has been discovered by Lamb (2021) that this misunderstanding endures even after education. The "smaller-larger" misconception is another problem. According to

Wilkins (2020), students who hold this misconception think that a smaller negative number is greater than a larger negative number. For instance, they would think that -3 is more than -7. This results from a lack of knowledge about the relative magnitudes of negative numbers and the number line. In addition, students frequently fail to apply the proper order of operations when evaluating expressions that contain a combination of positive and negative numbers, a problem related to directed numbers. Errors such as interpreting -3 + 4 × (-2) as -14 instead of the correct solution of -10 can arise from this. Schneider and Siegler (2022) pointed that, pupils struggle with directed number comparison and ranking, particularly when the numbers are spaced widely apart on the number line. This pertains to the fallacy known as "smaller-larger" and can result in errors when attempting to solve inequalities with directed numbers. The results of this study would be a useful tool for maths teachers as well as an addition to the body of knowledge regarding pupils' challenges in learning directed numbers. Through the identification of prevalent errors and misconceptions, teachers would possess the necessary knowledge to create and execute focused teaching approaches that cater to the individual requirements of their pupils.

The overall goal of this study was to improve directed numbers teaching and learning methodologies, which would raise students' mathematical competency and set them up for future academic achievement

1.2 Background of Study

As pupils met directed numbers in a formal mathematics environment for the first time, Form One is a crucial transitional stage. To solve difficulties, students must comprehend the fundamental operations on numbers. By ensuring that students possess the necessary abilities, such as a fundamental grasp of numbers, addition and subtraction, and the distinction between positive and negative numbers, teachers could teach the operations theoretically. Smith (2019) indicated that because to the topic's inherent complexity and the way it is usually presented; students frequently acquire misconceptions regarding directed numbers. Wilkins (2020) assert that, students frequently make the mistake of thinking that a smaller negative number is greater than a larger negative number, which is known as the "smaller-is-larger" misunderstanding). The reason for this is that pupils tend to overgeneralize what positive numbers mean, even though a smaller positive number is still less than a larger positive number. The "addition makes bigger, subtraction makes smaller" mistake, according to which pupils think that adding negative numbers always yields a smaller value and subtracting negative numbers always yields a larger value, is another common problem (Booth and Davenport 2020). When in use, this oversimplified rule becomes invalid.

Directed number misconceptions have also been linked to textbook presentations and instructor instruction. Boaler (2022) suggests that students' capacity to reason flexibly about negative numbers may be hampered by an over-reliance on number line models or "rules" in the absence of robust conceptual development. Additionally, educators could unintentionally prioritize procedural fluency over more profound comprehension. According to Akkan (2022), correcting directed number misconceptions necessitates a multifaceted strategy that emphasizes higher-order thinking skills, diverse representations, and deeper conceptual underpinnings Smith and Jones (2018) assert that directed numbers, often known as signed numbers, have long been a source of difficulty and misconceptions for children studying mathematics. Studies have demonstrated that many students struggle to understand the underlying logic and operations of positive and negative numbers, leading to recurring errors in their work. The innate propensity to see negative numbers as "less than" or "smaller than" positive numbers is a significant problem that can cause errors when comparing and sorting directed numbers. Furthermore, the laws governing the addition, subtraction, multiplication, and division of signed numbers frequently clash with pupils' innate tendencies, leading to frequent mistakes.

Lakoff and Nunez (2020) have stressed how critical it is to use focused teaching strategies to dispel these myths. For instance, it has been demonstrated that students' comprehension of directed numbers is enhanced by the use of visual models, tangible manipulatives, and real-world contextual examples. Furthermore, students can be assisted in overcoming their intuitive biases by receiving specific teaching on the characteristics and guidelines governing signed number operation. Jones and Smith (2024) assert that teachers can create more effective teaching techniques to help students' acquisition and mastery of this essential mathematical concept by gaining a grasp of the typical misconceptions and errors around directed numbers.

When they made an improper addition or subtraction of signs, they neglected to adjust the sign. For example, if two negative numbers are accidentally added, the outcome could be positive $(-3) + (-5) = +8$. When multiplying and dividing, some learners made errors and assumptions. When they multiply two negative integers, for instance, they failed to understand the rules and end up with a negative number $(-4) \times (-5) = -20$. Errors and misconceptions on directed numbers are not exclusive to Chimoyo Secondary; rather, they are a global problem. In a 2013 study that was published in the "International Journal of Educational Sciences," Ticharwa Masaya and Jemitias Chivhanga of Zimbabwe talked about the difficulties secondary school pupils in Zimbabwe have in mathematics generally, including misconceptions and errors. They emphasised how important it was for educators to identify and address these problems. In her thesis, "From counting on fingers to understanding numbers: A case study of Form One students in Zimbabwe," Florence Glenda Chareka (2010) investigated the process via which pupils go from learning primary mathematics to secondary mathematics. She observed that a lot of pupils continue basic misconceptions and errors from elementary school, including ideas about directed numbers.

Furthermore, studies conducted in the field of science education by Baroody, particularly in his work "Misconceptions and errors in teaching and learning science" (2024), highlighted the significance of misconceptions in the learning of Mathematics. Sadler lists frequent misconceptions that students have about a variety of science-related subjects and emphasised the value of diagnostic teaching techniques that addressed these misconceptions directly. Having evaluated the patterns of mistakes and misunderstandings in directed numbers over a four-year period, the researcher was inspired to conduct research on the subject.

1.3 Statement of the problem

The idea of directed numbers was derived from the ideas of integers, number lines, and precedence rules. Form One students are moving from primary school mathematics, which emphasised sets of numbers and built number line concepts from sets of natural numbers. Only in Form One are the negative numbers introduced, based on the definition of directed numbers.

According to Gunawan (2021), even after being introduced to the subject, students frequently continue to struggle with comprehending and using the directed numbers principles and operations. These errors and misunderstandings hinder their mathematical development because directed numbers are the basis for more complex subjects like algebra, equations, and graphing. This is a serious obstacle to their comprehension and application of mathematical ideas. Teachers could create focused interventions and instructional techniques to assist students in overcoming these obstacles and enhancing their comprehension of directed numbers by identifying typical mistakes and misconceptions.

1.4 Purpose of the study

An important area of research in mathematics education is the examination of errors and misconceptions in directed numbers among form one learners. A key idea that students need to grasp in order to succeed in higher-level mathematics is directed numbers. Nonetheless, a lot of students have trouble comprehending and using operations with directed numbers, which resulted in recurring mistakes and misunderstandings. This study's main goal was to look into the kinds of mistakes and misunderstandings that form one students made when using directed numbers. The study's specific objectives were to Identify common errors. This means listing the most typical mistakes made by form one students when carrying out addition, subtraction, multiplication, and division operations involving directed numbers.

In addition, the other purpose was to analyse misconceptions. This involved examining the underlying misconceptions, such as a misunderstanding of the guidelines for working with positive and negative numbers, that lead to the errors that have been seen. Thirdly, the purpose was to understand factors Influencing errors. This involved examining the elements such as instructional strategies, past knowledge, and cognitive capacities that might have a role in the emergence of these mistakes and misconceptions. Lastly, it is very important to develop Interventions. This involved creating focused interventions and instructional techniques based on the results to assist form one learners in overcoming their challenges with directed numbers.

1.5 Research Questions

The investigation intended to answer the following research questions:

- What are the errors and misconceptions observed in form one learners' written work in addition, subtraction, multiplication and division of directed numbers?

- Why do form one learners make errors and misconceptions in addition, subtraction, multiplication and division of directed numbers?
- How can these errors and misconceptions observed in form one learners' written work in addition, subtraction, multiplication and division of directed numbers be resolved?

1.6 Significance of study

The researcher thought that multiple groups would gain from this investigation. The discovery of frequent errors and misconceptions helped instructors, curriculum designers, and students of mathematics to create educational resources that specifically addressed these issues. In order to improve student accomplishment and mathematical proficiency, teachers were able to address students' errors and misconceptions in directed numbers by using the recommendations for instructional techniques made by the study. Teachers were also able to modify their teaching strategies to meet the needs of each student by having a deeper understanding of the underlying reasons of errors. Students now comprehend addition, subtraction, multiplication, and division of directed numbers more accurately. This had the unintended consequence of making mathematics seem less complicated and more like a regular topic. Because they would understand the notion of directed numbers, learners could therefore start attempting the subject at the advanced level. This research advanced the larger objective of fostering conceptual comprehension and mathematical fluency in mathematics education by improving our knowledge of the mistakes and misunderstandings made by Form One learners when working with directed numbers.

The researcher's findings were utilised by curriculum designers to guide their choices and raise the general efficacy of instructional initiatives. The curriculum was thoughtfully adjusted by planners to better promote learning outcomes by taking into account the areas in which students are having difficulty. Students had more successful educational experiences as a result, and schools were able to meet their academic objectives. The purpose of this study was to assist students in mastering the concept of directed number simplification. Several ideas in mathematics, including equations, algebraic expressions, indices, vectors, matrices, and several more concepts at the ordinary level, use directed numbers. As a result, students who struggled with the idea of simplifying directed numbers would also struggle greatly with other ideas that are linked to it. Failure to overcome the issue of directed number inaccuracies results in poor grades on their final exam.

1.7 Study Delimitations

The study concentrated on Chimoyo Secondary's form one students, Chatiza and Rukau secondary maths teachers and its conclusions were applied to that specific setting. Form One Syllabus served as the guide for the topic taught. The entire number of form one and the resources available were used to calculate the sample size. The study took place between March and June 2024. The research was conducted using specialised language based on the educational environment.

1.8 Limitations

The study was conducted from March until the end of May 2024, fulfilling the university's requirements. This time was not enough to complete a high-caliber study. To fulfill the deadlines, the researcher employed a restricted set of research tools. To ensure high-quality research was done, the researcher asked the parents and head of the school for permission to work with the students during weekends. Another issue was lack of resources, such as cash to purchase food for the participants and bond paper. In order to purchase the necessary supplies, the researcher planned to go into the broiler production business.

1.9 Definition of key terms

To set ground for assessment in an exploration of form one pupils' errors and misconceptions in directed numbers at Chimoyo secondary school, the researcher presented the working definitions for some of the terms used in this study.

Directed Number

It is a number that can be positive (+) or negative (-), depending on its position on the number line. Positive numbers are located to the right of zero, while negative numbers are located to the left.

Error

Refers to a mistake or inaccuracy that occurs during the process of performing mathematical operations, calculations or logical reasoning.

Misconception

It is a misunderstanding or a misinterpretation of a concept, fact, or information that is not based on the actual truth or reality of the situation.

1.10 Summary

Chapter one highlighted the importance of study, background of study, research questions, purpose of study, limitations, delimitations and definition of key terms. Chapter two will discuss the views of other authors in relation to errors and misconceptions made by form one learners in directed numbers.

CHAPTER 2
LITERATURE REVIEW

2.0 Chapter Introduction

Directed numbers is a topic found in Mathematics and is categorised under algebra in the Zimbabwean syllabus. Understanding the errors and misconceptions that Form One learners encounter in directed numbers is crucial for effective mathematics instruction. This literature review synthesizes recent research on this topic, highlighting key findings, prevalent misconceptions, and instructional strategies to address them.

2.1 Theoretical perspective on the learning of directed numbers

In mathematics education research, learning directed numbers which encompass both positive and negative integers have drawn a lot of attention. The embodied cognition framework, as proposed by Lakoff and Nunez (2020), is a prominent theoretical perspective on this subject matter. It posits that mathematical conceptions are derived from physical and perceptual experiences. Scholars have investigated how students' understanding is developed through embodied experiences in the context of directed numbers. Bofferding (2019), for instance, looked into how primary school children' experiences with elevation and temperature can affect how they conceptualize negative numbers. According to the study, pupils who were exposed to negative values in more tangible ways like below-freezing temperatures were more adept at using directed numbers to reason and function.

Lamb (2021) investigated the application of manipulatives and physical number lines in the instruction of directed numbers. According to their findings, using these tangible representations can support students in gaining a deeper comprehension of the characteristics and applications of both positive and negative numbers.

Smith (2021) suggested that the conceptual shift method is another theoretical stance that has been used to explain directed number learning According to this approach, it can be challenging to dispel pupils' instinctive or naive ideas about mathematical concepts. When it comes to directed numbers, students might at first find it difficult to make sense of the abstract idea of negative numbers in relation to their practical experiences with positive amounts (such as money and age).

Bofferding (2019) investigated the application of pedagogical approaches that promote conceptual transformation, include employing cognitive conflict exercises and overtly addressing prevalent misunderstandings. With the aid of these strategies, students should be able to reorganize their prior knowledge and get a stronger, more cohesive grasp of directed numbers.

Apart from these theoretical viewpoints, scholars have also examined the part linguistic and cultural elements play in the acquisition of directed numbers. For instance, Pimm (2019) looked at how students' conceptual understanding may be impacted by how negative numbers are linguistically represented in various languages (e.g., "negative five" vs. "minus five"). Theoretical viewpoints on directed number learning generally emphasize how crucial it is to take into account the cognitive, embodied, and cultural elements that influence students' mathematical comprehension. Educators can create more effective teaching strategies to assist students in mastering this basic mathematical topic by utilizing these frameworks.

2.2 Role of cognitive development and mental models in understanding the concepts of negative numbers

A fundamental idea in mathematics, negative numbers have applications in computer science, physics, and finance, among other subjects. Nonetheless, Lamb (2020) asserts that many pupils have traditionally struggled to comprehend negative numbers. The development of mental models and cognitive abilities are essential for learning and using this concept.

Negative Numbers and Cognitive Development

According to Piaget's theory of cognitive development, children develop cognitively in stages, and the formal operational stage is closely associated with the ability to recognize negative numbers (Peková and Hejnþ, 2022). People go through this phase where they learn to think abstractly and use logic to solve problems with negative numbers.

Negative Numbers and Mental Models

According to Bofferding (2019) people's comprehension and problem-solving skills can be greatly impacted by the mental models they create of negative numbers Numerous mental models, such as the number line, thermometer, and debt-asset model, have been found by researchers to be used by pupils to represent negative numbers. Doerr and Kurz, (2023) added that depending on the person's cognitive development and the difficulty of the job at hand, these mental models can be helpful in helping people understand negative numbers.

Negative Numbers and Cognitive Techniques

Shavelson (2020) indicate that the implementation of cognitive methods, like conceptual metaphors and analogical reasoning, might improve students' comprehension of negative numbers. These instructional tactics aid in the formation of a more comprehensive understanding by enabling students to draw links between the new notion of negative numbers and their prior knowledge. In summary, the creation of mental models and cognitive development are key components in the complicated process of comprehending negative numbers. When developing instructional strategies and interventions to promote students' understanding of this crucial mathematical subject, educators and researchers should take these considerations into account.

2.3 Conceptual Framework

A conceptual framework is described by Kumar & Phrommathed (2024) as a theoretical structure that offers a basis for comprehending a specific topic or subject matter. It provided a framework for study, analysis, and decision-making by defining the important ideas, variables, and connections among them. According to the researcher, a conceptual framework is an analytical instrument that is used to systematically organize ideas and direct study. It is employed in research to give an understanding and investigation of a certain event or issue a theoretical basis and framework. It acts as a road map for researchers as they develop their methodology, formulate their research questions, and analyze their results.

All things considered, a conceptual framework is employed in research to offer direction, theoretical support, and organization. It supports researchers successfully plan a study, develop research questions, create methods, analyze their findings, and present their findings.

Source of error	**Error**	**Conceptual understanding**
Teachers	Procedural Overemphasing on rules without understanding. For example teaching rules such as two negative numbers gives positive.	Students can perform operations but do not understand underlying mathematical concepts.
Learners	Operational Mistakes in applying rules for addition, subtraction, multiplication and division. For example, thinking that multiplying two negative numbers result to positive	Incorrect answers due to wrong rule.
Textbooks	Typographical and calculation Mistakes in sample calculations, and typos in formulas can mislead learners	Reinforce incorrect practices among learners

2.4 The Influence of language and cultural factors

Research on mathematics education has shown interest in the understanding and representation of directed numbers, such as positive and negative integers. Many research. Latif (2021) examined the ways in which linguistic and cultural variables can influence students' comprehension and manipulation of directed numbers.

Language-Related Elements

Studies have indicated that the way directed numbers are conceived and portrayed can be influenced by the linguistic structure of a language. For instance, Baroody (2024) discovered that, in contrast to languages that employ a single linguistic cue, like the "-" symbol in English, languages that use several linguistic cues for positive and negative numbers, like "más" (more) and "menos" (less), can result in unique cognitive models. Bofferding (2019) also emphasized how students' mental representations of directed numbers might be influenced by the directional vocabulary employed in some languages, such as "up" and "down" for positive and negative numbers.

Cultural Factors

There is evidence of cultural influences on how directed numbers are interpreted. In contrast to cultures where the number line is presented with positive numbers on the left and negative numbers on the right, Wilkins (2020) examined how the cultural context of Luxembourg, where the number line is typically presented with positive numbers on the right and negative numbers on the left, can result in different interpretations of directed numbers. The way that directed numbers are represented spatially varies among cultures, and this can have an effect on how well pupils comprehend concepts and approach problems.

According to the research review, directed numbers are interpreted and represented differently depending on linguistic and cultural context. When creating and implementing instructional strategies to improve students' conceptual comprehension of directed numbers, educators and researchers should take these elements into account.

2.5 The Impact of Instructional Approaches and Teaching Methods

One of the core ideas in mathematics education is the concept of directed numbers, which are often referred to as positive and negative numbers. Numerous investigations have examined the effects of various educational strategies and techniques on students' comprehension and proficiency with directed numbers.

According to Smith (2020), students' abilities to compare, order, and carry out operations with directed numbers were much enhanced by the use of concrete manipulatives such number lines and number chips. The researchers hypothesized that students' more intuitive grasp of the magnitude and relationships between positive and negative numbers was facilitated by the hands-on, visual character of these educational modalities.

In a similar vein, Lakoff and Nunez (2020) examined the efficacy of a technology-based teaching strategy in which students investigated directed numbers through interactive simulations and virtual manipulatives. The findings demonstrated that, in contrast to conventional lecture-based training, this strategy increased student involvement and enhanced conceptual understanding.

Pimm (2019), in contrast, investigated the effects of instructional strategies that prioritized procedural fluency above conceptual comprehension. According to the results, students could execute computational tasks with directed numbers, but they frequently had trouble applying what they had learned to solve problems and deal with real-world scenarios.

More recently, a study conducted by Baroody (2024) examined the application of a mixed-methods approach that combined problem-based learning, collaborative learning, and direct instruction. The outcomes demonstrated that the most notable enhancements in students' general comprehension and utilization of directed numbers were achieved through the implementation of this multifaceted strategy.

Lamb (2021) emphasizes how crucial it is to teach directed numbers while taking into account the harmony between conceptual and procedural knowledge as well as the incorporation of different instructional strategies. Teachers can help students understand and solve problems more successfully if they take a holistic approach to directed numbers, addressing both the conceptual and computational components of the subject.

2.6 Existing Research on Common Errors and Misconceptions in Directed Numbers

Numerous recurring mistakes and misunderstandings that students have when dealing with directed numbers have been found through research. Bofferding (2019) asserts that, the "rules of signs" fallacy is one frequent problem, when students misapply rules such as "a negative times a negative is a positive" without fully comprehending the underlying principles. When doing procedures involving negative values, this may result in errors.

Additionally, especially when working with negative values, students frequently struggle with ordering and comparing directed numbers. They can mistakenly think that negative numbers are always less than positive numbers or that a smaller negative number is always greater than a larger negative number. Schmidt (2022) recorded conceptual errors regarding the nature of zero and its function in directed number operations Pupils could have trouble realizing that zero is neither positive nor negative, or they might not comprehend what happens when they add or subtract zero from a directed number.

Akkan (2022) indicates that only using conventional teaching techniques to address these mistakes and misunderstandings may not be a simple solution. The use of visual models, various representations, and focused interventions that address the underlying conceptual challenges are some effective ways for resolving these issues.

2.7 Difficulties in Comparing and Ordering Directed Numbers

The difficulty of organizing and comparing directed numbers is one of the main obstacles when working with them. Jones (2021) asserts that, since the principles for ranking directed numbers are different from those for ordering natural numbers, many learners may find it paradoxical to compare and arrange directed numbers, such as positive and negative integers.

According to a Miller (2020), children frequently have trouble sorting directed numbers into the right order, especially when the numbers contain a mixture of positive and negative values. The researchers ascribed this challenge to students' propensity to ignore directionality and instead depend on the absolute values of the numbers.

Similar to this, Zhao (2022) found that when students are asked to compare directed numbers, they often get it wrong and conclude, for example, that a negative number is greater than a positive number. The issue can be attributed to a conceptual deficiency in comprehending the meaning and characteristics of directed numbers.

Johnson (2023) recommended using concrete models and visual representations to help students get a deeper knowledge of directed numbers and the rules for ordering and comparing them in order to solve these challenge. For instance, it has been demonstrated by Zhao (2022) that the usage of number lines can help pupils with their capacity to sort directed numbers.

Overall, the research emphasizes how difficult it is for students to compare and arrange directed numbers, and how crucial it is to use instructional strategies that can support students in gaining a deeper conceptual grasp of this basic mathematical idea.

2.8 Challenges in Performing Arithmetic Operations with Directed Numbers

Directed numbers can be positive, negative, or zero. They are sometimes referred to as signed numbers or integers. The positive and negative signs (+/-) are widely used to denote them in order to indicate the direction or magnitude of the number. For students and learners, carrying out directed number arithmetic operations including addition, subtraction, multiplication, and division can provide a variety of difficulties.

Addition and Subtraction Difficulties

Smith (2019) pointed out that, one of the main obstacles while working with directed numbers in addition and subtraction is understanding the "sign rule." When adding or subtracting numbers with different signs, students frequently find it difficult to recall and use the proper sign rule. Johnson (2023) added that when two numbers have the same sign, for instance, the rule for adding them is to add the absolute values and maintain the sign; nevertheless, when two numbers have different signs, the rule is to subtract the absolute values and maintain the sign of the number with the bigger absolute value Visualizing the meaning of the operation is another obstacle, particularly when working with negative numbers. Boaler (2022) pointed out that when working with directed numbers, students could struggle to understand the concept of subtracting a larger negative number from a smaller negative number or the connection between addition and subtraction.

Difficulties with Division and Multiplication

Dividing and multiplying directed numbers can pose special difficulties. According to Jones (2021), students may find it difficult to recall the sign rules for multiplication and division, which indicate that the product or quotient of two numbers with the same sign is positive and the product or quotient of two numbers with diverse signs is negative.

Furthermore, Boaler (2022) asserts that, particularly when working with larger or more complex expressions involving numerous operations, students may find it challenging to comprehend and apply these sign rules.

Directed numbers are fundamental concepts in mathematics that have applications in fields like physics and finance. Bofferding (2019) defines directed numbers as often referred to as signed numbers or integers. But for many pupils, carrying out mathematical operations involving directed numbers, such addition, subtraction, multiplication, and division, can be difficult. The cognitive and pedagogical elements that contribute to these difficulties are examined in this review of the literature.

Conceptual Knowledge of Oriented Sequences

Dougherty (2019) postulated that, when dealing with directed numbers, students encounter a number of misconceptions and challenges that have been discovered by researchers. These include the inability to comprehend the idea of negative numbers, the challenge of appreciating the significance of the sign in mathematical operations, and the incapacity to comprehend the relative scale of directed numbers.

Cognitive Aspects in Arithmetic with Directed Numbers

According to Ely (2020), performing arithmetic operations with directed numbers involves complicated cognitive processes that necessitate the integration of several mental models and methods. Prior knowledge, working memory capacity, and developmental stage all affect students' ability to meet these cognitive demands.

Methods of Teaching Directed Number Arithmetic

Doerr and Kurz (2023) looked into a variety of teaching techniques, including the use of conceptual metaphors, tangible models, and visual representations, to help students understand directed number arithmetic. However, Baroody (2024) asserts that the alignment of the teaching strategy with the mental processes involved in directed number arithmetic determines how effective these approaches will be.

Difficulties with Implementation in the Classroom

According to Dougherty (2019), putting into practice efficient teaching techniques for directed number arithmetic in the classroom might be difficult. The use of these techniques and the growth of a thorough understanding of directed number arithmetic might be hampered by elements like big class numbers, a diverse student body, and time restraints.

In summary, the complicated ability of performing mathematical operations with directed numbers necessitates the integration of cognitive processes, conceptual understanding, and efficient teaching methodologies. In order to assist students' mathematical development and their capacity to use directed number arithmetic in a variety of settings, it is imperative that the issues in this domain be addressed.

2.9 Misconceptions About Properties of Directed Numbers

According to Smith (2019), a lot of students have trouble correctly grasping the characteristics of directed numbers, such as positive and negative integers. A frequent misunderstanding is that a negative number's absolute value is always less than a positive number's absolute value. As an illustration, certain pupils might think that $|+3| < |-5|$ (Goldstein & Wu, 2019). Actually, regardless of sign, the absolute value function only shows a number's distance from zero on the number line.

Juaban (2022) asserts that, there is also a misperception that directed numbers always have the same sign as their operands when they are added or multiplied. This holds true when multiplying two integers that have the same sign, but not when adding or multiplying numbers that have different signs. For example, some students could mistakenly believe that the sum of $-3 + -2$ must be negative, but in reality, it is -5. Zhao (2022) added that, similar to this, people can assume that since the result is actually $+6$, $-3 \times +2$ must be negative.

According to Zhao and Lee (2022), misconceptions regarding the sequence of operations are also frequently present in directed number operations. For instance, instead of applying the proper sequence of operations, which is multiplication before addition, students can incorrectly evaluate an expression like $-3 + -2 \times +4$ by doing the addition first. This problem can be resolved by carefully ordering the instructions on the sequence of operations. In order to help students, improve their number sense and fluency with algebraic operations, it is crucial to address these and other misconceptions regarding directed number qualities.

2.10 Factors Influencing Learning of Directed Numbers

A key idea in mathematics education is learning directed numbers, which contain both positive and negative integers. The literature has identified a number of elements that may affect students' comprehension and mastery of this subject. The utilization of concrete models and visual representations is one important component. Smith (2020) indicated that the utilization of visual aids, like number lines, can enhance students' conceptual understanding of directed numbers. Furthermore, learning directed number operations can be aided by the use of tangible manipulatives like counters or integer chips.

The way that instruction is Scaffolded and sequenced is another important component. Doerr and Kurz (2023) indicate that improving comprehension can be achieved by introducing directed numbers gradually and systematically, beginning with the familiar idea of positive and negative values. Bofferding (2019) added that, it is also critical to give students plenty of chances to practice and apply their knowledge while receiving supportive feedback. It has also been investigated how misconceptions and past knowledge play a part. Park and Nunes (2019) discovered that pupils frequently had preconceived notions or gut feelings regarding the properties of numbers, which may impede their ability to acquire directed numbers. Students' conceptual understanding can be improved by clearing up these misunderstandings and expanding on their prior knowledge.

Furthermore, research has been done on the use of digital tools and technology to enhance directed number learning. Schmidt (2022) indicated that the utilization of interactive simulations, digital number lines, and educational software might enhance students' performance by facilitating their ability to visualize and manipulate directed numbers. In conclusion, a number of factors, such as the use of concrete models and visual representations, the sequencing and scaffolding of instruction, the correction of prior knowledge and misconceptions, and the integration of technology and digital tools, all have an impact on the learning of directed numbers. Taking these variables into account can improve teaching strategies and provide students a deeper comprehension of this crucial mathematical idea.

2.11 Incorporation of Problem Solving Activities and Real World Application

In mathematics education, the integration of problem-solving exercises and practical applications has been emphasized, especially concerning directed numbers. Smith (2019) underscored the significance of progressing beyond procedural fluency and rote memory to cultivate a more profound conceptual understanding. Using problem-solving exercises to get students to apply their understanding of directed numbers to real-world situations is one strategy that has proven promise.

For instance, Booth and Davenport (2020) looked into the effects of adding problem-solving exercises involving changes in elevation, temperature, and financial transactions. Compared to children who received standard training, they discovered that pupils who participated in these activities showed a greater comprehension of the meaning and application of positive and negative numbers.

Similar to this, Zhao and Li (2022) investigated how directed number problems could be included into a broader project-based learning framework. Students had to take into account both positive and negative values when designing a sustainable community as part of their coursework, which involved group projects to design a community's energy use, transportation, and land use. The approach taken by the researchers resulted in a more comprehensive comprehension by the students about the practical significance of directed numbers. Researchers have emphasized the significance of real-world contexts in the teaching and learning of directed numbers, in addition to problem-solving exercises. According to Shavelson (2020), students were able to understand and use positive and negative values more effectively when they were given directed number problems that were incorporated into real-world scenarios like banking transactions or temperature variations.

The available literature indicates that augmenting students' comprehension and utilization of directed numbers can be achieved through the integration of problem-solving exercises and practical applications. Students can get a richer conceptual understanding of directed numbers, an important mathematical concept, by participating in meaningful problem-solving activities and investigating the practical application of directed numbers.

2.12 Existing Strategies and Interventions for Addressing Errors and Misconceptions in Directed Numbers

Students frequently find it difficult to completely comprehend directed numbers, which comprise both positive and negative integers. According to Wilkins (2020) directed numbers are a fundamental topic in mathematics. Research has shown that students often make mistakes and misconceptions when working with directed numbers. Examples of these include thinking that "a negative times a negative is always negative" or having trouble comparing the magnitude of negative numbers. Radatz (2018) suggested a range of intervention and instructional ways to address these problems. Goldstein and Wu (2019) suggest that one method for assisting students in gaining a more tangible comprehension of directed number operations is the utilization of visual model and representations, like number lines. Research has demonstrated that the use of these visual aids can greatly enhance students' conceptual knowledge and directed numerical problem-solving skills.

Using organized, methodical problem-solving techniques is another successful intervention strategy. A methodical approach to teaching directed number operations was devised by Smith (2019). It featured opportunities for guided practice and feedback, together with clear instruction on addition, subtraction, multiplication, and division rules. Ely (2018) discovered that students who had previously struggled with directed number concepts benefited most from this technique. Researchers have looked at the use of technology-based interventions in treating directed number misunderstandings in addition to these instructional tactics. Research has demonstrated that the use of these visual aids can greatly enhance pupils' conceptual knowledge and directed numerical problem-solving skills. Using organized, methodical problem-solving techniques is another successful intervention strategy. A methodical approach to teaching directed number operations was devised by Bofferding (2019). It featured opportunities for guided practice and feedback, together with clear instruction on addition, subtraction, multiplication, and division rules. It was discovered that students who had previously struggled with directed number concepts benefited most from this technique.

Researchers have looked at the use of technology-based interventions in treating directed number misunderstandings in addition to these instructional tactics. Radatz (2018), for instance, looked into the use of interactive simulations and digital manipulatives, which gave students the opportunity to experiment with various operations and visually examine the behavior of directed numbers. According to their findings, students' conceptual knowledge and problem-solving abilities can be improved by using these technology tools. The body of research emphasizes how critical it is to correct misconceptions about directed numbers using a range of instructional strategies, such as technology-based interventions, structured problem-solving, and the use of visual models. Teachers can assist students in gaining a more solid and adaptable knowledge of directed numbers a crucial skill for success in higher-level mathematics by focusing on these foundational mathematical ideas.

2.13 The complexity of conceptual understanding required in directed numbers.

In mathematics education, the mental grasp of directed numbers, or integers, is an important but difficult subject. Jones (2021) asserts that, positive and negative integers are included in directed numbers, and manipulating them requires pupils to get a thorough grasp of quantity, magnitude, and their relationship. Ely (2018) added that negative numbers are abstract and counterintuitive, which is one of the main reasons why directed numbers are hard to understand. In contrast to their common experiences and understanding of numbers, students frequently find it difficult to understand that a negative number signifies a quantity less than zero.

When executing operations with directed numbers, this conceptual barrier may cause misunderstandings and mistakes Researchers have looked into a number of intervention strategies and instructional approaches to address this issue. According to Olson (2023), students can gain a stronger knowledge of directed numbers and related operations by using visual models like number lines and chip models. Similar to this, Lamb (2021) stresses the significance of helping students to draw meaningful links between the abstract notions and their everyday experiences as well as relating directed numbers to real-world circumstances.

Furthermore, Olson (2023) demonstrates how language and the growth of mathematical vocabulary contribute to the comprehension of directed numbers. Akkan (2022) reports that there is a significant improvement in pupils' conceptual understanding when the terminology related with directed numbers, such as "positive," "negative," "increase," and "decrease," is explicitly taught and reinforced. Moreover, directed numbers are more complicated than simple addition, subtraction, multiplication, and division operations. Scholars have also investigated the difficulties that students encounter when attempting to comprehend more complex ideas, like exponents, roots, and the characteristics of operations involving directed numbers.

In summary, the conceptual knowledge of directed numbers is a broad and intricate subject in mathematics education. A complete strategy including the use of visual models, real-world situations, and explicit education in the language of directed numbers is needed to address the difficulties posed by directed numbers. To enhance students' learning and comprehension of this foundational mathematical idea, greater study in this field can help develop instructional strategies and learning materials.

2.14 Current Trends related to Misconceptions and Errors in Directed Numbers Operations

Current studies have brought to light persistent patterns of mistakes and misunderstandings when adding directed numbers. According to Smith and Jones (2019), students still have trouble grasping the principles governing the addition of positive and negative integers, which causes them to make mistakes when figuring out the sign of the total. For instance, instead of comprehending the idea of subtracting a negative integer's absolute value, students can still mistakenly think that adding a negative number always results in a negative sum. Booth and Davenport (2019) assert that, as with addition, learners continue to face chronic obstacles when it comes to the subtraction of directed numbers, as seen by current trends in errors and misconceptions. When conducting subtraction, students frequently flip the signs of operands or the result, according to. This behavior is indicative of a persistent misunderstanding of the idea of subtracting a negative integer. Furthermore, Lakoff and Nunez (2020) pointed out that students can have trouble deciphering word problems that require the subtraction of directed numbers, which could result in mistakes when solving problems.

Moreover, emerging patterns in errors and misconceptions related to directed number multiplication have been found in recent investigations. According to Latif (2021), students frequently make mistakes while figuring out the sign of the product because they don't comprehend the rules governing the multiplication of positive and negative numbers. For instance, instead of comprehending the idea of mixing opposite values, pupils can erroneously think that multiplying two negative numbers always resulted in a positive outcome. Persistent issues among learners are also highlighted by current trends in errors and misconceptions in the division of directed numbers. According to Boaler (2022), students frequently have trouble understanding and implementing the rules for dividing positive and negative numbers, which causes them to make mistakes when figuring out the quotient's sign. Furthermore, Bofferding (2019) pointed out that students could have trouble comprehending the idea of dividing by zero and what it means in practical situations.

In summary, the addition, subtraction, multiplication, and division of directed numbers errors and misconceptions that are now trending show that there are still difficulties faced by students. These patterns show a continuing inability to comprehend the abstract nature of directed numbers, how they are operated upon, and the many rules that regulate their manipulation. Teachers can create focused teaching techniques to successfully correct misconceptions and assist students' conceptual comprehension of directed number operations by recognizing existing trends and patterns of errors.

2.15 The Literature's Gaps

Recent research had clarified the most frequent errors and misconceptions made by students when working with directed numbers. Smith (2019) noted recurring difficulties with signed-number operations, such as misunderstandings regarding the results of these operations and confusion between addition and subtraction rules. In their investigation of the teaching and learning of directed numbers, Lakoff and Nunez (2020) discovered that a significant number of students have difficulty conceptualizing negative numbers as amounts that signify losses or debts.

Even while new research has shed light on common mistakes and misconceptions with directed numbers, there are still unanswered questions. To fully address learners' misunderstandings, more study is required to determine which instructional strategies and treatments work best. Furthermore, longitudinal research should look into how long these myths last and how they affect students' ability to solve mathematical problems.

2. 16 Summary

This chapter looked at the literature related to the topic. It discussed what other authors say about errors and misconceptions made by form one learners in addition, subtraction, multiplication and division of directed numbers. In the next chapter, research methodology is going to be discussed.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

This chapter focused on research design, research instruments, the merits and demerits of each instrument and sampling methods used and why they were chosen. It also explains how data was collected and the reliability and viability of instruments used.

3.1 Research Methods

According to Creswell (2021) research methods are the plans, approaches, procedures, and processes utilised in the conduct of research to collect accurate and trustworthy data and analyse it in a way that yields significant findings. Applied fields like engineering and healthcare, as well as the social sciences and humanities, all depend on these techniques as fundamental to scientific inquiry. The researcher combined qualitative and quantitative methodologies. Understanding things from a more subjective, in-depth perspective is the main goal of qualitative research. They are typically employed to thoroughly and in-depth investigate processes, comprehend perspectives, and study difficult ideas. A qualitative study approach (interview) was employed to determine the reasons behind learners' misconceptions. Quantitative research methods (testing) was an additional technique employed. Numerical data gathering and analysis were part of it. In this investigation, the researcher employed mixed methods. Mertens (2019) said that a wide range of academic disciplines and professional domains have recognised and endorsed the use of mixed techniques for data collection, which combine qualitative and quantitative research approaches. Numerous advantages of this method improve the scope and depth of research findings. Researchers got a comprehensive understanding of the research problem by using mixed approaches. Qualitative data adds depth and context to quantitative data, giving a fuller view of the underlying causes and motives behind trends shown in the numerical data, whereas quantitative data offers a comprehensive numerical analysis. This all-encompassing method is especially helpful in challenging fields of study like education and the social sciences. The researcher used mixed methodologies as a result of this.

3.2 Research Design

Research design is "a blueprint for conducting a study with maximum control over factors that may interfere with validity of the findings," according to Field (2000:195). Research Design and Approach. The researcher employed quasi-experimental design in this investigation.

A quasi-experimental design is a kind of research approach that mimics an experimental design but excludes the random assignment of subjects to treatment and control groups, according to Zhu and Fan (2019). When controlled experimental designs are unfeasible or immoral, it is employed. Quasi-experimental designs have the important feature of attempting to establish a cause-and-effect link, even though they are not as confident in their ability to do so as randomised controlled trials. Since a quasi-experimental approach is more acceptable given the ethical and practical constraints, the researcher opted for it. Random assignment is frequently impractical because of logistical or ethical issues. For example, it would be immoral to withhold a potentially helpful educational intervention from certain children while arbitrarily assigning others to receive it for research purposes only. Furthermore, it has real-world applications. Quasi-experiments can be carried out in natural environments and are frequently more representative of actual situations. Because the study's settings were closely mimicked by the real world, the results have more external validity or generalizability. Because quasi-experimental design takes use of pre-existing group, the researcher intends to employ it. Researchers frequently have to work with pre-existing groups (e.g., school classes, department employees), for which it is impractical to randomly assign participants to different circumstances. The researcher chose to employ quasi-experimental techniques in this study because they enable researchers to examine the effects of variables on these naturally occurring groups.

3.3 Target Population

The broad group of individuals on which the research study will be focused and who share one or more characteristics is the target population of the sample. Teachers and students are the study's target group.

3.4 Population

According to Charles (2021), a population is a collection of people who are relevant to the study and to whom the researcher hopes to generalize the findings. All form one students at Chimoyo Secondary School received special attention. There were fifty students in each class. The students' ages range from thirteen to fifteen years old. For the study, thirty students were sampled. Johnson & Onwuegbuzie (2019) state that a sample is characterized as a group or portion of the entire population that has been chosen for examination and study. Mertens (2019) notes that the information gleaned from the sample is indicative of the entire population that is the subject of the investigation. Two groups of people participated in this study: Chimoyo Secondary School mathematics teachers and form one students.

3.5 Procedures for Sampling

Creswell (2021) defines sampling as the process of studying a small group of individuals with the goal of extrapolating the results of the population. Thus, a small group was selected and investigated after the population has been identified. In the study, the researcher worked with thirty students, fifteen from one east and fifteen from one west. A number of students were permitted to select a piece of paper from the box after it has been thoroughly shaken. This prevented bias when selecting students to participate in a focus group discussion. Participants in the yes-written papers were taken as part of a focus group discussion. In the process of random sampling, each participant of the group's population had an equal chance of getting chosen.

3.6 Data collection tools

For this investigation, the researcher used primary data collection tools. Pre- and post-tests as well as interviews were used to gather primary data. For this study, multiple instruments were employed because relying just on one could lead to bias or distortion of a specific piece of data (Johnson 2019). These data collection tools provided a comprehensive understanding of form one learners' errors and misconceptions in directed numbers. These instruments facilitated the development of targeted instructional strategies and interventions to address these challenges. By using these tools, the researcher was able to gather as much information as possible from the respondents to protect validity and reliability by allowing the researcher to compare responses from several perspectives.

3.6.1 Interview

Smith, (2023) defines an interview as an oral questionnaire. The researcher views an interview as a conversation between two or more subjects where questions are asked by the interviewer in order to collect data from interviewees. In this study, structured interviews were used.

Structured interview

An interviewer using a structured interview technique asks a planned set of questions in a consistent way. The purpose of the questions is to elicit specific information from the respondent and are usually written beforehand depending on the study objectives.

In a formal interview, every interviewee receives the same set of questions in the same order since all interviewees receive the same set of questions. To enable methodical data collection, the interviewer prepares a script of questions ahead of time and sticks to it during the interview. The interviewer's ability to stray from the pre-planned questions or delve further into responses is restricted because the main objective is to collect standardized data. Structured interviews are helpful for studies that seek to find patterns or trends because they frequently produce quantitative data that is simple to evaluate and compare among participants. In quantitative research projects, surveys, and evaluations where answer standardization and comparability are crucial, structured interviews are frequently employed. They offer a methodical approach to data collecting that reduces interviewer bias and guarantees consistency. Quantitative research uses structured interviews, which can be performed in-person, online, over the phone, and occasionally with the help of laptop computers. Face-to-face was used in this investigation.

3.6.2 Testing

Pre-testing

Pre-tests are defined by Sagor (2019) as assignments designed to gauge a student's conceptual knowledge. A pre-test is an exam that students take before the researcher's intervention. Students' usage of the number line and their addition and subtraction of directed numbers were tested first in the pre-test. According to Charles (2021), pretests offer the advantage of enabling researchers to assess students' conceptual understanding and proficiency.

Post- test

According to Creswell (2021), a post-test is an assessment conducted to ascertain the knowledge and skills of students following a lesson or instructional time. Post-test results from the research resembled the pre-test results. This is to see if the teacher's intervention has an effect on the students' understanding.

According to Johnson et al. (2019), data representation is a technique for organizing and describing data so that it is simple for people or computer systems to understand, analyze, and handle it. It entails converting unstructured data into a structured format that can effectively manipulate data and convey meaning. Think about the audience, the kind of data, and the message you want to convey when selecting a data representation technique. Try out various visualization methods to determine which one best presents the data. Because bar charts and pie charts are simple to comprehend, the researcher utilized them in this study. The comprehension and interpretation of data can frequently be improved by combining several presentation strategies.

3.7 Procedures for Data Analysis

Mertens (2019) defines data analysis as the process of revising, categorizing, tabulating, and coding gathered data. The procedure entails actions taken with the intention of organizing and summarizing the field data that has been gathered. Following data collection, the researcher carefully examined the information before classifying it according to test results and interviewee responses. To make data analysis and presentation easier, data was analyzed thematically.

3.8 Validity and Reliability of the Study Instruments

The researcher used testing and interviews as her research instruments. Zhu et al (2022) asserts that validity refers to how sound or effective the measuring instrument is. The results from interviews and tests were used to form generalized conclusions in order to make sure the measuring instruments are effective and that the questions have validity. Gunawan (2021) defines reliability as concerned with accuracy to test the reliability of respondents. Some questions were rephrased so that there are two questions which look different but effectively asking the same questions. The test is considered trustworthy if there is a strong correlation between students' answers to the original questions and their rephrased versions.

3.9 Ethical l considerations

Since the study involves minors, the researcher adhered to ethical guidelines by getting permission from the parents of the students and the school administration. Students got a consent document outlining the specifics of the study and granting them permission to take part. The researcher guaranteed that everyone concerned gives their informed consent by doing this. Additionally, the researcher guaranteed the participants' privacy and anonymity by not giving away their personal information or educational background to outside parties. Additionally, the researcher made sure that the volunteers suffer as little physical, psychological, or emotional injury as possible. The researcher designed the diagnostic test and interview questions in a manner that is age appropriate, non-threatening, and respectful of the participants' well-being This is an essential ethical consideration in research studies as it protects the privacy and confidentiality of the participants

3.10 Summary

The researcher looked at the research design, population, sampling, research instruments used, data collection procedures and presentation and analysis plan. In chapter four will cover data presentation, analysis and interpretation.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Introduction

This chapter looked at what was found from the study through tests and interviews. The chapter presents, analyses and interprets data collected by the researcher with the aid of tables and graphs. To maintain confidentiality of the information provided by the respondents, the study did not use real names.

4.1 Data presentation and analysis

Data was presented in the form of tables and graphs for easy analysis

4.1.1 Presentation of data from tests

The researcher administered tests to pupils as a way of gathering data. Data was presented in form of graphs.

Table 4.1 Pre-test results

Mark interval %	0-25	26-49	50-75	76-100
Frequency	14	11	3	2

Fig 4.1 pre-test stem plot in percentage

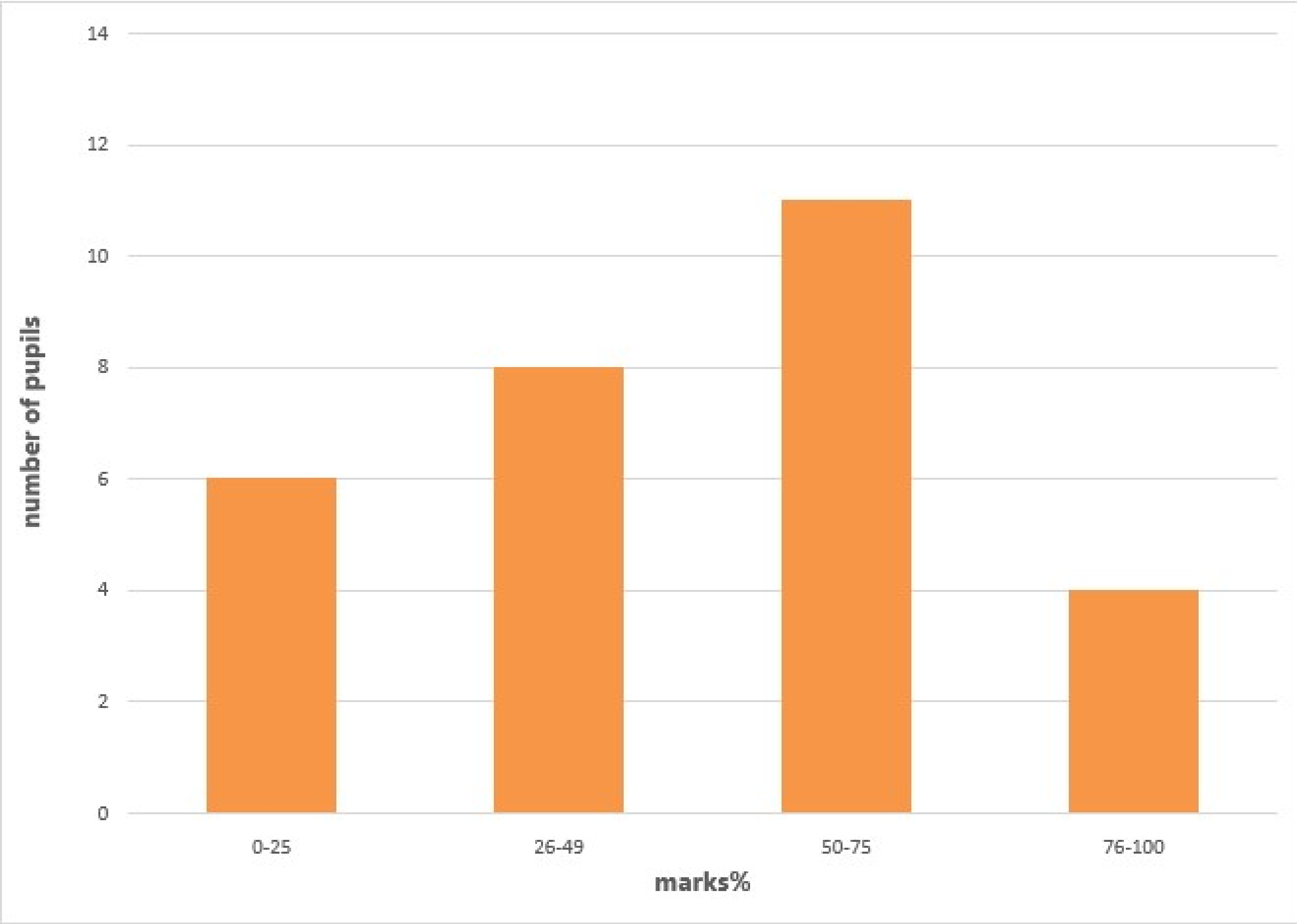
Stem	Leaf
1	0 0 0 0 0 0 0 0
2	0 0 0 0 0 0
3	0 0 0 0 0
4	0 0 0 0 0 0
5	0 0
6	0
7	
8	0 0

KEY

1/0 means 10

Thirty pupils wrote the tests. The pre-test was marked out of ten and converted to percentage. Results from the pre-test indicated that twenty- five pupils out of thirty failed the test. Fourteen pupils obtained 0-25 percent. Eighty learners got 10% and six learners got 20%.

Fig 4.2: Post-test results



The test was marked out of 10 and converted to percentage. The number of learners who obtained 0-25 percent reduced from 14 to 6. Eight learners obtained marks ranging from 26-49 percent. A marked improvement was shown on marks ranging from 50-76 percent. In the pre-test 3 learners managed to get marks ranging from 50-76 percent but after teacher' intervention eleven learners obtained marks ranging from 50-76 in the post-test. Five learners obtained marks ranging from 76-100. Teacher used a variety of media and teaching methods like demonstration, explanation and group work to assist learners before they wrote the post test. Remediation was also done to assist pupils with challenges.

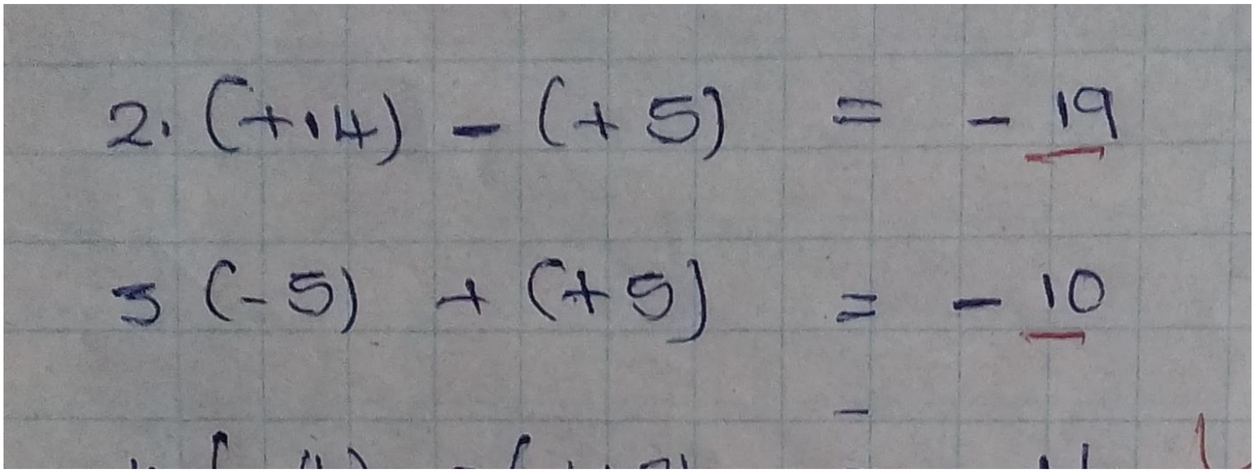
4.2 Misconceptions held by the form one pupils

The form one pupils in both parts made the following misunderstandings, which the researchers identified after analyzing the results: (1) addition, (2) subtraction, (3) multiplication, and (4) division. Regardless of their section or gender, all form ones share these misconceptions.

4.2.1 Misconceptions in the Addition of Integers

Pupils were having trouble adding integers with dissimilar signs, and they frequently confused signed numbers with the right sign to employ in the final product. For instance, the question 3 is +5 + (-5). Nonetheless, pupils ignore the negative symbol and indicate this in their response as 5+ 5 = 10 instead of 5+ (-5) = 0. Similarly, in question 2, students were required to simplify this expression: (+14) – (+5). Rather than following the rules for adding integers with unlike signs, which state that (+14) – (+ 5) = 9, the pupils simplify this as (+14) – (+5) = 19 and (+14) – (+ 5) = -19. In question 4, which asked learners to add an integer with the same signs both of which are negative contains another mistake. They answered the expression, which is (-4) - (+12) = 16, by ignoring the expression's negative signs, even though the correct result is (-4) - (+12) = -16. This outcome is consistent with the research conducted by Latif (2021), which states that students had trouble grasping the notions of negative numbers in relation to operations on integers.

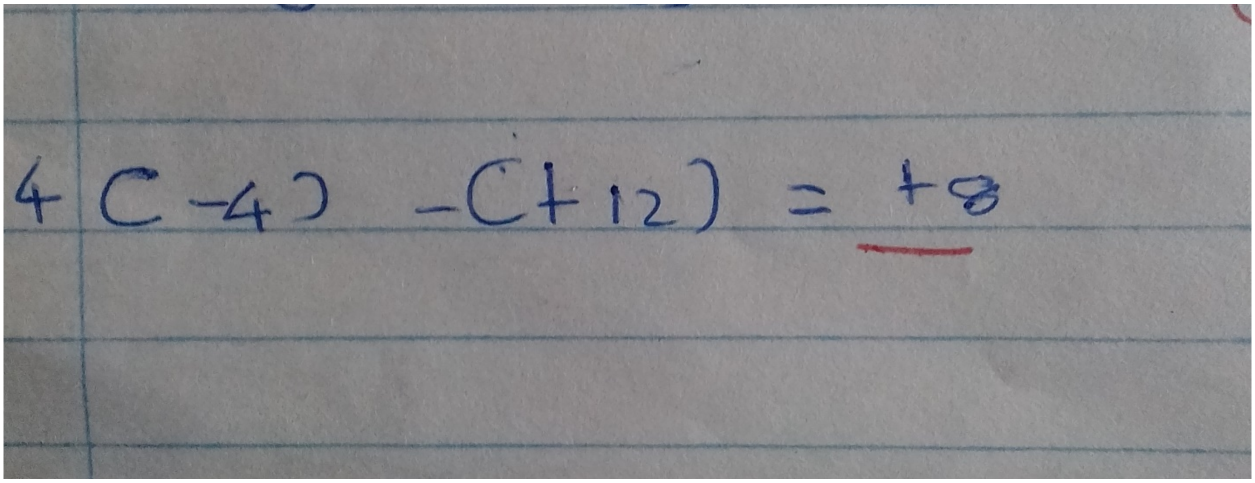
Figure 4.3 Misconceptions regarding the Addition of Integers



4.2.2 Misconception in the Subtraction of integers

When subtracting integers, the majority of misconceptions were experienced by the students. Out of thirty pupils, only four (4) correctly answered question 1. When asked to subtract (-6) +4, the majority of pupils understood the query to mean 6-4. The usage of the switch word in an expression caused the pupils to become perplexed and ignorant; instead of reducing the phrase as -6 +4 =- 2, they arrived at -6+4 = 2. The method of solving this statement, is to use the rules for subtracting numbers with unlike signs. Some students estimated it as -6+4=10. Another method used by some students to solve -4 - 12 = -8 was to simply subtract the integers and apply the sign of the larger number, -12, to the difference, following the same guidelines as when adding unlike sign integers. This fallacy, referred to as "rule mix-up," supports the research by Balu (2020), which found that while students tended to recall the rules governing integer operations, they applied them incorrectly while solving integer problems. Furthermore, these results support the findings of Jones and Brown (2020) about students' difficulties subtracting integers with dissimilar signs.

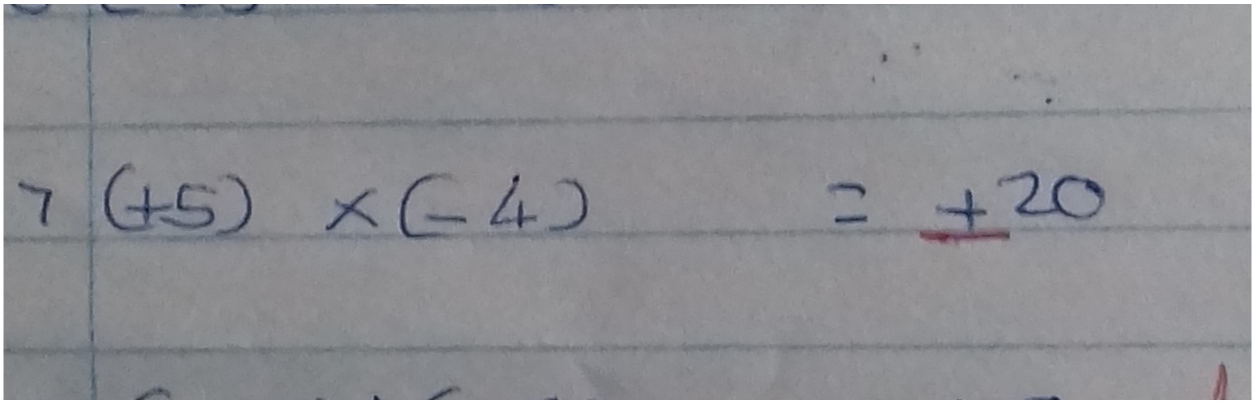
Figure 4.4 Misconceptions in the Subtraction of directed Numbers



4.2.3 Misconceptions regarding Multiplying Integers

Students encountered misconceptions about multiplying integers with unlike signs. For instance, the students were required to evaluate (-5) (4) in question 6. A few learners correctly identified the solution, which is (-5) (4) = -20. Some, on the other hand, chose to ignore the negative sign and wrote (-5) (4) = 20 instead. This problem also exhibits rule mix-up misinterpretation, with pupils solving it as (-5) -4= -9, by following the rules for subtracting unlike sign numbers and, in some cases, adding unlike sign integers, (-5) + 4 = -1. In question 5, -3 x (-4), the same misconceptions were also identified. Pupils frequently ignore the rule, which results in the incorrect response -3× (-4) = -12 rather than -3 × (-4) = 12. Also, they misinterpreted the guidelines and came up with the following solutions: (-3) (-4) = -7. This is consistent with the findings of Smith (2021), who found that students did not understand the multiplication property rule when it came to multiplying a number with both negative signs.

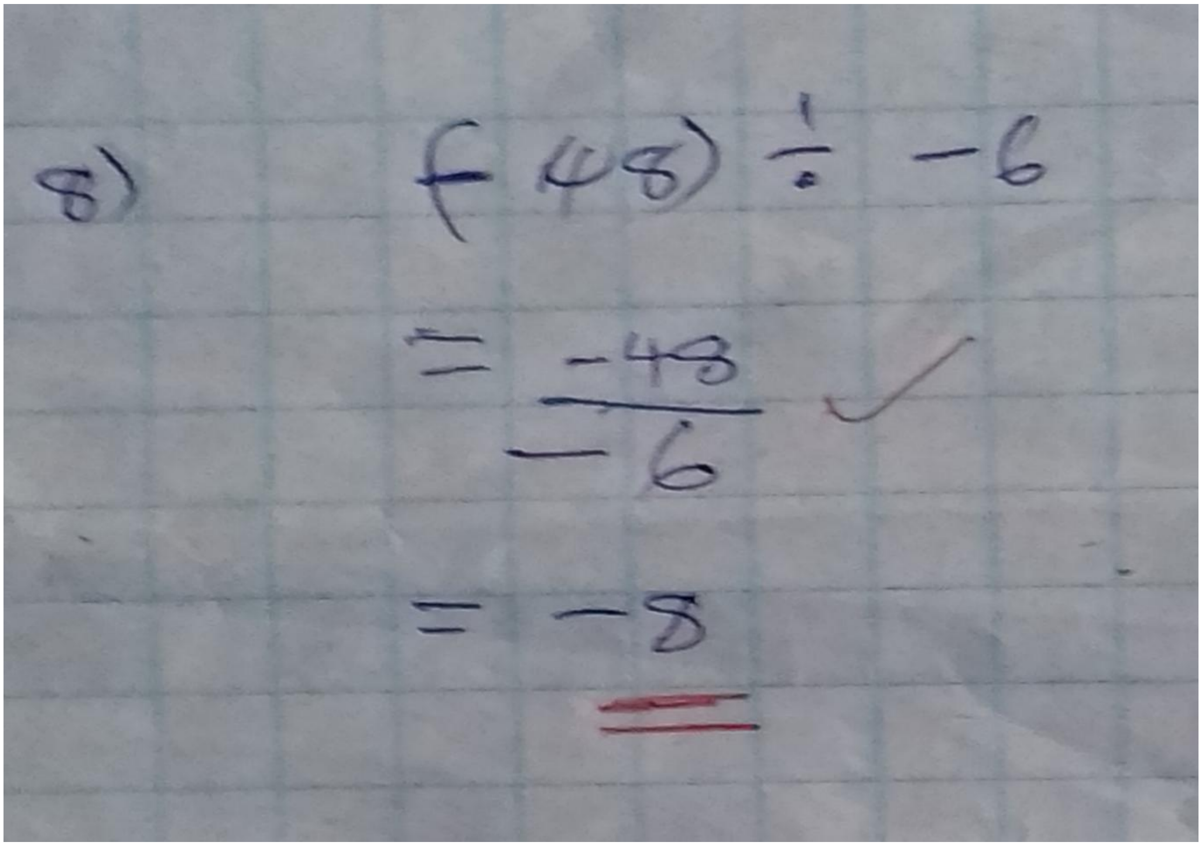
Figure 4.5 Misconceptions Regarding Multiplying Integers



4.2.4 Misconceptions in the Division of Integers

The sole distinction between dividing and multiplying integers is which operations are employed. The rules and circumstances for both are the same. In addition to the challenges of splitting unlike sign integers and rule confusion, a further misunderstanding was found in this operation. The results showed that learners had difficulty dividing numbers. They had to solve - 48 ÷ (-6) for item 8. Still ignoring the negative sign, the pupils solved this as (- 48) ÷ (- 6) = -8 rather than 8. Some pupils, however, applied the rules to subtract unlike sign numbers [48- (-6) = 54] and add unlike sign integers 48 + (-6) = 42. On the other hand, item 8's assumption reveals that the majority of students lack basic division skills. The expression is -48 ÷ 12, and using the unlike sign integer division rules, the quotient must be -4. However, due to their inadequate understanding of number division, the pupils answered the supplied statement with 4. These misconceptions are consistent with the findings of Dube and Robinson (2018), who showed that students struggled to perform division of integers, leading to incorrect sign and value, and had a poor conceptual understanding of number division.

Fig 4.6 Division



4.3 Presentation of data from teacher' interviews

Table 4.2 Teaching experience of teachers

Number of years	**Number of teachers**
0-2	1
3-5	1
6+	3
Total	5

Five Mathematics teachers were interviewed by the researcher on number of years they had in service. From the responses, one teacher had one year in teaching service. One had three years teaching experience and the other three had more than six years in the service.

4.3.1 common errors and misconceptions that form learners typically have regarding addition, subtraction multiplication and division of directed numbers.

From the discussion, all the five teachers said that the common errors and misconceptions made by form one learners are lack of understanding of the sign rules. This is when learners are not knowing when to use the addition, subtraction, multiplication, or division rules for positive and negative numbers. One teacher pointed out that learners forget to change sign when multiplying and dividing negative numbers resulting to incorrect results. Three teachers added that learners had a tendency of Ignoring the absolute value while calculating an operation's outcome, particularly when dividing and subtracting. This was also identified by the researcher in learners' pre and post-tests. All the five teachers mentioned that the common errors made by learners is confusing positive and negative integers when adding, subtracting, multiplying and dividing. They mix the rules leading to wrong computations and solutions.

4.3.2 Reasons why form one learners make errors and misconceptions in directed numbers.

When working with directed numbers, form one students frequently make mistakes and misconceptions for a number of reasons. Four teachers mentioned that learners made mistakes due to lack of conceptual understanding. They may not fully understand the fundamental ideas behind positive and negative numbers, particularly how they relate to one another and how they are represented on a number line. All the five teachers added that learners made errors and misconceptions due to failure to internalize rules. Despite having been taught the guidelines for working with directed numbers, individuals could not have fully internalized them, which could result in errors when putting the guidelines into practice. In addition, two teachers pointed out that learners made errors and misconceptions due to limited practice. Learners may not acquire the fluency necessary to reliably carry out operations with directed numbers if they do not receive enough practice with a range of tasks. Four of the teachers mentioned that learners made errors due to misinterpretation of signs. When interpreting signs in word problems or equations incorrectly, one may make mistakes in figuring out whether to multiply, divide, add, or subtract directed numbers. Lack of feedback is also a major reason why learners made errors. Learners may perpetuate inaccurate approaches or misunderstandings if they do not receive prompt feedback on their errors, which will impede their ability to comprehend directed numbers

4.3.3 Addressing errors and misconceptions about directed numbers in teaching

In order to address errors and misconceptions in addition, subtraction, multiplication and division, all the five teachers pointed out that there is need to establish conceptual knowledge. Teachers should make sure the learners have a firm conceptual grasp of positive and negative numbers before they start. To assist children in understanding the link between positive and negative integers, they should provide them with visual aids such as number lines. One of the interviewees also mentioned that teachers should provide clear explanations by clearly stating the guidelines for multiplying, dividing, adding, and subtracting directed numbers while stressing the rationale behind each step. In addition, three of the teachers pointed out that there is need to use actual instances by the teacher. To demonstrate how directed numbers are applied in real-world contexts, provide actual scenarios and instances. Students may find it easier to relate abstract ideas to real-world scenarios in this way. One of the teachers proposed that educators should provide practice possibilities. This is whereby learners are given lots of chances to practice directed number operations by beginning with easy problems and work your way up to more complex ones. Provide advice and comments while they solve issues. The viable strategy mentioned by four teachers is to address typical misconceptions. This is done by paying close attention to the typical mistakes and misunderstandings that students could have. Clarify these points with explanations and examples. Lastly, all the five teachers mentioned that remediation is very important when addressing errors and misconceptions made by learners in addition, subtraction, division and multiplication of directed numbers. Teachers should assist students who are having difficulty with particular directed number concepts or skills by providing them with focused guidance and remediation.

4.3.4 Instructional strategies best for assisting students in understanding directed number concepts.

Teachers mentioned that, instructional strategies best for assisting learners include visual representations. To represent positive and negative numbers, teachers must use visual aids like number lines, integer chips, or colored counters. Students can grasp abstract things more easily and concretely when they are presented visually. Two teachers pointed out that, teachers must use real-world examples in order to assist learners in understanding directed numbers. Teachers need to include situations and examples from everyday life that use directed numbers. This makes it easier for students to understand how these ideas connect to real-world scenarios and how they may be applied practically. One interviewee emphasised on peer cooperation. Teachers should promote cooperative learning activities and peer cooperation so that students may work together to solve issues, exchange ideas, and defend their conclusions. Peer contact can bring diverse perspectives and strengthen comprehension. Two teachers added that Scaffolded instruction can be used to assist learners in understanding directed numbers. Teachers should provide students with scaffolding and support as they work through each phase of the process by breaking down big concepts into smaller, more manageable chunks. Students gain confidence and comprehension as a result of this gradual release of accountability. They further mentioned that, educators must use differentiated instruction to improve understanding in directed numbers. Teachers should tailor their lessons to each student's unique needs in the classroom. Students should be given extra help or challenges according to their unique learning styles and skills.

4.3.5 Role of real world applications in comprehending the significance of directed numbers.

Teachers’ responses on role of real world applications in comprehending the significance of directed numbers indicated that it improves contextual understanding. Directed numbers are understood in context thanks to real-world instances. Pupils can observe how positive and negative numbers are employed in commonplace contexts including temperature fluctuations, money exchanges, and geographic locations. One interviewee pointed on relevance. This means students can comprehend the significance of studying directed numbers by drawing connections between abstract mathematical ideas and real-world situations. For instance, reading financial documents and monitoring temperature changes require a grasp of negative numbers. All the five teachers emphasised on motivation. By demonstrating the real-world applications of what they are studying, real-world applications can inspire learners. Students may be more interested in and driven to learn when they can relate mathematics to real-world situations. Two teachers pointed out that directed numbers have a connection to other courses. The use of directed numbers is essential to many other courses, including physics, geography, and economics. Students can better understand these subjects' concepts and draw connections between other disciplines if they have a solid understanding of directed numbers. They also mentioned that directed numbers play a major role in cultural and global understanding. Real-world examples can demonstrate how directed numbers are viewed from various cultural and global viewpoints. For instance, evaluating economic data or comprehending global weather patterns require a grasp of negative numbers. All things considered, directed numbers are meaningfully contextualized through real-world applications, which aids students in understanding the significance and applicability of these ideas to their everyday lives and future pursuits.

4.3.6 Importance of establishing a solid conceptual basis in directed numbers before tackling more complex subjects

Before tackling more complex issues, it is imperative to have a solid conceptual foundation in directed numbers for a number of reasons. All the five teachers mentioned that it provides foundation for advanced concepts. Algebra, calculus, and physics are examples of more complex mathematical ideas that are constructed using directed numbers. Students could find it difficult to understand these more advanced ideas if they don't have a firm grasp of directed numbers. Three interviewees added that solid conceptual base in directed numbers help in problem-solving skills. Students must acquire logical reasoning, critical thinking, and problem-solving techniques in order to comprehend directed numbers. There are several applications of these abilities in mathematics and other fields. A strong grasp of directed numbers is necessary for many mathematical concepts and procedures, including graphing functions, solving equations, and data analysis. It could be challenging for pupils to advance in their mathematical studies without this core knowledge. Two teachers mentioned that solid conceptual basis in directed numbers is essential in real-world applications. There are several real-world applications for directed numbers, including temperature calculations, financial transaction analysis, and coordinate interpretation. Students who possess a solid conceptual basis in directed numbers are better equipped to use their mathematical skills in real-world scenarios. It is also necessary to have a strong base in directed numbers to prevent misconceptions. Students may acquire misconceptions or misunderstandings regarding directed numbers in the absence of a solid conceptual foundation, which may impede their learning in subsequent years. Having a strong grasp from the start aids in avoiding the formation of these myths. Three teachers mentioned that a strong base in directed numbers boosts confidence and motivation Students who possess a solid understanding of directed numbers are more driven to take on new tasks and feel more confident in their mathematical abilities. Students who have a strong foundation are better equipped to succeed in mathematics and other subjects. In general, students must have a solid conceptual foundation in directed numbers in order to excel in mathematics and to cultivate the critical thinking and problem-solving skills necessary for success in a variety of other domains.

4.3.7 Ways of helping students, particularly those who might find the subject difficult to develop a positive attitude toward learning about directed numbers.

It takes an interesting and supportive learning environment to cultivate a positive attitude about directed numbers, especially in students who find the subject difficult. All the five teachers have of the opinion that positive attitude towards directed numbers can be instilled by providing encouragement. This is done by congratulating and encouraging learners, particularly when they show improvement or make an attempt to comprehend directed numbers. Their self-esteem and motivation can be increased with positive reinforcement. One of the teachers mentioned that, there is need to break down topics in order for learners to develop positive attitude towards directed numbers. This is done by providing students with step-by-step instructions to help them understand each portion of complicated topics by breaking them down into smaller, more digestible chunks. This method can help learners understand the subject better and feel less overwhelmed. All the interviewees are of the opinion that educators had to use relatable instances to develop positive attitude. This is done by using situations and instances from real life that the students can connect to, including money transfers, temperature swings, or sports results. Engaging examples make the concept more relatable and assist students in seeing the practical significance of directed numbers. Three teachers added that educators must provide instruction that is differentiated. They should acknowledge that every student is unique in their learning preferences and skill levels, and adapt your training to suit each one. Provide extra help, enrichment activities, or different explanations for pupils who might be having trouble understanding the material. Lastly, four interviewees mentioned that teachers should offer opportunities for success so as to eliminate negative attitude. This is done by arranging assignments and learning activities so that pupils can succeed and gain confidence. Beginning with simpler problems, progressively raise the difficulty level as students gain greater familiarity with the subject matter. Use interactive simulations, games, riddles, and hands-on activities to help students learn directed numbers in an entertaining and interesting way. Positive attitudes about the subject matter can be fostered in pupils through engaging and dynamic learning opportunities.

4.3.8 Causes of errors and misconception when adding, subtracting, multiplying, and dividing directed numbers

Misconceptions and errors in directed number addition, subtraction, multiplication, and division can come from a number of places. Three teachers mentioned that errors and misconceptions are caused by ignorance of sign rules. Not knowing when to use the rules for operations involving positive and negative numbers, such as adding a positive and a negative number that results in subtraction. Some learners also forget to change sign when dealing with directed numbers. Inaccurate results might arise when signs are not correctly switched while multiplying or dividing negative numbers. Mistakes and errors might arise from a lack of experience with a range of directed number problems. Moreover, three teachers pointed out that learners made errors and misconceptions due to lack of conceptual understanding. Mistakes and misunderstandings might result from a lack of knowledge about the conceptual underpinnings of directed numbers, such as how they are represented on a number line or how they relate to one another. Another key cause mentioned was overreliance on memorizing. When presented with new or complicated problems, relying only on rule memorizing without comprehending the underlying principles might result in mistakes.

4.4 Summary

Chapter four looked at data presentation, analysis and interpretation. It also answered all the research questions on an exploration of form one learners' errors and misconceptions in directed numbers. Chapter five will look at summary, conclusion and recommendations

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter focuses on the summary of all chapters of the study. The researcher came up with conclusions and recommendations basing on the research findings.

5.1 Summary

According to the findings, a large majority of students in form1 make procedural mistakes and misconceptions when adding and subtracting directed numbers. Typical mistakes consist of focusing primarily on the operation indication and disregarding the numerical signs, reversing the minuend and subtrahend's order applying rules incorrectly, such as thinking negatively and negative results in positive. These mistakes are caused by inadequate conceptual knowledge, an incapacity to reason through the connections between ideas, and a surface-learning tendency to depend solely on rules that have been memorably learned. Students tend to overgeneralize what they have learned in the past to numbers. Teachers that hurry through the material, lack multiple representations in their instruction, and undervalue conceptual comprehension are some of the factors that contribute to these errors. In order to pinpoint specific mistakes and direct focused training toward the development of solid integer concepts, diagnostic tools are required. A lot of form ones have trouble understanding integer operations because they have ingrained beliefs from their shallow education. To address these problems, instructional strategies that build conceptual underpinnings and adaptable reasoning must be carefully planned.

5.2 Conclusion

In summary, the investigation of form one learners' mistakes and misunderstandings about directed numbers has highlighted important issues in this subject area. It has become clear from thorough analysis that students frequently struggle with basic concepts, which can result in a variety of mistakes and misconceptions. These include challenges with directed number ordering and comparison, confusion with basic operation rules, conflation between absolute value and directed numbers, and uneven application of rules in mixed operations These problems can be caused by misconceptions from previous learning experiences, a lack of conceptual understanding, or inadequate instructional support. To successfully address these problems, educators can create focused interventions and instructional strategies by recognizing these challenges. Through individualized support and the development of a more profound comprehension of directed numbers, teachers can assist students in overcoming these challenges and advancing their mathematical proficiency. In the end, this study emphasizes how critical it is to correct mistakes and misunderstandings in directed numbers in order to support form one learners' successful learning outcomes.

5.3 Recommendations

Since the researcher established that learners faced various problems in the learning of directed numbers, the researcher recommends the following:

- Teachers should place an emphasis on conceptual knowledge rather than concentrating only on procedural fluency, assist students get a deeper comprehension of positive and negative numbers conceptually. Explain directed numbers and related operations using practical exercises, visual aids, and real-world scenarios
- Teachers should recognize and clearly address common misunderstandings, such as the difference between directed and absolute values, the uneven implementation of regulations, and the significance of the negative sign by creating focused educational activities and interventions to assist students in dispelling these myths.
- Teachers should give pupils the chance to justify their methods for solving problems and their thought processes when they are dealing with directed numbers. This can assist educators in determining the reason behind students' mistakes and help them get a deeper comprehension of the material.
- Teachers should assist students in connecting the dots and gaining a flexible grasp of directed numbers, employ a range of representations, including number lines, integer chips,

and symbolic expressions. To improve their comprehension, encourage students to translate between several representations.

- Teachers should help students understand the principles more deeply, include directed numbers into real-world examples and applications. This can assist pupils in realizing the significance and use of directed numbers in their daily lives.
- Teachers should acknowledge that pupils could struggle with directed numbers and have differing comprehension levels. Use varied teaching techniques to meet the various learning demands of your students.
- Learners should develop the spirit of practising in any topic in Mathematics.
- Learners need to be focused on their education and brush aside the mentality that Mathematics is so difficult to tackle.
- The administrators must organise competitions with different schools such as Mathematics Olympia. Those who would have done well in these competitions are supposed to be rewarded.

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APPENDICES

Appendix A: Pre and Post- Test

Pre- test

Use the number line to simplify the following:

1. (+6) + (+8) [1]
2. (+14) – (+5) [1]
3. (-5) + (+5) [1]
4. (-4) – (+ 12) [1]

Simplify without using a number line

5. (-4) – (-85) [1]

6. (-6) × (-9) [1]

7. +5 × -4 [1]

8. (-48) ÷ (-6) [1]

9. $\frac{(+6) \times (-10)}{-5}$ [2]

(Total: 10 marks)

Marking scheme

1.(+6) + (+8)

= 6 + 8

=14 [1]

2. (+14) – (+5)

=14 – 5

9 [1]

3. (-5) + (+5)

= -5 + 5

=0 [1]

4. (-4) – (12)

=-4 -12

= -16 [1]

5.(-4) – (-85)

=-4 + 85

= 81 [1]

6. $(-6) \times (-9)$

$= -6 \times -9$

$= 54$ [1]

7. $(+5) \times (-4)$

$=+5 \times -4$

$= -20$ [1]

8. $(-48) \div (-6)$

$= \frac{-48}{-6}$

$= 8$ [1]

9. $\frac{(+6) \times (-10)}{-5}$

$= \frac{-60}{-5}$ [1]

$= 12$ [1]

Post- test

Use number line to simplify:

1. (-6) + (+4) [1]
2. (-3) – (+7) [1]

Simplify the following without using a number line:

3. (-32) – (- 18) [1]
4. (+12) – (+5) – (+10) [1]

5. (-3) × (-4) [1]

6. (-5) × (+4) [1]

7. $\frac{(-6) - (-26)}{-5}$ [2]

8. $\frac{(-8) \times (+6)}{12}$ [2]

(TOTAL 10 MARKS)

MARKING SCHEME

1. (-6) + (+4)

   = -6 +4

   = -2

2. (-3) – (+7) [1]

   = -3 -7

   = -10

   [1]

3. (-32) – (-18)

   = -32 +18

   = -14 [1]

4. (+12) – (+5) – (+10)

   = (+12) – 15

   = -3 [1]

5. (-3) × (-4)

   =-3 × -4

   =12 [1]

6. (-5) × (+4)

   =-5 × 4

   =-20 [1]

7. $\frac{(-6) - (-26)}{-5}$

$= \frac{-6 + 26}{-5}$ [1]

$= \frac{20}{-5}$

= -4 [1]

8. $\frac{(-8) \times (+6)}{12}$

$= \frac{-8 \times 6}{12}$

$= \frac{-48}{12}$ [1]

= -4 [1]

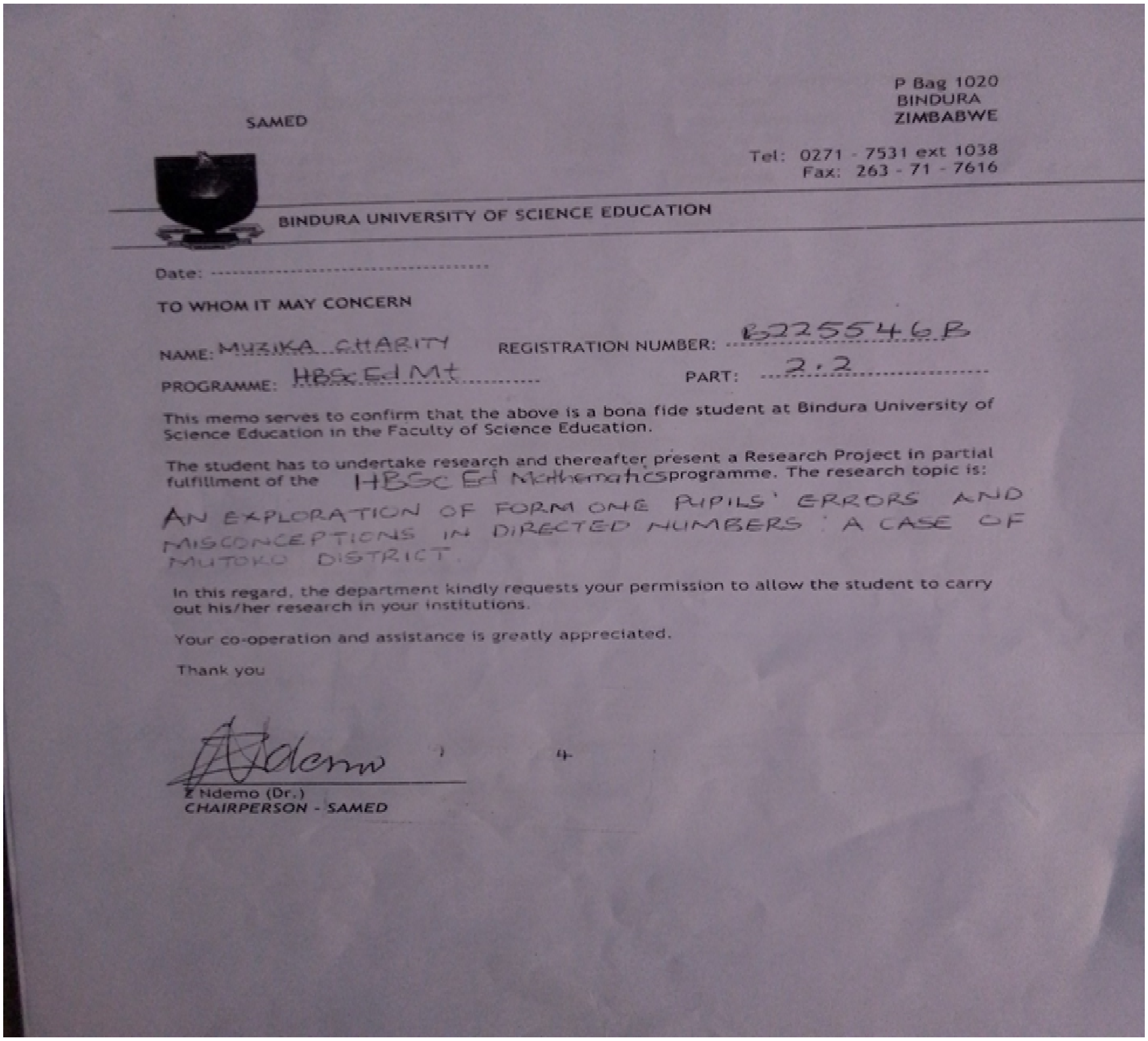
Appendix B: Teacher Interviews

Interview schedule for Teachers

1. For how long have you been teaching mathematics?
2. What are the common errors and misconceptions that form one learners typically have regarding addition, subtraction, multiplication and division of directed numbers?
3. Why do form one learners make errors and misconceptions in addition, subtraction, multiplication and division of directed numbers?
4. How do you address errors and misconceptions about directed numbers in your teaching?
5. . What instructional strategies do you find most effective for helping students grasp concepts related to directed numbers?
6. What role do real-world applications play in helping students understand the relevance of directed numbers?

7. What are the importance of building a strong conceptual foundation in directed numbers before moving on to more advanced topics?
8. How do you foster a positive attitude towards learning about directed numbers among your students, especially those who may initially find the topic challenging?

Appendix C: Request for permission to carry out research



SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: ....

TO WHOM IT MAY CONCERN

NAME: MUZIKA CHARITY REGISTRATION NUMBER: B225546B

PROGRAMME: HBSc Ed Mt PART: 2.2

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

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

AN EXPLORATION OF FORM ONE PUPILS' ERRORS AND MISCONCEPTIONS IN DIRECTED NUMBERS : A CASE OF MUTOKO DISTRICT.

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

Your co-operation and assistance is greatly appreciated.

Thank you

Z Ndemo (Dr.)
CHAIRPERSON - SAMED

Appendix D: Permission letter from Head Office

All communications should be addressed to the
Secretary for Primary and
Secondary Education
Telephone:+263 242 794 509
Toll Free: 317

ZIMBABWE

Ministry of Primary and Secondary Education
88 Kwame Nkrumah Avenue
Queen Lozikeyi House
P O Box 121
Causeway, Harare

Reference : C/426/3

09May 2024

Charity Muzika
Chimoyo Secondary School
P O Box 400
Mutoko

RE: PERMISSION TO CARRY OUT A RESEARCH IN MASHONALAND EAST PROVINCE: MUTOKO DISTRICT : CHATIZA HIGH,RUKAU AND CHIMOYO SECONDARY SCHOOLS.

Reference is made to your application to carry a research from the above mentioned district schools on the research title:

"AN EXPLORATION OF FORM ONE LEARNERS` ERRORS AND MISCONCEPTIONS IN DIRECTED NUMBERS : A CASE OF MUTOKO DISTRICT."

Permission is hereby granted. However, you must liaise with the Provincial Education Director of Mashonaland East Province, who is responsible for the schools which you want to involve in your research. You should ensure that your research work does not disrupt the normal operations of the schools. Where students are involved, parental consent is required.

You are also required to provide a copy of your final report to the Secretary for Primary and Secondary Education.

Musingarimi M.

PP **Acting Deputy Director: Research, Innovation and Development**
For:Secretary for Primary and Secondary Education

MIN. OF PRY & SEC. EDUCATION
POLICY PLANNING RESEARCH
AND DEVELOPMENT
09 MAY 2024
P.O. BOX CY121 CAUSEWAY
ZIMBABWE

@MoPSEZ https://www.facebook.com/MoPSEducationGovtZimbabwe https://www.mopse.co.zw/ https://www.linkedin.com/company/ministry-of-primary-and-secondary-education-of-zimbabwe/

Appendix E: Permission letter from Province.

Reference: P| Muzika C

E. C. No.: 54012734

All communications should be addressed to
"The Provincial Education Director
Mashonaland East Province"
Telephone: 0279-24811/4 and 24792
Telex :
Fax: 079-24791

ZIMBABWE

Ministry of Education, Sport & Culture
Mashonaland East Province
P.O. Box 752
Marondera
Zimbabwe

09/5/24

Mr./Mrs./Miss Charity Muzika
Chimoyo Secondary School
P.O. Box 400 Mutoko

PERMISSION TO CARRY OUT RESEARCH IN SCHOOL FOR EDUCATIONAL PURPOSES: MR/MRS/MISS Muzika C **E. C. NO.** 54012734
STUDENT I. D. B2255468 **HEAD/TEACHER AT** Chimoyo Sec **SCHOOL**

Reference is made to your minute dated 8 May 2024
Please be advised that permission has been granted that you carry out research work in our schools. You are accordingly being asked to furnish the Ministry with information about your findings so that we share the knowledge for the benefit of the system as well as our nation at large.

We wish you all the best and hope to hear from you after completing your project work.

MIN. OF PRY & SEC. EDUCATION
MASHONALAND EAST PROVINCE
09 MAY 2024
P.O. BOX 752, MARONDERA
ZIMBABWE TEL: 0279-21806

MUTSIPA

HUMAN RESOURCES OFFICER – DISCIPLINE
FOR PROVINCIAL EDUCATION DIRECTOR
MASHONALAND EAST PROVINCE
/mm

Appendix F: Permission letters from Mutoko district to Chimoyo, Chatiza and Rukau secondary schools

All communications should be addres
"The District Education Officer
Mutoko District Office"
Telephone: 0272-2427
Mobile: 0772 819 456
Email: mutokodst@gmail.com

ZIMBABWE

Ministry of Primary and Secondary Education
Mutoko District
P.O. Box 20
Mutoko
Zimbabwe

10 May 2024

The Head
Rukau Secondary School

RE: PERMISSION TO CARRY OUT RESEARCH IN SCHOOLS FOR EDUCATIONAL PURPOSES: MISS MUZIKA C E.C. NO: 5401273 Y: SENIOR TEACHER: CHIMOYO SECONDARY SCHOOL: MUTOKO DISTRICT:

The above subject matter refers: Kind assist the above named to carry out her research project at your school.

Your assistance will be greatly appreciated

Yours faithfully

pp
Katuka Hayiwanziwe

District Schools Inspector – Mutoko District

SCHOOLS INSPECTOR
Primary & Secondary Education

16/05/24

THE SENIOR MASTER
RUKAU SECONDARY SCHOOL
10 MAY 2024
P. O. BOX 366
MUTOKO, ZIMBABWE

PERMISSION GRANTED

All communications should be addres
"The District Education Officer
Mutoko District Office"
Telephone: 0272-2427
Mobile: 0772 819 456
Email: mutokodst@gmail.com

ZIMBABWE

Ministry of Primary and Secondary Education
Mutoko District
P.O. Box 20
Mutoko
Zimbabwe

10 May 2024

The Head

CHIMOYO Secondary School

RE: PERMISSION TO CARRY OUT RESEARCH IN SCHOOLS FOR EDUCATIONAL PURPOSES: MISS MUZIKA C E.C. NO: 5401273 Y: SENIOR TEACHER: CHIMOYO SECONDARY SCHOOL: MUTOKO DISTRICT:

The above subject matter refers: Kind assist the above named to carry out her research project at your school.

Your assistance will be greatly appreciated

Yours faithfully

PP ZINHANZWA BENJAMIN

Katuka Hayiwanziwe

District Schools Inspector – Mutoko District

SCHOOLS INSPECTOR
Primary & Secondary Education

16/05/24

THE HEAD
CHIMOYO SECONDARY SCHOOL
20 MAY 2024
P.O. BOX 400
MUTOKO

Permission granted.

All communications should be addres
"The District Education Officer
Mutoko District Office"
Telephone: 0272-2427
Mobile: 0772 819 456
Email: mutokodst@gmail.com

ZIMBABWE

Ministry of Primary and Secondary Education
Mutoko District
P.O. Box 20
Mutoko
Zimbabwe

10 May 2024

The Head

CHATIZA Secondary School

<u>RE: PERMISSION TO CARRY OUT RESEARCH IN SCHOOLS FOR EDUCATIONAL PURPOSES: MISS MUZIKA C E.C. NO: 5401273 Y: SENIOR TEACHER: CHIMOYO SECONDARY SCHOOL: MUTOKO DISTRICT:</u>

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PP Zinhanhwa Benhamin

Katuka Hayiwanziwe

District Schools Inspector – Mutoko District

SCHOOLS INSPECTOR
Primary & Secondary Education

16/05/24

THE HEAD
CHATIZA HIGH
30 MAY 2024
P.O. BOX
MUTOKO

Dzomutswa
Permission granted