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ASSESSMENT OF CHALLENGES FACED IN TEACHING DIRECTED NUMBERS IN SECONDARY SCHOOLS: A CASE OF GWERU DISTRICT

BY

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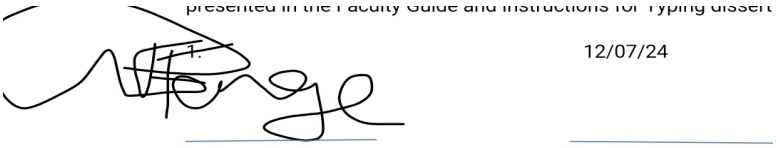

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DEDICATION

This work is dedicated to my father and mother, Mr and Mrs Chenge, for their unending support, love and encouragement during the course of this research project.

ABREVIATIONS/ACCRONYMS

ZIMSEC- Zimbabwe Schools Examinations Council

HBSCED- Honours Bachelors Science Education Degree

ABSTRACT

This study was carried out in 2024 on secondary schools found in Gweru District of Midlands Province, on a population of fifty-five participants; among them fifty students and five teachers. The purpose of carrying out this study was to assess challenged faced by teachers and learners in the teaching and learning of Directed Numbers at secondary school level. The sample of fifty-five participants was selected randomly from the case study schools. All the participants highlighted that: gross shortages of resources in many school and the concept of removing brackets when dealing with negative numbers were serious challenges they faced. It also emerged that teachers hardly used tangible aids, and that learners felt disengaged, poorly applied positive and negative numbers in everyday situations, and felt de-motivated when confronted with challenges involving Directed Numbers. Basing on the findings of this study, the researcher proposed that the Ministry of Primary and Secondary Education should come to the rescue of schools, and assist with procuring resources, as well as availing workshops to Mathematics teachers so as to equip them with skills to effectively teach Directed Numbers, and that all the concerned stakeholders (heads, teachers, learners and members of the parent community) should team up to avert them.

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CHAPTER ONE: INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

This study seeks to explore the challenges faced by both teachers and learners during the teaching and learning of Directed Numbers at secondary school level. Also to be assessed in the study, are the effects of these challenges on learners' acquisition of skills on Directed numbers as well as mechanisms to avert the identified challenges. The studying of Directed numbers is essential for Mathematics learners since most topics in the learning area depend on their application. The teaching and learning of Directed numbers is not only challenging to learners, but it also poses challenges to the educators of the subject. Evidence from Zimbabwe Schools Examination Council (ZIMSEC) reports is indicative that items involving Directed numbers confuse many learners, prompting teachers to capitalize on them whenever they want to challenge their learners.

In this chapter, the researcher seeks to outline the entire study's overview, which entails: the background to the study of Directed numbers, the problem statement, underlying objectives and research questions, as well as the significance of the study to various stakeholders. As the chapter progresses, the researcher would examine study delimitations, assumptions that undergird the study, limitations that scuttled the findings of this study, possible solutions taken as the conceptual analysis of key terms used in the study.

1.2 BACKGROUND OF THE STUDY

Worldwide, Mathematics is construed as one of the challenging subjects in the Zimbabwean secondary school curriculum. Its challenges stem from a myriad of factors, among them: limited resources, misconceptions about other topics within it, its abstract nature as well as the way other educators teach it (Mhatye, 2021). On a global scale, Mathematics teaching

takes varied trajectories, with the developed world implementing technologies and other contemporary aids in its teaching and learning, while the developing world reels under the agony of resource shortages. According to Chimhini (2021), there is no even playing field when teaching Directed numbers in developed nations and elsewhere in impoverished countries.

In Africa, the teaching of Directed numbers is not uniform across the entire region. A study carried by Victoria (2017) indicates that there are developed and developing countries in Africa that are already adopting contemporary mechanisms of dealing with troublesome topics in Mathematics like Directed numbers. Developed countries like South Africa, Botswana, Egypt and Tunisia also face numerous challenges, but they have stepped up their efforts of teaching Directed numbers, as they heavily rely on technology and other modern aids (Chaturuka and Chirume, 2023). Developing nations like Kenya and Zimbabwe continue to face countless challenges when teaching Directed numbers due to the way their curricula are designed as well as limited efforts exerted by teachers owing to low remuneration packages (Brown, 2020).

Directed numbers form the basis of all mathematical literacy, and they are such an indispensable concept which requires underscoring if further Mathematics concepts are to be grasped with ease. According to Manjengwa (2018), Directed numbers, commonly called integers, include all positive and negative whole numbers, together with zero. Their understanding lays the foundation of all mathematical calculations, and is crucial for the development of mathematical concepts such as Algebraic expressions. Previous studies have shown that students often struggle with the concept of negativity and the rules for arithmetic operations involving negative numbers (Chaturuka and Chirume, 2023). These struggles, if

not addressed in their early stages, can impede progress in more advanced mathematical topics.

An assessment of reports from the Zimbabwe School Examination Council (ZIMSEC) indicates that Directed numbers cost learners a chunk of marks if they lack precision in their manipulation. For example, the November 2022 ZIMSEC 4004/02 Examiner report indicated that though question 5 was on Matrices, the poor manipulation of Directed numbers forced many candidates to lose marks on many occasions. Similarly, the November 2023 ZIMSEC 4004/01 Examiner report unraveled that if it was not the concept of Directed numbers troubling learners, the item on inequalities would have been done easily by many candidates. From the above reports, it is noticeable that whenever Directed numbers are included in a question or concept, they have a tendency to bring challenges to the learners. Hence it could be deduced that the concept of Directed numbers should be accentuated when solving problems in the Secondary School Mathematics course.

In Zimbabwean secondary schools, particularly at Form 1 level, Directed numbers are first taught using the number line concept. This number line concept is weaned off as learners amass confidence and get used to working with Directed numbers in numerous situations. The teaching and learning of Directed numbers is dependent upon countless variables, among them: the teacher's methodologies and competences, the learners' background and motivation, availability of resources, as well as the teacher-pupil ratios (Mhatye, 2021). Each of the above variables has to be seriously taken cognizant of if the learners are to be aided to effectively comprehend Directed numbers with ease. In Gweru District, factors such as resource limitations, teacher preparedness, and the curriculum design might further complicate the teaching of Directed numbers.

Despite the critical nature of Directed numbers in the Mathematics curriculum, there is limited research focusing specifically on the challenges faced by teachers when teaching Directed numbers in Gweru District secondary schools. As alluded to before, the teaching and learning of Mathematics in secondary schools plays a pivotal role in shaping the analytical skills necessary for both higher education and everyday problem-solving. Directed numbers, as an integral component of mathematical education, provide foundational knowledge that is crucial for the understanding of more complex mathematical concepts. However, the researcher noted that the effective teaching and learning of Directed numbers effectively can be challenging, particularly in diverse educational settings like those found in Gweru District. It is against this background that this research was motivated to identify and analyze these challenges, with the intent to propose possible and actionable solutions that can enhance the efficient teaching and learning experience in this critical area.

1.3 STATEMENT OF THE PROBLEM

This study purports to make an assessment of the challenges being faced by teachers and learners in the teaching and learning of Directed numbers at secondary school level. The study was prompted by findings from previous related studies as well as a number of observations made by the researcher during the day-to-day teaching and learning of Mathematics, particularly Directed numbers. According to Mhatye (2021), Directed number operations, e.g. adding, subtracting, multiplying, and dividing, can be confusing, especially when dealing with different signs. In addition, Manjengwa (2018) submits that Directed numbers continue to be a threat to student achievement in Mathematics due to their confusing nature and demand for an exquisite approach by teachers and learners to aid understanding.

Again, Chimhini (2021) acknowledges that many students struggle to apply Directed numbers to real-world scenarios or word problems and the prior understanding of basic number concepts by students may be inconsistent. In addition to these earlier findings, the researcher also noted that the majority of teachers rushed through the topic of Directed numbers, and this compelled learners to face challenges to manipulate further mathematical calculations requiring negative numbers. Further observations made indicated that the majority of the Mathematics teachers lacked innovative tendencies and there were some educators struggling with coming up with viable techniques of teaching Directed numbers effectively. It was against these observations that the researcher was motivated to make an assessment of challenges bedeviling the teaching and learning of Directed numbers in selected schools in Gweru District.

1.4 RESEARCH OBJECTIVES

- To identify the challenges teachers and learners face when teaching Directed numbers in Gweru District secondary schools.
- To examine how these challenges affect students' understanding and mastery of Directed numbers.
- To propose strategic interventions aimed at overcoming these challenges.

1.5 RESEARCH QUESTIONS

- Which challenges are faced by teachers and learners during the teaching and learning of Directed numbers in Gweru District schools?
- How do these challenges impact on student comprehension and performance of other Mathematics topics?

- What strategies can be implemented by teachers and learners to improve the teaching and learning of Directed numbers at secondary level?

1.6 SIGNIFICANCE OF THE STUDY

The findings from this research could significantly contribute to improving Mathematics education in Gweru District by specifically addressing and mitigating challenges in teaching Directed numbers. This improvement in foundational Mathematics education could enhance overall student performance and interest in STEM fields, like Physics, Chemistry, Computer Science and Biology. In addition, Mathematics teachers may significantly benefit from this study as they are going to be acquainted with the recommended techniques of effectively teaching Directed numbers to secondary school learners. This would not only improve learner motivation in Mathematics education, but it would also improve teacher methodologies in delivering Mathematics lessons.

Moreover, policy makers are certain to benefit from this study as they shall also be familiarized with the techniques to recommend to educators of Mathematics, particularly on the teaching and learning of Directed numbers. The techniques would include teaching methods, associated aids as well as any useful recommendations to improve learner understanding. Again, in designing the Mathematics curriculum, curriculum developers may also recommend possible methodologies to be proposed by this study to improve teaching of Directed numbers. Thus, this study would eventually help learners, as all the mechanisms to be proposed by this study would be to their advantage.

1.7 DELIMITATIONS

Delimitations are the specific boundaries or parameters that are set for the research study. They define the scope and focus of the study and help to ensure that the research is manageable and feasible. The study was limited to 10 teachers and 50 learners chosen from 10 selected public schools in Gweru District. The study was also done in 5 weeks. These delimitations helped to ensure that the study was focused and manageable, and that the findings were relevant to the study.

1.8 LIMITATIONS

The researcher would have preferred to carry this study in many schools in Gweru District but due to time and monetary constraints, this study was conducted in a limited number of schools, which may not be representative of all Gweru District Schools. The research was carried out within 5 weeks, which was insufficient time to fully explore all aspects of the challenges faced by teachers and learners in teaching and learning of Directed numbers. Again, due to the limited population used, the findings of the study were not generalizable to church-owned schools, private schools and schools in other districts. Thus, the researcher selected the research sample with discretion to improve the validity of the findings. To a greater extent, the act of conducting the research influenced the behaviour of the teachers involved, thus, potentially affecting the validity of the findings. This means that the time educators were notified that such a study was being carried out, they were compelled to change their approach to the way they had been teaching Directed numbers. Thus, extra care was taken before the conduct of the study, lest the participants changed their way of delivering Mathematics.

1.9 ASSUMPTIONS

The study was hinged on the following assumptions:

1.9.1 That all participants of this study were mature enough to proffer credible and unbiased information

1.9.2 That all issues under investigation remained constant throughout the study.

1.9.3 That teachers and learners used in this study had an appreciation and understanding of Directed numbers.

1.10 DEFINITIONS OF KEY TERMS

Directed numbers – both negative and positive numbers, together with zero:

Mathematics – the scientific study of numbers and their manipulations in a variety of settings.

Teaching and learning – the process by which teachers impart knowledge and skills to learners using diversified methodologies (Gwarinda, 2015).

1.11 SUMMARY

In this elementary chapter, the researcher examined the background of the study, statement to the problem, research questions, study objectives, importance of the study to different groups of people, and study limitations. Moreover, the researcher examined assumptions of the study as well as the conceptual analysis of key terms. In the next chapter, the attention is now focused on the literature review.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This section articulated on what earlier researchers found regarding the main concepts of the study, among these: the general teaching and learning of Directed numbers, challenges encountered by teachers and learners during the learning process as well as the mechanisms to put in place to aid comprehension of the topic. The conceptual framework and the theory which underpinned this study were also discussed in this section.

2.2 TEACHING OF DIRECTED NUMBERS

Though approaches of teaching Mathematics topics follow a similar trajectory, the teaching and learning of Directed numbers is a special case in which the educators have to be as innovative as possible, lest they may not reap intended instructional objectives. According to Victoria (2017), Directed numbers have varied approaches of teaching their concepts but they remain a challenging topic in the secondary school curriculum. All the four operations: addition, subtraction, multiplication and division of Directed numbers pose different kinds of challenges depending on the context in question. For example, Brown (2020) concedes that the teaching and learning of Directed numbers, particularly addition and subtraction of Directed numbers can pose several challenges, including: understanding the concept of direction and magnitude, dealing with negative numbers and their operations, visualizing and representing Directed numbers on a number line or coordinate plane as well as applying the correct rules for adding Directed numbers, e.g. the same signs add, different signs subtract phenomenon.

Moreover, the teaching and learning of Directed numbers involves managing calculations involving multiple Directed numbers, interpreting the meaning of the result in the context of

the problem and overcoming common misconceptions, e.g. thinking that -3 - -2 is -5 instead of -1. Again, the teaching and learning of Directed numbers also incorporates transferring understanding to real-world applications and word problems, adapting to different notation and terminology, e.g. minus vs. negative, and building fluency and efficiency in calculations involving Directed numbers, among others (Manjengwa, 2018). To navigate with ease on some of these challenges, it's essential for teachers to provide clear explanations, visual aids, practice opportunities, and real-world connections, as well as to address common misconceptions and offer targeted support.

2.3 CONCEPTUAL FRAMEWORK

The conceptual framework serves as a pathway that directs the way this study was undertaken, and this involves a sequential linkage of how issues at stake were tackled by the researcher. This study is conceptualized to determine challenges that militate on the effective teaching and learning of Directed numbers at secondary school level. This is achieved by looking at various aspects, among these: a general overview of the teaching and learning of Directed numbers, why they are such an important topic in the Mathematics curriculum, as well as mechanisms that can be instituted to improve the teaching and learning of Directed numbers. The diagram below sheds light on the investigative path to be taken by the researcher.

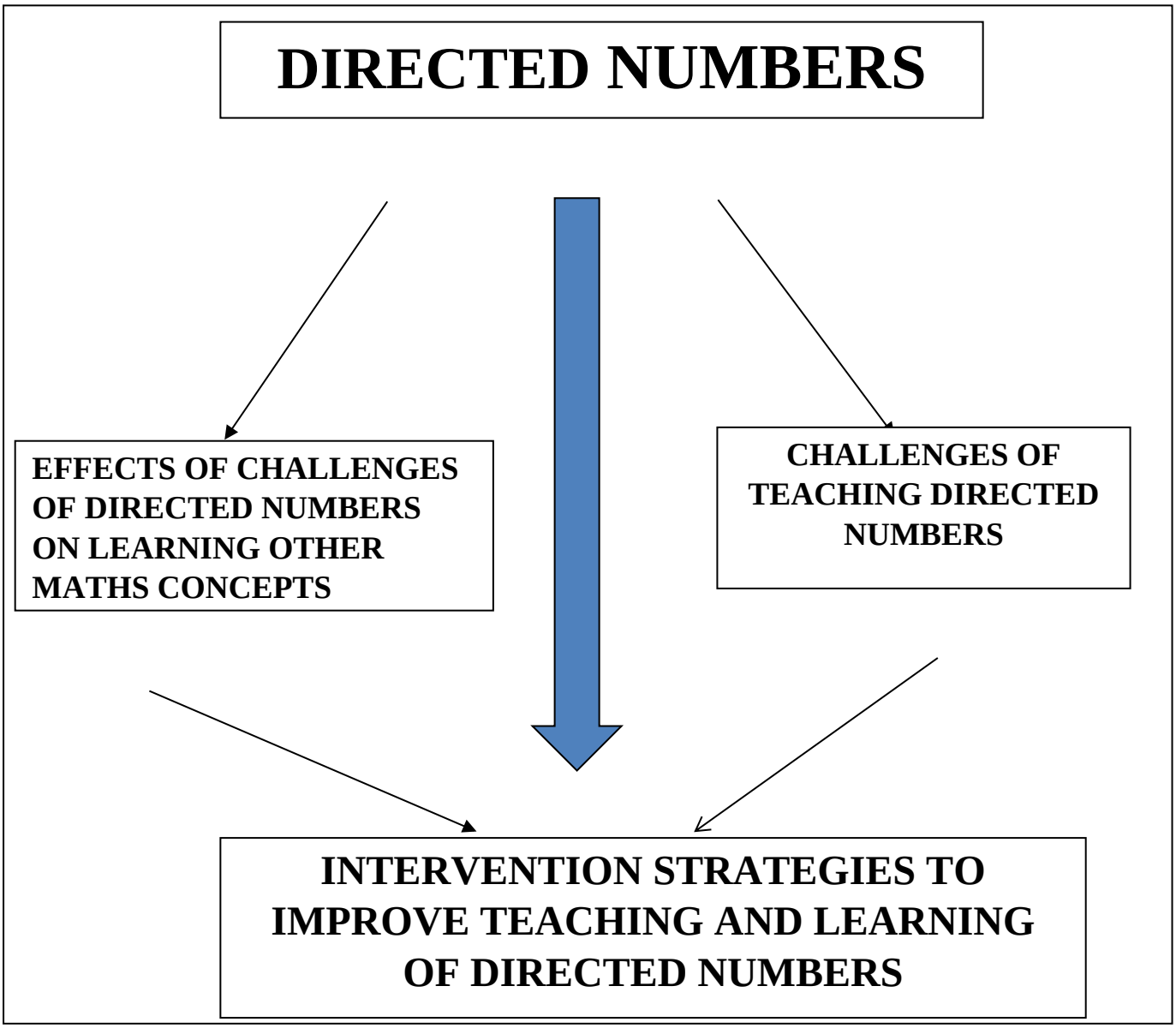

FIGURE 1.9.2 CONCEPTUAL FRAMEWORK (OWN SOURCE)

2.3 THEORETICAL FRAMEWORK

This study is grounded in the constructivist theory, which posits that learning occurs through the interaction between a child's existing knowledge and new ideas (Glaserfield, 2019). This means that learners actively interpret, organize, and understand new information in relation to their current knowledge. If learners are not given the opportunity to construct their own

understanding, they may simply memorize rules and formulas without truly comprehending the underlying concepts. Meyer (2019) notes that constructivism supports relational understanding, emphasizing the importance of active learning experiences in the teaching and learning of directed numbers. Rather than providing ready-made rules, learners should be given opportunities to actively construct their own understanding of directed number manipulation.

The constructivism learning theory highlights the learner's active role in constructing their own understanding (Fostnot, 2015). The theory's key principles, as outlined by Smith, Dissessa, and Rochelle (2014), are that: knowledge is constructed, not passively received; learning is a social activity, facilitated by interactions with others; learning is an active process, requiring engagement and participation, and that learning is contextual, occurring within the context of our lives and experiences. According to constructivists, learners build upon their pre-existing knowledge, actively engaging in discussions and activities to construct new understanding. Learning is a dynamic process that occurs alongside other aspects of our lives, and as learners progress, they develop the ability to select and organize knowledge more effectively. This theory emphasizes the importance of active learning, social interaction, and contextual understanding in the learning process

According to Skemp (2017), instrumental understanding, which is based on rote learning, is often difficult to recall and apply in new situations because it lacks depth and meaning. This shallow understanding can lead to mistakes, particularly in tasks involving abstract concepts like negative numbers. Learners may attempt to apply rules without fully comprehending their relevance or connection to prior knowledge, resulting in errors. To develop a robust understanding, learners must reconstruct knowledge in a meaningful way, but this construction is not entirely free-form; rather, it is guided by existing mathematical structures and principles.

Constructivism as a learning theory also suggests that students construct their own knowledge and understanding through experiences and social interactions. In the context of teaching Directed numbers, also known as integers, constructivism can be applied in many ways. For example, Smith et al., (2014) submits that teachers can use everyday situations to demonstrate the use of Directed numbers, such as temperatures, elevations, or financial transactions. Again, Oliveira (2018) posits that educators may employ collaborative activities in which they pair students to work together to solve problems involving Directed numbers, encouraging them to share their thinking and learn from each other. Similarly, Vlassis (2018) contends that constructivism encourages inquiry-based learning, which provides students with open-ended questions or scenarios that require the use of Directed numbers to solve, allowing them to explore and discover concepts on their own.

Using the constructivist theory, it could be established that learners acquire knowledge on Directed numbers through visual representations. This implies that teachers may resort to the use of number lines, graphs, or diagrams to help students visualize and understand the concept of Directed numbers. Other proponents of the constructivism theory propound that problem-solving, which offers students a range of problems, gradually increasing in complexity, to develop their understanding and application of Directed numbers, is also another viable approach to their teaching and learning (Shahrill, 2017; Brodie, 2014). Reflection and feedback, which are also tenets of constructivism, can also be used to encourage students to reflect on their learning and provide constructive feedback to help them refine their understanding of Directed numbers. Thus, by applying constructivist principles, students will develop a deeper understanding of Directed numbers and improve their problem-solving skills, critical thinking, and collaboration.

2.5 WHICH CHALLENGES ARE FACED BY TEACHERS AND LEARNERS DURING THE TEACHING AND LEARNING OF DIRECTED NUMBERS?

2.5.1 Removing brackets

The teaching and learning of Directed numbers poses challenges in multifaceted forms. When concluding the Focus on Maths Students' Book 3, the topic Directed numbers is highlighted as one of the two troublesome topics in Mathematics, together with Algebra (Stakesby, 2003). This indicates that the author is reminding readers that before they progress to the next level, they should be fully acquainted with the concepts of Directed numbers and Algebraic processes. Chimhini (2021) also hints that there are certain concepts where Directed numbers tend to bring challenges to learners, for example, when removing a bracket using a negative multiplier [-4(2x – 8)]. Again, the use of Directed numbers in manipulating inequalities, where dividing by a negative number changes the inequality sign, is also another useful application worth mentioning.

2.5.2 Poor application in other related topics

Chaturuka and Chirume (2023) also aver that Directed numbers pose challenges when tackling topics like Factorization, Equations as well as Matrices. All these cited examples indicate that Directed numbers are very challenging though indispensable in enhancing comprehension of various mathematical concepts.Relatedly, Chimhini (2021) submits that when teaching positive and negative numbers, some common problems that teachers may encounter include: students struggling to understand the concept of negative numbers and their relationship to positive numbers, difficulty in visualizing and representing negative numbers on a number line or coordinate plane, confusion between the concepts of "negative" and "minus", e.g. understanding that "-3" means "negative three" rather than "minus

three"and trouble with understanding the rules for operations with negative numbers, e.g. multiplying or dividing by a negative number.

2.5.3 Applying Directed numbers in real life situations

By the same token, Smith and Doe (2018) assert that learners face difficulties in applying positive and negative numbers to real-world scenarios or word problems and some students' prior experiences and intuition about numbers can lead to misconceptions, e.g. thinking that "-5" is greater than "3" because it has a larger absolute value. To add to that Chimhini (2021) acknowledges that many students struggle to understand the concept of zero as a placeholder and its relationship to positive and negative numbers. Some learners also face difficulties with mental Mathematics calculations involving negative numbers and show limited understanding of vocabulary related to positive and negative numbers, e.g. magnitude and direction. On the other hand teachers also face challenges in assessing students' understanding of positive and negative numbers due to limited or unclear assessment tools. By being aware of these potential challenges, teachers can proactively address them and create targeted strategies to support their students' learning.

2.5.4 Inadequate conceptual understanding

Inappropriate conceptual understanding can negatively impact on the teaching and learning of Directed numbers in several ways, among them: lack of foundation, confusion and misconceptions, difficulties with operations, inability to apply to real-world situations, as well as fear or anxiety (Levison, 2016; Adler and Pillay, 2017). This means that if students don't fully understand the concept of negative numbers, they may struggle to build upon that knowledge, making it harder to learn more advanced concepts. Again, inadequate conceptual understanding can lead to confusion and misconceptions, such as thinking that negative numbers are greater than zero or struggling to understand the concept of zero itself. Nesher

(2017) avers that without a solid conceptual understanding, students may find it challenging to perform arithmetic operations involving Directed numbers, leading to errors and frustration. Thus, if students don't grasp the conceptual understanding of Directed numbers from the onset, they may struggle to apply them to real-world scenarios, eventually limiting their ability to solve everyday problems that involve them. Thus, conceptual difficulties can lead to fear or anxiety, causing students to become disengaged and disconnected from the learning process.

2.5.5 Poor assessment criteria

In the same line of opinion, Makonye and Fakuda (2016) opine that teachers may become frustrated if students lack conceptual understanding, leading to a lack of patience and effective teaching strategies. Again, without a clear understanding of conceptual knowledge, teacher assessments may focus too much on procedural fluency, rather than deep understanding, and gaps in conceptual understanding can lead to a snowball effect, making it harder for students to catch up and understand more advanced Mathematics concepts. Davies (2017) also views disconnection from prior knowledge as detrimental, since if students don't see the connection between Directed numbers and prior knowledge, they may view it as isolated and unrelated, leading to a lack of engagement. Eventually, learners will have limited problem-solving skills because without a solid conceptual understanding, students may struggle to develop effective problem-solving skills, limiting their ability to tackle complex challenges (Charalambous, Hill & Ball, 2011; Wallach and Even, 2015). Nonetheless, by addressing conceptual understanding appropriately and in befitting contexts, teachers can help students build a strong foundation, reduce misconceptions, and foster a deeper understanding of Directed numbers.

2.5.6 Improper number line visualization

Number line visualization can negatively affect the teaching and learning of Directed numbers through limited representation, confusion between negative and positive placements, difficulties with zero as well as inadequate representation of magnitude (Qris, Putri&Susanti, 2017). This entails that a traditional number line may only show positive numbers, making it difficult for students to visualize and understand negative numbers, and as a result, students may struggle to distinguish between positive and negative numbers on the number line, leading to confusion and errors. Moreover, the number line may not adequately represent the concept of zero, leading to confusion about its role in the number system. To add to that, Oni (2018) concedes that number lines may not effectively convey the magnitude of negative numbers, making it hard for students to understand their relative sizes. In other instances, overreliance on number lines may oversimplify the concept of Directed numbers, leading to a lack of depth in understanding required in its absence.

2.5.7 Use of inappropriate diagrams

In another version of findings, McNeil and Jarvin (2017) posit that use of cluttered or complex diagrams can cause visual overload, making it difficult for students to focus and understand. For example, the given diagrams may not provide enough contexts for students to understand the real-world applications and relevance of Directed numbers. Relatedly, some of the diagrams used by teachers may provide insufficient differentiation, implying that they may not be suitable to different learning styles, leading to some students struggling to understand the concept of Directed numbers (Wessman-Enzinger and Mooney, 2019). Some diagrams may focus too much on procedural fluency, rather than conceptual understanding, leading to a lack of deep understanding. Consequently, this may not provide enough support for students to solve word problems involving Directed numbers, leading to difficulty in applying their concepts to real-world scenarios. By acknowledging these limitations, teachers

can supplement diagrammatic visualization with other teaching strategies to provide a more comprehensive understanding of Directed numbers.

2.5.8 Inconsistent operations with negative numbers

Operations with negative numbers can negatively affect the teaching and learning of Directed numbers in several ways. According to Zakaria, Solfitri, Daudi&Abdin (2013), most learners encounter confusion with sign rules and resultantly struggle to remember and apply the correct sign rules for addition, subtraction, multiplication, and division involving negative numbers. Similar findings by Brown and Drougard (2014) also reveal that some students may find it challenging to perform mental calculations involving negative numbers, leading to errors and frustration. This may be a result of different notation conventions, e.g. -5 or 0 – 5, can cause confusion and inconsistency in teaching and learning. Again, operations with negative numbers may not be easily represented visually, making it hard for students to understand the concepts, and gaps in understanding operations with negative numbers can lead to a snowball effect, making it harder for students to understand more advanced Mathematics concepts (Makonye and Fakuda, 2016). By acknowledging these challenges, teachers can develop targeted strategies to support students' understanding and proficiency with operations involving Directed numbers.

2.5.8 Inability to interpret word problems

Word problem interpretation can negatively affect the teaching and learning of Directed numbers in numerous ways. For example, word problems may not provide enough contexts for students to understand the real-world applications and relevance of Directed numbers, and students may struggle to translate word problems into numerical expressions, leading to errors and frustration (Levison, 2016; Shahrill, 2017). Moreover, students may not

understand key vocabulary related to Directed numbers, and most educators use word problems primarily to practice procedural fluency, rather than encouraging conceptual understanding and critical thinking. Stoner (2004) also contends that word problems may not adequately represent diverse scenarios, leading to a lack of connection to students' lives and interests. This entails that word problems involving Directed numbers may be too complex, causing cognitive overload and difficulty for students to focus on the mathematical concepts. In a similar finding, Oni (2018) submits that word problems may not include visual aids, making it harder for students to understand and interpret the situations. By acknowledging these challenges, teachers can develop strategies to support students' interpretation and solution of word problems involving Directed numbers, such as using real-world examples, visual aids, and diverse scenarios.

2.5.9 Lack of practice

Lack of practice can negatively affect the teaching and learning of Directed numbers as it can lead to a lack of fluency and proficiency in performing operations with Directed numbers. Sentiments by Seb, Tengah &Shahrill (2017) reveal that without adequate practice, students may struggle to retain and recall concepts and procedures related to Directed numbers. This also means that lack of practice can lead to lack of confidence and motivation, causing students to become disengaged and disconnected from the learning process. Practice reinforces and consolidates learning, and limited practice can lead to lack of reinforcement and consolidation of Directed number concepts. Aris et al., (2017) also concede that practice also helps to develop procedural fluency, and to build connections between concepts, and lack of practice can make it difficult for students to connect Directed numbers to other mathematical concepts. Practice helps students develop problem-solving strategies, which are essential for working with Directed numbers. By providing adequate practice opportunities,

teachers can help students develop fluency, confidence, and a deeper understanding of Directed number

2.5.10 Language barriers

Language barriers can also negatively impact on the teaching and learning of Directed numbers as students may struggle to understand key vocabulary and terminology related to Directed numbers, leading to confusion and misunderstanding. According to Cornelius-Ukpepi, Olglazor&Odey (2016), language barriers can make it difficult for students to grasp the conceptual understanding of Directed numbers, leading to lack of depth in understanding, and students may struggle to understand word problems and applications involving Directed numbers. On the other hand, Seb et al., (2017) posit that due to language barriers, teachers may struggle to communicate Directed number concepts clearly, causing decreased participation and engagement in class, as students may feel uncomfortable to understand the language. Language barriers can also make it difficult for students to work collaboratively and support each other in learning and can make it challenging for teachers to provide targeted support and feedback to students, leading to lack of personalized learning (Levison, 2017). By acknowledging and addressing language barriers, teachers can develop strategies to support students' proficiency with Directed numbers, such as using visual aids, providing extra support, and using multilingual resources.

2.6 HOW DO CHALLENGES ON DIRECTED NUMBERS IMPACT ON STUDENT COMPREHENSION AND PERFORMANCE IN OTHER MATHEMATICS TOPICS AND OTHER SUBJECT AREAS?

2.6.1 Failure to apply Directed numbers in other learning areas

The teaching and learning of Directed numbers is a concept developed in early secondary education, and serves as preparatory for advanced concepts not only in Mathematics, but also

in other related STEM learning areas like Physics, Computer Science, Biology and Chemistry. According to Mhatye (2021), learners who encounter serious challenges with Directed numbers at an early stage find it difficult to navigate through other Mathematics topics like Equations. This entails that the topic of Directed numbers should be taught effectively so that it sets a firm underpinning upon which all other mathematical concepts will build upon. Chaturuka and Chirume (2023) also posit that even the established Mathematics student is sometimes caught within the intricate maze of mathematical calculations involving Directed numbers. This implies that, experience working with them notwithstanding, Directed numbers can pose challenges at any stage of the education ladder. Even Mathematics teachers sometimes make glaring mistakes when manipulating Directed numbers in front of learners, an indication that the topic requires a meticulous approach to tackle it.

2.6.2 Building connections with other Mathematics concepts

Directed numbers are connected to other mathematical concepts, such as algebra, geometry, and calculus, and challenges in understanding Directed numbers can make it difficult to build connections to these other concepts (Zakaria et al., 2013). This means that Directed numbers are a fundamental concept in Mathematics, and difficulties in understanding them can create a weak foundation for future mathematical concepts. Sarwad and Sahrill (2014) also aver that building connections between Directed numbers and other mathematical concepts can actually positively affect the teaching and learning of Mathematics. However, if not done effectively, building connections can have some negative effects, such as: lack of depth in understanding individual concepts, confusion and cognitive overload, especially for students who struggle to understand individual concepts (Vlassis, 2018; Amino, Helmanto&Hidayat, 2020). Again, if connections are not clearly explained, students may become confused and

struggle to understand the relationships between concepts, and inadequate assessment may not accurately evaluate students' understanding of individual concepts if too much emphasis is placed on connections.

2.6.3 Challenges in problem-solving and reasoning

According to Levison (2016), problem solving and reasoning are essential skills in Directed numbers, and they can actually positively affect the teaching and learning of other Mathematics concepts. Nonetheless, according to Salam and Shahrill (2014), focusing too much on problem solving and reasoning can lead to an overemphasis on procedural fluency, potentially neglecting conceptual understanding, and if problem solving and reasoning are not balanced with conceptual understanding, students may develop a superficial understanding of math concepts. Again, teachers may inadvertently bias their instruction towards problem-solving and reasoning, potentially neglecting other important mathematical concepts, and this can lead to anxiety and stress, potentially negatively affecting students' mathematical achievement. Likewise, Oliveira (2018) submits that if problem solving and reasoning are overly structured during teaching of Directed numbers, students may not have the opportunity to explore and develop their own problem-solving strategies. Thus, if students are not provided with adequate support and scaffolding, problem solving and reasoning can become a source of frustration and confusion.

2.6.4 Anxiety and lack of confidence

Challenges in understanding Directed numbers can lead to mathematical anxiety and lack of confidence, affecting students' willingness to engage with other math concepts. Mathematics anxiety and lack of confidence in Directed numbers can negatively affect the teaching and learning of other Mathematics concepts by causing students to avoid challenging

mathematical problems and concepts, as well as inducing disengagement and a lack of motivation to learn new mathematical concepts (Charalambous et al., 2011). Moreover, students with mathematics anxiety may engage in negative self-talk, telling themselves they are not good in Directed numbers, leading to a lack of confidence. It also follows that teachers may avoid teaching challenging Mathematics topics if they perceive students as lacking confidence or having math anxiety in Directed numbers. To add to that, Sikoyo and Jacklin (2019) posit that Mathematics anxiety can lead to stereotype threats, where students feel they belong to a group that is not expected to be good at math, as well as a fixed mindset, where students believe their math ability is fixed and cannot be changed. Consequently, students lack persistence and resilience when faced with challenging math problems involving Directed numbers.

2.6.5 Limited teacher confidence and poor instruction

Findings by Young and Muller (2013) indicate that those teachers who lack confidence in teaching Directed numbers may also lack confidence in teaching other math concepts, potentially leading to inadequate instruction. This means that teachers who lack a deep understanding of Directed numbers may also lack a deep understanding of other related mathematical concepts, potentially limiting their ability to teach effectively. In addition, Singh (2012) opines that teachers who struggle to plan effective lessons for Directed numbers may also struggle to plan effective lessons for other mathematical concepts, and resultantly these teachers may also lack confidence in assessing and testing other mathematical concepts, potentially leading to inadequate evaluation of student learning. Thus, teachers who lack confidence and effectiveness in teaching Directed numbers may also struggle to motivate and engage students in other math concepts, and may also struggle to teach more advanced math concepts, potentially limiting curriculum progression.

2.6.6 Flawed curriculum progression

Curriculum progression can actually positively affect the teaching and learning of Directed numbers, as it allows for a logical and coherent sequence of concepts. However, if not implemented effectively, curriculum progression can have some negative effects. For example, Sherin (2015) suggests that rushing through Directed number concepts to meet curriculum deadlines can lead to superficial understanding and inadequate retention. Again, inadequate review and practice of previously taught concepts can lead to forgetting and a lack of fluency. Thus, curriculum progression can reveal gaps in understanding, as students may not have fully grasped previous concepts. Curriculum progression can also lead to lack of context and applications, making Directed numbers seem abstract and irrelevant. For most educators, Rowland and Turner (2018) upholds that rushing through the curriculum can lead to teacher burnout and student disengagement, as students may feel overwhelmed or disconnected from the concepts at hand.

2.6.7 Lack of student motivation and engagement

Student motivation and engagement can gainfully affect the teaching and learning of Directed numbers. Nonetheless, if student motivation and engagement are low, it can negatively impact the teaching of numerous Mathematics concepts. For example, unmotivated students may not participate in class, potentially disrupting the learning environment and affecting others' engagement. Again, negative attitudes towards Directed numbers can spread to other students, creating a toxic learning environment. As opined by Zaski and Leikin (2015), most unmotivated students may not put in the necessary effort to learn new concepts, potentially leading to lack of understanding and achievement; and they may not see the relevance of Directed numbers to their lives, potentially leading to a lack of interest in other mathematical concepts. This follows that unmotivated students may not perform well on assessments and

tests, potentially leading to lack of confidence and motivation, and teaching unmotivated students can lead to teacher burnout and decreased enthusiasm for teaching.

2.7WHAT STRATEGIES CAN BE IMPLEMENTED BY TEACHERS AND LEARNERS TO IMPROVE THE TEACHING AND LEARNING OF DIRECTED NUMBERS AT SECONDARY LEVEL?

2.7.1 Regular assessment on Directed numbers

Chimhini's (2021) analysis of learner workbooks and tasks revealed that the primary obstacle in learning directed numbers is the lack of utilizing the number line model to demonstrate relational understanding of addition and subtraction. Similarly, Makonye and Fakuda's (2016) study identified premature calculator use, inadequate textbook examples, and limited English proficiency as sources of errors in directed number manipulation. To address these challenges, Makonye (2012) recommends regular assessments using diverse tools and strategies, encouraging student reflection, providing feedback and encouragement, and staying updated with best practices in mathematics education. By implementing these strategies, teachers can create a supportive environment that fosters mastery of directed numbers.

2.7.2 Incorporating real-life scenarios

Real-life scenarios can significantly enhance the teaching and learning of Directed numbers by making concepts more relatable and tangible, providing context and purpose for learning, helping students see the practical applications and relevance of Directed numbers, encouraging students to think critically and solve problems, and developing a deeper understanding of Directed numbers through authentic experiences (Cole, 2022; Baku, 2020). As espoused by Yohannes, Bhatti&Hasan (2016), examples of real-life scenarios that can improve teaching and learning of Directed numbers include: temperature changes, elevation

and depth (e.g., hiking, scuba diving), financial transactions (e.g., gains and losses) as well as time zones and travel. Similarly, Bernstein (2020) suggests that educators can use measurement conversions (e.g., Celsius to Fahrenheit), stock market fluctuations, scorekeeping in games, as well as, altitude and atmospheric pressure. By incorporating real-life scenarios into teaching and learning, educators can help students develop a more practical understanding of Directed numbers, making the concepts more memorable.

2.7.3 Practice and reinforcement

To a greater extent, practice and reinforcement are essential to improve teaching and learning of Directed numbers as they aid to consolidate new knowledge and skills, build confidence and fluency, develop long-term retention, enhance problem-solving and critical thinking, and encourage active learning and engagement (Bell, 2015). Through practice and reinforcement, teachers can also identify and address misconceptions, provide opportunities for feedback and assessment, and foster a deeper understanding of concepts and relationships. Effective practice and reinforcement strategies include: worksheets, online resources, interactive games, mathematical puzzles, as well as brain teasers. Through incorporating regular practice and reinforcement, educators can help students develop a strong foundation in Directed numbers, leading to improved understanding, retention, and application of mathematical concepts (Jacobs, Lamp & Phillip, 2010; Muller, 2012; Peng and Luo, 2019).

2.7.4 Use of storytelling

Apart from it being a narrative teaching and learning approach, Schunk (2021) contends that storytelling can improve teaching and learning of Directed numbers through making concepts more relatable and memorable, providing a context for learning, as well as encouraging active listening and engagement. This means that storytelling helps students to visualize and connect abstractly with Directed numbers and develop problem-solving and critical thinking

skills in learners. Again, storytelling makes Directed numbers more enjoyable and interactive and it allows students to see the relevance and application of Directed numbers through creativity, imagination, differentiated instruction and creating a positive and inclusive learning environment (Ryan and Williams, 2017; Hill, Ball & Schilling, 2018). Examples of storytelling strategies for teaching Directed numbers include: word problems with a narrative twist, real-life scenarios, case studies, and student-generated stories. By incorporating storytelling into teaching and learning, educators can make Directed numbers more accessible, engaging, and memorable for students, leading to a deeper understanding.

2.7.5 Using games

Games are also instrumental and can improve teaching and learning of Directed numbers by: making learning fun and engaging, providing an interactive and immersive experience, encouraging active participation and experimentation, developing problem-solving and critical thinking skills, as well as offering a safe space to take risks and learn from mistakes (Jacobs et al., 2010; Zakaria et al., 2013). Similarly, McNeil and Jarvin (2017) consolidate the above assertions and further adds that use of games when teaching Directed numbers aid in promoting collaboration and teamwork, reinforcing concepts through repetition and practice, providing immediate feedback and assessment, and enhancing retention and recall of math concepts. Examples of games for teaching Directed numbers include: Number Line Hop, Math bingo, Directed Number War and Directed Number Scavenger Hunt (Curriculum Development Unit, 2017). Games can also be adapted to suit various learning needs and styles, making them an effective tool for teaching Directed numbers and promoting a positive mathematical culture.

2.7.6 Technology integration

Technology integration can improve teaching and learning of Directed numbers by inducing interactive visualizations. This entails using digital tools to create interactive number lines, graphs, and diagrams as well as utilizing digital manipulatives, like virtual blocks or number tiles to explore Directed numbers (Baku, 2020). In addition, Chang (2015) accepts that technology integration involves use of online resources, i.e. accessing and making use of a wealth of online resources, such as videos, tutorials. Thus, technology integration can improve teaching and learning of Directed numbers by stimulating interactive visualizations and use of collaborative tools. Again, digitalization can be essential when tackling Directed numbers as digital platforms enable students to collaborate, share ideas, and work together. Davies (2017) also advises educators to utilize technology for formative and summative assessments, adjusting difficulty levels to aid comprehension of Directed numbers.

2.7.7 Collaborative learning

Collaborative learning, commonly called group work, improves teaching and learning of Directed numbers by: encouraging peer-to-peer learning and support as well as fostering a sense of community and teamwork (Wallach and Even, 2015; Sikoyo and Jacklin, 2019). This means that collaborative learning promotes active participation and engagement, develops communication and problem-solving skills and encourages diverse perspectives and ideas among learners. Similarly, Oni (2018) contends that collaborative learning builds confidence and self-esteem; and provides opportunities for feedback and assessment. This is made possible by group work facilitating differentiated instruction and learning, developing critical thinking and creativity as well as enhancing retention and recall of math concepts. Collaborative learning strategies for teaching Directed numbers include: pair work and peer-to-peer learning, small group discussions, Mathematics clubs and study groups (Aris et al., 2017). When incorporating collaborative learning, educators can create a supportive and

inclusive learning environment, promoting a deeper understanding and improved proficiency in Directed numbers.

2.7.8 Using visual aids

In a study carried out in South Africa by Oni (2018), visual aids improved teaching and learning of Directed numbers by helping students visualize and understand concepts more clearly and making abstract ideas more concrete and tangible. This means that visual aids provide a clear and concise representation of information and they facilitate comparison and contrast of different concepts, by supporting students with different learning styles, e.g. visual and spatial. In the same vein, Baku (2020) also acknowledges that visual aids help to enhance retention and recall of mathematical concepts and encourage active learning and engagement by providing a shared reference point for discussion and collaboration. This resultantly helps students to recognize patterns and relationships, ultimately making Directed numbers more accessible and enjoyable. Common visual aids for teaching Directed numbers include: number lines, graphs and charts, diagrams, flowcharts, pictures as well as videos and animations. By incorporating visual aids into teaching and learning, educators can create a more engaging, inclusive and effective mathematics learning experience.

2.7.9 Implementing concrete learning

Sentiments opined by Amino (2020) indicate that concrete learning improves teaching and learning of Directed numbers by using physical materials, like blocks, number lines, or other manipulatives, and by providing a concrete representation of abstract concepts, making them more accessible. Again, Sahat, Tengah &Prahmana (2018) aver that by encouraging students to interact with materials to foster a deeper understanding, using everyday objects to demonstrate Directed numbers to make them more relatable. This means that concrete learning helps by engaging visual, tactile, and kinesthetic learners, and therefore catering to

different learning styles. Examples of concrete learning materials for Directed numbers include: number tiles or blocks; Directed number lines or hundreds charts, counting cubes or measurement tools such as rulers and thermometers. Similarly, Cornelius-Ukpepi et al., (2016) observe that teachers may use real-world objects like temperature gauges or elevators and other manipulatives like geoboards, pegboards, pattern blocks, fraction tiles or money or shopping scenarios. By incorporating concrete learning, educators can create a hands-on, interactive, and engaging learning environment that enhances effective skill acquisition in Directed numbers.

2.7 RESEARCH GAP

While the literature referred to in this study outlined a number of attributes pertaining to the teaching and learning of Directed numbers, there seems to be a research gap regarding the challenges facing teachers and learners in manipulating them, particularly when negations are involved. The consulted literature revealed that while efforts were being made by educators to improve the teaching and learning of Directed numbers, challenges continued to dog this topic, particularly its application in other Mathematics concepts or other subjects. The literature consulted in this study did not only unravel the most common challenges that bedevil the teaching and learning of Directed numbers, but also revealed other emerging shortcomings often overlooked by teachers. It is against these revelations that the study will make an assessment of challenges that hamper the effective teaching of Directed numbers in the sampled schools.

2.8 SUMMARY

The chapter examined the literature that the researcher obtained from earlier educationists on the teaching and learning of Directed numbers, particularly the challenges they pose to learners, how these challenges militate on the comprehension of other mathematical concepts, as well the possible strategies that can be implemented to improve the teaching and learning

of Directed numbers. Of particular mention were challenges to do with manipulation of negative numbers, the detrimental effects these challenges pose to topics like Algebraic expressions, Matrices of Inequalities, as mechanisms of averting the challenges such as technology integration, use of visual aids and incorporating of real life scenarios. The researcher also outlined the research gap that prompted her to partake of this study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter alludes to the methods adopted by the researcher when gathering data for this study. Examined by the researcher were: the research design, target population, sample, sampling procedure, as well as research instruments. Also examined in this chapter were the merits and demerits of the research design adopted and the instruments used, as well as mechanisms employed to avert the latter.

3.2 RESEARCH DESIGN

According to Phillips and Pugh (2016), a research design serves as a roadmap for collecting, analyzing, and interpreting data. In this study, the researcher employed a mixed methods approach, which offered the flexibility to conduct face-to-face interviews (Punch, 2015) and utilize both quantitative and qualitative methods for data collection, presentation, and analysis. This approach enabled the researcher to gain a deeper understanding of the research topic from the perspective of the local population, capturing cultural behaviors in a social context. The mixed methods design was chosen to provide new insights and depth to existing knowledge, leveraging the strengths of both qualitative and quantitative approaches to compensate for their individual limitations (Leedy, 2019).

3.3 POPULATION, SAMPLE AND SAMPLING PROCEDURE

Creswell (2012) defines population as the collection of individuals known to have similar characteristics. Gweru District comprises 48 secondary schools, with close to ten thousand learners taking Mathematics at Ordinary Level. The district had up to 130 Mathematics teachers as well as more than 5000 Mathematics students, and since the student population

was too big, the researcher shall target 50 pupils doing Ordinary Level Mathematics. Ten Mathematics teachers were also selected for use in this study. The researcher chose this sample size because it was a fairly large sample to enable generalization of the findings, but not too large to be too expensive and time consuming.

Borg and Gall (2019) define a sample as a subset of a population that is used to represent the entire group. When doing research, it is often impractical to survey every member of a particular population. Popper (2014) also states that a research sample should not only be representative of the population from which it is drawn, but should also give results which share common features. Thus, sampling was a way of selecting individuals who participated in the study. The researcher used purposive sampling to come up with her desired population. Popper (2014) accepts that this type of sampling selects the subjects using a particular characteristic, in this case the fact of being an Ordinary Level Mathematics student or Mathematics teacher. Stratified sampling, which entails categorizing the respondents in two strata, was also be used to select teachers and learners before randomization.

This follows that the study totally excluded those students and teachers not doing or teaching Mathematics respectively. This enabled the researcher to specifically collect data on the challenges experienced by teachers and learners during the teaching and learning of Directed numbers. To come up with the required sample of 50 students, the researcher also used the random sampling technique. Popper (2014) defines randomization as a sampling technique in which participants are selected in a free and irregular way, and the researcher preferred this method as a fair way of selecting a sample from a given population, since all members were given equal opportunities of being selected. The teachers who participated in the study were also selected using random sampling, and were all taken from the Mathematics departments.

3.4 Research Instruments

The researcher employed a multi-faceted approach to data collection, utilizing three research instruments: questionnaires, direct observations, and interviews (Phillips & Pugh, 2016). This triangulation methodology enhanced the validity and reliability of the data. Interviews were conducted with teachers, questionnaires were administered to learners and observations were done on both teachers and learners. By leveraging these three instruments, the researcher achieved a comprehensive understanding of the research topic, mitigating the limitations of relying on a single method. The merits and drawbacks of each instrument are discussed below, highlighting their contributions to the study's overall validity and reliability.

3.4.1 Questionnaires

According to Best and Kahn (2013), a questionnaire is a tool used to gather information for data analysis. Questionnaires are widely used and familiar, making them easy to analyze and comfortable for participants to complete (Popper, 2014; Creswell, 2014). Unlike other data collection methods, questionnaires don't typically cause anxiety or discomfort. This made it easier for the researcher to gather data, as participants were willing to complete the questionnaires. Additionally, the anonymity of the questionnaires allowed participants to respond honestly and freely, without fear of judgment (Best & Khan, 2013).

Questionnaires offer additional advantages, including reduced bias and uniformity in questioning, eliminating the influence of intermediaries (Popper, 2014). This allowed respondents to answer questions without being swayed by the researcher's opinions. Questionnaires were also tailored to the respondents' level, using both closed and open-ended questions to make answering easy and allow respondents to elaborate on their thoughts (Best & Khan, 2013). This enabled the researcher to collect large amounts of data quickly and efficiently (Best & Khan, 2013; Leedy, 2015). Questionnaires also helped focus respondents on relevant information, reducing unnecessary data (Leedy, 2015). Additionally,

questionnaires are easy to design and administer, allowing respondents to express themselves freely and anonymously (Popper, 2014).

However, questionnaires have limitations. They don't allow for follow-up questions to clarify interesting or unclear responses, and they're not suitable for participants who can't read or write (Popper, 2014). This can lead to vague answers, especially with open-ended questions, making data analysis challenging. Additionally, questionnaires may not be effective if respondents choose not to complete them or destroy them. Fortunately, the researcher avoided these issues by only administering questionnaires to literate participants and conducting a pilot study to test and refine the questionnaires, reducing ambiguity and bias.

3.4.2 Observations

In addition to the learner questionnaires, the researcher also conducted observations of both teachers and students, recording relevant data for analysis. According to Best and Kahn (2013), observation is a systematic research method that involves using all one's senses to study behavior in natural environments. This definition highlights the unique advantages and disadvantages of observations as a research tool.

According to Wandelt (2015), observations offer a significant advantage by providing direct access to the participants being studied. By physically observing the subjects, the researcher was able to collect data firsthand, reducing the risk of falsified information. Additionally, Leedy (2015) notes that observations provide a permanent record of events and behavior, which is particularly important for capturing short-lived phenomena that may be of great interest to the researcher. The act of recording observations ensures that the data is preserved, allowing for future analysis and comparisons to be made easily.

However, Leedy (2015) also acknowledges that direct observation has its limitations. It is a time-consuming method and is prone to observer bias, where the researcher may

inadvertently record inaccurate information or be influenced by their own preconceptions. Moreover, the observer effect can also occur, where the presence of the researcher influences the behavior of the participants being observed (Popper, 2014). This can lead to artificial results, threatening the validity and reliability of the data. To mitigate these risks, the researcher took extra precautions to ensure that the participants' behaviors were not skewed by the observation process.

3.4.3 Structured Interviews

According to Creswell (2014), an interview is a data collection method that involves direct verbal communication between individuals. Like other research tools, interviews have their advantages and disadvantages. Creswell (2014) argues that interviews are particularly useful when seeking information from individuals who may be illiterate, as the interviewer can adapt the language to suit the respondent's level of understanding. Additionally, interviews allow for the collection of authentic data, such as age, sex, and race, which cannot be falsified by respondents (Creswell, 2014). This makes interviews a valuable tool for gathering accurate and reliable information.

Furthermore, interviews enabled the researcher to establish a rapport with the respondents, fostering a trusting relationship that encouraged open sharing of sensitive information (Popper, 2014). This led to a deeper level of understanding and improved interpersonal relations between the interviewer and interviewees. The researcher sought to gather personal feelings, opinions, and perceptions, and oral interviews proved ideal for soliciting sensitive information (Phillips & Pugh, 2011). The respondents' own words were recorded, with clarifications made to address any ambiguities. Additionally, respondents were able to provide reasons behind their responses without being influenced by others, and the researcher

was able to capture firsthand information, including emotions, directly from the participants (Best & Khan, 2013).

However, oral interviews also had some drawbacks. They were subjective and biased, and required a significant amount of time, especially when working with large populations. To minimize these limitations, the interviewer used neutral probes and allowed respondents sufficient time to answer questions without interrupting or anticipating their responses (Creswell, 2014). Additionally, some respondents may have felt uncomfortable or used avoidance tactics when faced with lengthy, sensitive, or probing questions. To overcome this, the interviewer established trust and rapport with the respondents, creating a safe and supportive environment that enabled the collection of sensitive information that might not have been accessible through other data collection methods.

3.5 Ethical Considerations

According to Webster's dictionary (2015), ethics refer to the principles of moral behavior that distinguish right from wrong. In research, ethics are essential guidelines for good behavior, as emphasized by Leedy (2019). Since this study involved human participants in both quantitative and qualitative approaches, the researcher was obligated to uphold high moral standards. The study prioritized the following ethical considerations: obtaining informed consent from participants, ensuring voluntary participation, maintaining anonymity, and guaranteeing confidentiality. These ethical principles guided the researcher's interactions with participants to ensure their rights and privacy were respected.

3.5.1 Anonymity and Confidentiality

This study placed great importance on maintaining both anonymity and confidentiality, as emphasized by Punch (2015). To ensure anonymity, the questionnaires distributed to learners did not include any fields for personal identification, such as names, credentials, or other

identifiable features. Additionally, the researcher guaranteed confidentiality by assuring participants that their responses would be used solely for educational purposes and would not be shared with anyone outside the research team, thereby creating a safe and trustworthy environment for participants to share their thoughts and opinions freely.

3.5.2 Voluntary participation and informed consent

Prior to participating in the study, the researcher ensured that respondents were aware that their participation was entirely voluntary, and that they could withdraw from the study at any point without facing any consequences (Popper, 2014). This meant that participation was not coerced, but rather a personal choice. Informed consent was also obtained, where the researcher clearly explained the purpose, aims, and objectives of the study to the participants (Punch, 2015). Furthermore, participants signed a consent form that outlined the study's relevance to various stakeholders, making them feel valued and encouraging them to provide authentic and credible information (Cohen &Manion, 2019). This process empowered participants to make informed decisions about their involvement in the study

3.6 DATA PRESENTATION, INTERPRETATION AND ANALYSIS PLAN

The researcher employed various statistical tools, including frequency distribution tables, pie charts, and bar graphs, to present the data collected through questionnaires. Additionally, observations and oral interviews were conducted to gather further data, with observation checklists and interview schedules designed to align with the sub-research questions and objectives. To ensure social distancing and prevent the spread of Cholera, online interviews and observations were conducted, with a mobile phone used to record the interviews. The respondents were assured that the results would be used solely for research purposes, encouraging them to provide candid responses. The recorded responses were collected and stored for future analysis.

3.7 SUMMARY

This chapter outlined the research methodology used in the study. It covered various aspects, including the research design, population, sampling procedure, research instruments, data collection and analysis procedures, and ethical considerations. The chapter provided a clear overview of how the researcher collected data from participants and how the data would be presented and analyzed. The methodology chapter provides a foundation for the entire research study, and this chapter has demonstrated a rigorous and systematic approach to ensuring the quality and integrity of the research findings. The next chapter covers data presentation, analysis and interpretation.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presented the researcher's findings on pie charts, bar graphs and frequency distribution tables. The above statistical tables did not only make the researcher's data amenable for analysis, but also compacted the data, at the same time retaining original findings. The presented data was then analysed and interpreted with the aim of answering the study's research questions. The analysis and interpretation also sought to reveal any correlations between the researcher's findings and the findings of other earlier authorities.

4.1 Demographic data of participants

Table 4.1 Frequency Table Showing Ages of Teacher Respondents

AGE (YEARS)	FREQUENCY	PERCENTAGE (%)
Between 20 and 40 years	6	60
Between 40 and 50 years	3	30
Above 50 years	1	10
TOTAL	10	100

Of the ten teachers who participated in the study, 60% (six) were between twenty and forty years of age, while 30% (three) were between forty and fifty years, and only 10% (one) was above 50 years. The above ages reflect that, from the sampled schools, Mathematics teachers were mostly middle-aged, who could be fresh from college, and could be conversant with techniques of effectively teaching Directed Numbers in the secondary school. The teachers were also not too young to be novices in teaching secondary school learners; hence the researcher assumed that she gathered reliable and valid data from the teacher respondents.

4.2.1 Analysis of learners' ages

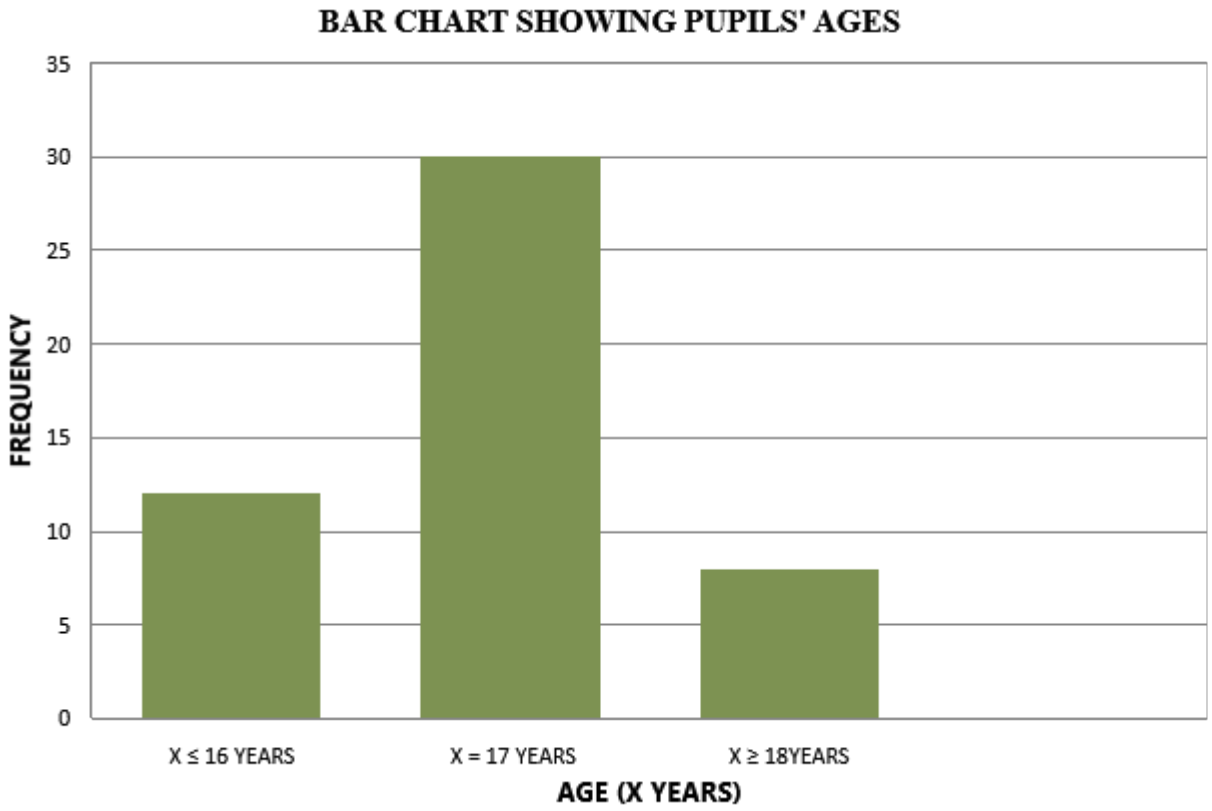

Figure 4.1 Bar Chart Showing Learners' Ages

On the bar graph below, it is shown that 24% (12) learners are 16 years or less, while 60% (30) learners are 17 years old, and 16% (8) learners are 18 years or above. In Zimbabwean secondary schools, this is the most appropriate age group for learners at Ordinary Level, after starting Grade 1 with seven years or less. To the researcher's line of thought, these learners are now grown-ups, who can understand the teaching and learning of Directed Numbers in Mathematics, and who can also identify those areas which pose challenges to them. Thus, the researcher feels that she collected reliable and valid data from her student respondents.

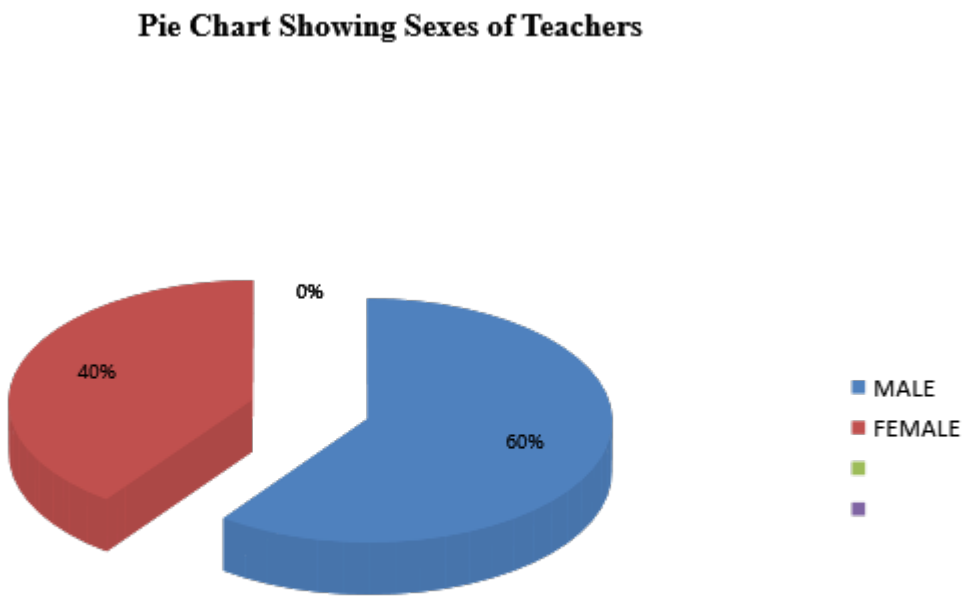

Figure 4.2 Pie Chart showing sexes of teacher respondents

The pie chart above shows that there were 40% (4) female teachers, and 60% (six) male ones, who worked with the researcher in this study. The inclusion of both sex groups in the study indicates that the researcher obtained authentic data from both male and female respondents. This ensured credibility to the information gathered, and the researcher was assured that her findings are generalizable. Creswell (2022) advises researchers to select their research populations with discretion, lest they fail to gather evidence that is not only valid or reliable, but also fail to gather data that can be generalized on various similar populations. Thus, the researcher was assured that the data obtained in this study was representative of all other similar groups of people on which it could be used.

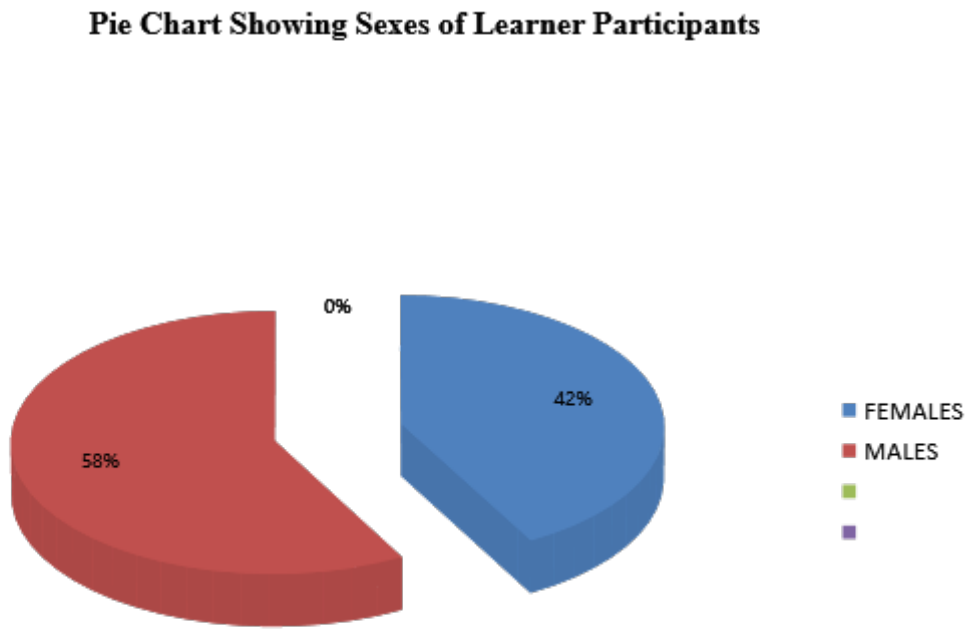

Figure 4.3 Pie Chart Showing Learners' Sexes

Figure 4.2: Pie Chart Showing Sexes of Teacher Respondents

Data revealed on the pie chart above indicates that the researcher worked with 58% (29) male learners, as well as 42% (21) females, in this study. The same data also shows that the researcher worked with a population of fifty (50) learners, with the figure of males surpassing that of females. This data indicates that, in the schools where this study was done, the population of female learners was below that of their male counterparts, and the researcher got views of both boys and girls, regarding the challenges they encounter when using instructional ICTs in Mathematics teaching and learning. Though the researcher was not keen

to establish the sentiments from either males or females regarding challenges of teaching Directed Numbers, it was noteworthy that the student population was balanced for the study.

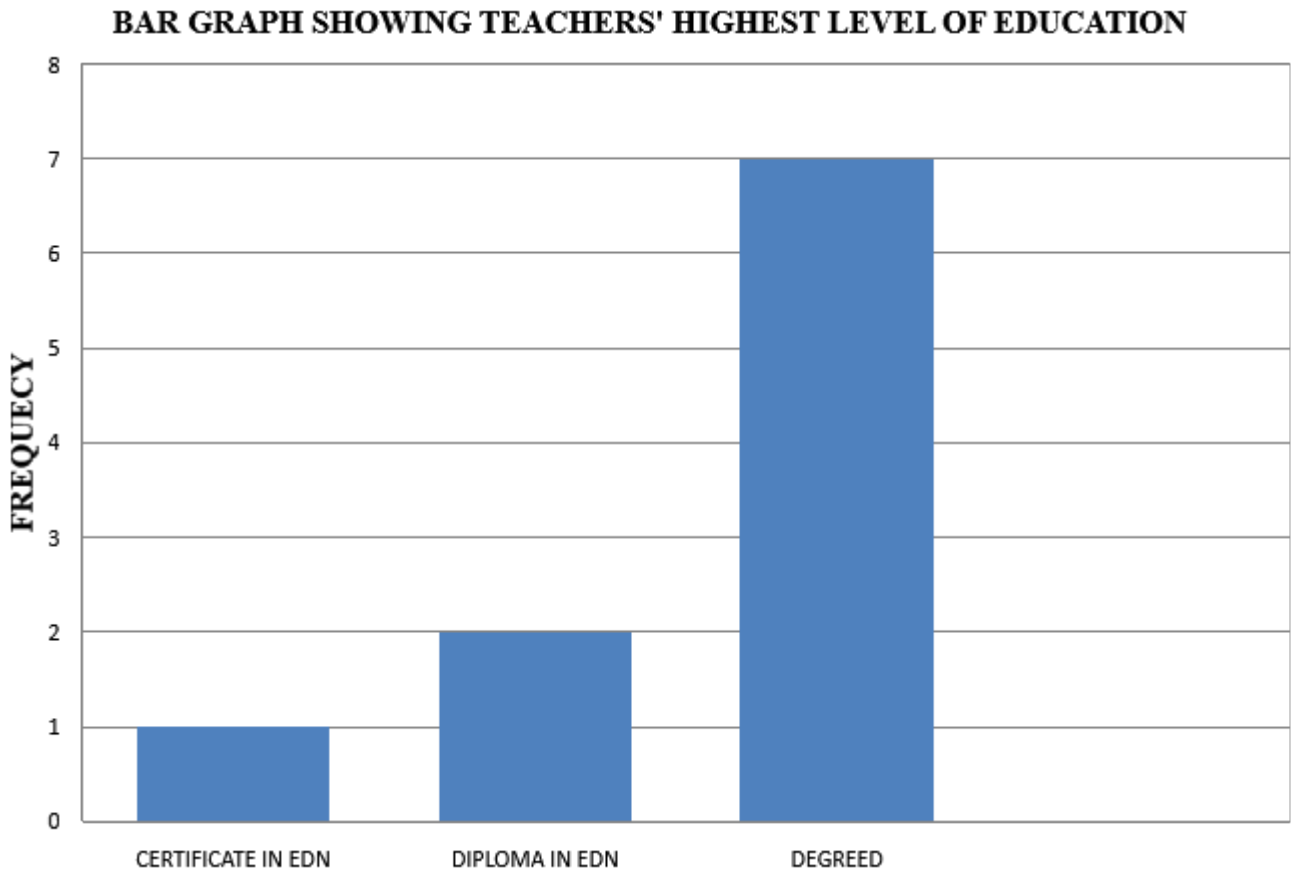

Figure 4.4 Bar Chart Showing Teachers' Educational Qualifications

At the schools on which this study was carried out, there were 70 % (seven) Mathematics teachers who were Degree holders, while 20% (two) of them held Diplomas in Education, and only 10% (one) teacher was a Certificate in Education holder. The data above indicates that the teachers used in this study were properly qualified, and conversant with the need to effectively teach Directed Numbers during Mathematics lessons. The evidence above also indicates that in many secondary schools in Zimbabwe, there are no classes taught by relief teachers, as there is ample manpower, and mostly degreed teachers. The researcher also wants to believe that the properly qualified teachers she used in this study opened up their hearts, as regards the teaching and learning of Directed Numbers at Ordinary level in Gweru District.

Table 4.2 Frequency Table Showing Years of Teaching Experience

Working Experience	Frequency	Percentage (%)
Less than or equal to 5 years	0	0
Between 5 and 10 years	4	40
Between 10 and 15 years	4	40
Above or equal to 15 years	2	20
TOTAL	10	100

As shown on the Frequency Table above 4.2 , 40% (four) teachers had teaching experience of between five and ten years, 40% (four) others had teaching experience of between ten and fifteen years, and 20% (two) of them had more than fifteen years' experience as a classroom practitioner. No teacher had less than or five years of teaching experience. The levels of

teaching experience were ideal for this study, since the researcher intended to unravel technicalities regarding the teaching and learning of Directed Numbers at Ordinary level in Gweru District. Though these highly experienced teachers could be maintaining the status quo, and failing to completely find possible solutions to challenges they face when teaching Directed Numbers, the researcher felt that they must have found possible intervention mechanisms to address the above challenges during their countless years of teaching experience.

4.3 ANALYSIS OF DATA FROM RESEARCH QUESTIONS

4.3.1 Research Question 1: Which challenges are faced by teachers and learners during the teaching and learning of Directed Numbers?

Table 4.5 Table Showing possible challenges faced by teachers and learners during the teaching and learning of Directed Numbers

Possible challenges faced during the teaching and learning of Directed Numbers	SA %	A %	D %	SD %
Removing brackets	84	10	06	0
Poor application in other related topics	06	78	16	0
Applying Directed numbers in real life situations	04	86	10	0
Inadequate conceptual understanding	0	14	74	12
Poor assessment criteria	0	0	08	98
Improper number line visualization	86	12	02	0
Use of inappropriate diagrams	10	0	82	08

Inconsistent operations with negative numbers	94	06	0	0
Inability to interpret word problems	76	24	0	0
Lack of practice	0	0	68	32
Language barriers	0	28	0	72

KEY: SA- Strongly Agree; A- Agree; D- Disagree; SD- Strongly Disagree

From the Likert Table in Figure 4.5, it is noticeable that the respondents strongly agreed that challenges faced by both teachers and learners when teaching Directed Numbers include removing brackets (84%), improper visualization of the number line (86%), inconsistent operations with negative numbers (94%) as well as inability to interpret word problems. In addition, other respondents also agreed, though not strongly, that there was poor application of Directed numbers in other mathematical related topics (78%) and that learners were failing to rope in Directed Numbers in clear everyday life situations (86%). On the same Likert Table, it can be seen that other respondents strongly disagreed that there were language barriers (72%) and learners were being assessed poorly in Directed Numbers (98%).

Most of the findings from the respondents are closely related to earlier findings. For example, the assertions that learners confuse Directed Numbers when removing brackets were also opined by Nesher (2017), who underscored the need to highlight the presence of a negative value outside brackets before unveiling the concept to learners; e.g. *-3(4xy -8)* gives *-12xy + 24.* This concept requires adequate time as it is applicable in numerous mathematical scenarios or even those in other subject areas. Again, the sentiments by the respondents that learners were finding it difficult to apply Directed Numbers in other topics and in real life situations is closely related to the findings by Brown (2020) and Victoria (2017) respectively. Nonetheless, the disagreements that use of inappropriate diagrams (82%) and that lack of

practice (68%) are possible challenges are a stark contrast to findings by Chaturuka and Chirume (2023) and Oni (2018) respectively.

4.3.2 Analysis of Data from Observations

4.3.2.1 Applying Directed numbers in real life situations

The researcher observed that even teachers were failing to find suitable real life examples of illustrating the importance of Directed Numbers in everyday lives. The most popular examples used by teachers to illustrate Directed Numbers was that of the thermometer when measuring temperature of cold items that went beyond freezing point. This made learners understand the presence and consequent importance of negative values. Again, in some instances teachers used the concept of profit and loss to make learners comprehend Directed Numbers. Likewise, another concept consistently roped in to aid comprehension of Directed Numbers was that of the bird in a tree compared with a miner underground. The diagrammatic representations of these real life situations were better comprehended by learners than situations that were absolutely abstract. The researcher realized that the recommendations of Levison (2016) were of great importance when equated to these observations, as there was great need to use real life scenarios to explain the concept of Directed Numbers.

4.3.2.2 Number line visualization

As regards the teachers' reliance on using the number line to explain the concept of positive and negative numbers, the researcher observed that the majority of the learners could comprehend some problems involving smaller values, but tended to be confounded when higher values were brought into the fray. For example, learners could use number lines to manipulate problems like 3-(-4); -5+ (-8) or –8-(-9) + 4. Nonetheless, the learners could not transfer this knowledge to manipulate those problems that involved larger values such as 37-

(-25); -123+ (-82), among others. The researcher also noticed that some gifted learners could coin some self-help rules using the number lines, so as to assist them to effectively manipulate positive and negative numbers. The need to correctly visualize number lines when tackling Directed Numbers is the brainchild of Brown and Drougard (2014), who advised teachers to go step-by-step with the number line till learners gather confidence.

4.3.2.3 Comprehension of language of Directed Numbers

As regards the language commonly used to manipulate Directed Numbers, the researcher's observations unravelled that the majority of the learners had no linguistic challenges regarding integers as both negative and positive numbers coupled with zero. The learners could also appreciate the fact that zero was neither positive nor negative, hence its placement in between the positive and negative values. Again; learners were also quick to draw a labelled number line each time they were tasked to do so, an indication that they comprehended what it was. Moreover, the researcher also noticed that the learners were able to use greater than, less than, greater than or equal to, as well as less than or equal to on the number line to denote the relationships between Directed Numbers. After thorough exposure to the number line, the majority of the learners could appreciate tricky situations such as –6 is less than +1, situations that previously challenged them.

4.3.3 Analysis of Data from Interviews

As regards the challenges that scuttle the effective teaching of Directed Numbers to Ordinary level learners, it emerged that removing brackets as well as working with word problems proved to be very challenging for the bulk of learners. The concept of removing brackets, which starts in Form one, falls under Algebraic expressions, and becomes more complex when it begins to incorporate Directed Numbers. While only a few learners master this concept, the majority of learners continuously make the same mistake. When it comes to

word problems, the interviewed teachers indicated that learners have a tendency to shun their inclusion in the syllabus, arguing that they do not only require ample time to be fully grasped, but they also required all learners to be linguistically competent to be able to effectively tackle them. Another teacher also offered that confusing working with negative numbers, to the extent of rushing through them without showing understanding, was another major blow teachers faced to get the topic of Directed Numbers effectively taught.

The ideas that Directed Numbers pose serious problems on removing brackets and on manipulating word problems in Algebraic expressions go in tandem with beliefs of Smith and Doe (2018) and Chimhini (2021), who respectively conceded that a negative sign outside brackets is like a danger and word problems with integer operations were challenging to the learners.

Research Question 2: How do challenges on Directed Numbers impact on student comprehension and performance in other mathematics topics and other subject areas?

Table 4.3.1 Showing teachers' views on how challenges faced on Directed Numbers impact on comprehension and performance in other mathematics topics and other subject areas

Possible effect of challenges faced on Directed Numbers	SA	A	D	SD
Failure to apply Directed numbers in other learning areas	86	14	0	0
Building connections with other Mathematics concepts	94	06	0	0
Challenges in problem-solving and reasoning	02	20	78	0
Anxiety and lack of confidence	24	72	04	0
Limited teacher confidence and poor instruction	0	68	32	0
Flawed curriculum progression	82	16	02	0
Lack of student motivation and engagement	0	14	76	10

KEY: SA- Strongly Agree; A- Agree; D- Disagree; SD- Strongly Disagree

The sentiments displayed on the Likert Table 4.3.1 are reflective that the respondents strongly agreed that failure to apply Directed Numbers in other learning areas (84%), poorly building connections with other mathematical concepts (94%) and a flawed progression of the curriculum (82%) were effects emanating from the challenges of using Directed Numbers. Similarly, though not agreeing strongly, 72% of the respondents agreed that failure to manipulate Directed Numbers led to anxiety and lack of confidence, and 68% of the respondents attributed poor teacher confidence and instruction to the challenges experienced during manipulation of Directed Numbers.

However, the respondents disagreed, though not strongly that poor operations in Directed Numbers led to challenges in problem-solving and reasoning (78%) and lack of student motivation and engagement (76%). Notably, most of the data is a replica of earlier findings, e.g. Aris et al. (2017) and Mhatye (2021) averred that challenges in Directed Numbers affected learning of other subjects and other concepts, respectively. However, the assertion that dissociates lack of student motivation and engagement from challenges emanating from poor manipulation of Directed Numbers goes against the findings of Vlasis (2018), who indicated that when learners face challenges in Directed Numbers, they reach very low motivation levels, and feel less engaged when faced with concepts requiring their application.

4.3.3 Analysis of Data from Observations

4.4.2.1 Ability to apply Directed numbers in other mathematical concepts

The researcher also observed a good number of topics being taught and Directed Numbers being applied to aid comprehension of these topics. Some of the topics taught include: Equations, Inequalities, Matrices as well as Simplifying Algebraic Expressions. As these

topics were being taught, the researcher was mainly concerned with how teachers brought in the concept of Directed Numbers, and whether they ever considered them as assumed knowledge. The researcher noticed that almost all the teachers assumed that learners were conversant with Directed Numbers, and hence they never checked prior understanding. In some instances, teachers assigned learners to revisit their knowledge of Directed Numbers for them to understand the current concept, while in other situations teachers cruised through the topic at the expense of learners' understanding. The concept which troubled learners most involved removing brackets with a negative sign outside brackets, e.g. Simplify *-2x (3x-2y).*

4.4.2.2 Amount of confidence in tackling aspects involving Directed Numbers

As regards the confidence exhibited by learners when tackling questions involving Directed Numbers, the researcher noted that errors were rampant despite the perceived confidence. This means that learners made glaring mistakes when manipulating Directed Numbers, particularly in other topics. When observing multiplication of matrices with a good number of negative values, the researcher noted that silly mistakes were the order of the day, and the learners were now reluctant to revisit the number line concept. The presence of silly mistakes made it possible to reboot the number line concept, and seemed to improve the confidence of learners in handling Directed Numbers. Assertions that successes in tackling questions involving Directed Numbers build confidence were coined by Mhatye (2021), whose sentiments were of the opinion that continuously registering success when working with Directed Numbers breeds a lot of confidence among learners.

4.4.2.3 Teacher methodologies when teaching Directed Numbers

The researcher also noticed that the teacher never varied methods of teaching Directed Numbers to their learners, as they mainly used the lecture method of instruction or the teacher-chalk approach, which were all mainly teacher centred. Rarely did the researcher observe teachers using innovative approaches like discovery learning, save for games and

storytelling that characterized introductory sessions of some of the lessons. The researcher finally concluded that teachers were interested in teaching methods that were not so laborious at the expense of learner understanding. Relatedly, the researcher attributed that these poor teaching approaches were also contributory to the limited understanding of Directed Numbers by learners. Salam and Sahrill (2017) also hinted that some of the poor methods of teaching used by educators lead to poor comprehension of many concepts in Directed Numbers.

4.4.3 Analysis of Data from Interviews

When interviewed on what they attributed to as the chief effect of the challenges of effectively manipulating Directed Numbers, the majority of teachers pointed out that eventually learners failed to link Directed Numbers to other mathematical concepts, consequently affecting a progressive flow of the mathematics curriculum. This assertion meant that Directed Numbers were supposed to correlate with a good number of related topics in Mathematics, but the challenges they posed overlapped to these related topics causing a continuum of challenges for learners. One other educator hinted that Directed Numbers were so troublesome to learners such that some of the students end up being demotivated to sail through other topics where Directed Numbers feature. The sentiments of the teacher regarding low motivation levels ushered by Directed Numbers echo the opinions of Makonye and Fakuda (2016), who viewed Directed Numbers as a topic capable of ruining a learner's interest in other mathematical topics.

4.5 Research Question 3: What strategies can be implemented by teachers and learners to improve the teaching and learning of Directed Numbers at secondary level?

Table 4.5.1 Showing strategies that can be implemented by teachers and learners to improve the teaching and learning of Directed Numbers at secondary level

Possible strategies that can be implemented to improve the teaching and learning of Directed Numbers	SD %	A %	D %	SD %
Regular assessment on Directed numbers	0	14	32	72
Incorporating real-life scenarios	22	78	0	0
Practice and reinforcement	0	84	16	0
Use of storytelling	78	22	0	0
Using games	0	18	82	0
Technology integration	88	12	0	0
Collaborative learning	92	08	0	0
Using visual aids	0	0	68	32
Implementing concrete learning	06	82	12	0

KEY: SA- Strongly Agree; A- Agree; D- Disagree; SD- Strongly Disagree

As regards possible interventionstrategies that can be implemented to improve the teaching and learning of Directed Numbers, 78% of the respondents strongly agreed to the use of storytelling, 88% strongly agreed to the integration of technology, and 92% strongly agreed to the use of collaborative learning approaches. Though not strongly agreeing, other respondents agreed that incorporating real-life scenarios (78%), consistent practice and reinforcement (84%) as well as implementing concrete learning (82%) were also viable techniques to improve effective acquisition of Directed Number concepts by learners. Moreover, the respondents strongly disagreed that regular assessment on Directed Numbers

(72%) and disagreed but not strongly, that using games (82%) as well as using visual aids (68%).

The findings from this study strongly correlated with previous findings, as Manjengwa (2018), Oni (2018) and Nesher (2017) posited that storytelling, technology use and collaborative learning were viable mechanisms to scaffold efforts by teachers to help learners comprehend Directed Numbers concepts and skills. Again, the need for roping in real life situations, regular practice and reinforcement as well as implementing concrete learning were emphasized by Zakaria et al. (2013), Oris et al. (2017) and Chimhini (2021) respectively. It was however surprising to note respondents refuting to the use of games and visual aids in improving the teaching and learning of Directed Numbers, as this was against the opinions of Smith and Doe (2018) and Brown (2020) respectively.

4.5.2 Analysis of data from observations

4.5.2.1 Teacher-pupil ratios in Mathematics lessons at Ordinary level

The teacher-pupil ratios depended on the schools' catchment areas and the average teacher-pupil ratio in the sampled schools was 1:40, which the researcher regarded as equitable to enable effective teaching and learning of Directed Numbers. The minimum teacher-pupil ratio was 1:36 while the maximum teacher pupil ratio was 1:44. This implies that in Gweru District, Mathematics classes were not overcrowded to disallow effective teaching and learning of Directed Numbers. The researcher realized that the size of Mathematics classes was not directly related to the respective schools' enrolment, but possibly the level of difficulty placed on the Mathematics by the majority of rural learners. The researcher also noted that irrespective of the class sizes, some classes still faced challenges of manipulating Directed Numbers with ease.

4.5.2.2 Use of media in Mathematics lessons at Ordinary level

In most of the lessons observed by the researcher, it was established that teachers did not resort to use of any real media save for diagrams drawn on the chalkboard. The researcher observed that teachers found it difficult to design instructional media that could be used to effectively illustrate the concept of Directed Numbers. The researcher however noted that though no tangible forms of media were used by teachers, there was use of storytelling to consolidate some of the concepts in Directed Numbers that tended to confuse learners. The use of storytelling as an alternative to media use was propounded by Makonye and Fakuda (2016), who acknowledged that where there are no real artifacts to use as media, the concept of motivating teaching approaches like storytelling can be substituted.

4.5.2.3 Nature of teaching methods used to teach Directed Numbers

During the lesson time with learners, the researcher observed that the storytelling teaching method was only used at the beginning of the lesson, but thereafter the teachers solely relied on chalkboard illustrations to teach aspects linked to Directed Numbers. The other methods of teaching used included pair-work and group-work, and the teachers moved around the class checking the pair work or group work activities, and assisting those having challenges. The researcher also noticed that despite the challenging nature of Directed Numbers, coupled with their abstractness, some learners were gifted and they could manipulate them without the aid of number lines in spite of their complexities. Likewise, there were some learners who exhibited signs of being challenged by Directed Numbers despite efforts made by teachers to simplify them. These observations resonate with the assertions of Zakaria et al. (2013), who advised educators to use varied teaching and learning approaches in their teaching and learning of Directed Numbers to open more opportunities for effective learning.

4.5.3 Analysis of Data from Interviews

When interviewed on what they thought would be effective strategies improving the teaching and learning of Directed Numbers, the teachers highlighted that there was need to use

concrete learning, to regularly assess learners in Directed Numbers and to give learners as much practice and reinforcement as possible. The sentiments of the teachers were that to keep learners occupied with Directed Numbers, and eventually mastering them, teachers should include them in weekly tests they give their learners, and they should also be given as much homework or holiday work as possible so as to improve learners' performance. To consolidate the above findings, Mhatye (2021) condescends that it is advisable for teachers to regularly pose challenging work on Directed Numbers to learners, as a way to continuously expose them to practice. Relatedly, Shahrill (2017) also supports the above sentiments and further recommends teachers to ensure that for every piece of work they give learners, feedback and reinforcement should ensue.

4.6 SUMMARY

This chapter presented the data that the researcher collected from questionnaires, oral interviews and direct observations. The data was displayed on statistical graphs such as: frequency distribution tables, bar graphs and pie charts. Thereafter, the researcher explained the meaning of the displayed information, and then gave analysis and interpretation of the findings in relation to the research objectives. Thus, the data gathered was analyzed and interpreted to ascertain any correlations between the researcher's data and other earlier findings. The next section, Chapter 5, gives the summary of the entire study, conclusions drawn from the findings, recommendations proposed as well as research questions generated by the study.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The chapter gave the summary of the whole study, the conclusions deduced by the researcher using the data obtained, and the recommendations proposed basing on the researcher's findings. Finally, the researcher gave research questions generated by this study and the overall conclusion.

5.2 Summary of the study

This study was completed in 2024, and it was carried out in Gweru District. The main purpose of carrying out this study was to explore the challenges faced by teachers and learners during the teaching and learning of Directed Numbers at secondary school level in Gweru District. The study involved 60 participants, among them 10 Mathematics teachers and 50 learners.

In the first chapter, the researcher outlined the problem and its setting. It is in this chapter where the researcher highlighted: the background to the study, the motivation behind carrying out the study, study objectives and research questions, as well as the importance of the study to various stakeholders. Also examined in the first chapter were: study boundaries and the underlying assumptions of the study, issues that impeded the successful completion of this study and a conceptual analysis of the major terminology used in the study.

The second chapter referred to related literature, and a good number of authorities consulted highlighted numerous aspects related to the teaching and learning of Directed Numbers at secondary school level. Both the conceptual and theoretical frameworks guiding this study were examined in Chapter 2. The researcher also analysed the challenges faced by teachers and learners during teaching and learning of Directed Numbers, the effects of these challenges on solving related mathematical problems, as well as the strategies that can be implemented to improve the teaching and learning of Directed Numbers at secondary school level.

A mixed methods descriptive survey research design was preferred by the researcher to collect data for this study. The research design adopted by the researcher relied on oral interviews, questionnaires and non-participatory observations as key research instruments used to gather data for analysis. The oral interviews were conducted with teachers while questionnaires were administered on learners. On top of these research instruments, the

researcher also made direct observations on lessons where Directed Numbers were being taught using various teaching approaches.

The data collected from questionnaires, oral interviews and direct observations was recorded and presented on pie charts, bar graphs and frequency tables. The data collected by the researcher indicated that in Gweru District, challenges pertaining to the teaching and learning of Directed numbers manifested through numerous shortcomings, such as manipulating brackets, applying Directed numbers in other mathematical concepts or learning areas as well as inappropriate visualizations of the number lines. No serious challenges were encountered by the researcher during the conduct of the study, save for time constraints and limited resources to effectively move around schools to carry out the study.

5.3 Conclusions

The researcher came out with the following conclusions

- There were gross shortages of resources in many schools to enable the effective teaching and learning of Directed Numbers in the secondary school.
- The concept of removing brackets when dealing with negative numbers proved to be the most challenging amongst secondary school learners.
- Teachers hardly used tangible aids to assist them in the teaching and learning of Directed Numbers at secondary school level.
- The most noticeable effects of poor comprehension of Directed Numbers were seen by: learners feeling disengaged, poor application of positive and negative numbers in everyday situations, as well as feeling demotivated when confronted with challenges involving Directed Numbers

- Gweru District schools were characterized by average classes, which made it conducive for teachers and learners to effectively comprehend concepts involving Directed Numbers.
- The responsible Ministry was not doing its part in making efforts to procure resources for impoverished schools, and availing workshops aimed at imparting requisite skills in Mathematics teachers as regards the effective teaching and learning of troublesome topics like Directed Numbers.

5.4 Recommendations

Basing on the findings of this study, the researcher would like to propose the following recommendations:

- The Ministry of Primary and Secondary Education should come to the rescue of schools, and assist with procuring resources, as well as availing workshops to Mathematics teachers so as to equip them with skills to teaching and learning Directed Numbers.
- Since it emerged that teachers were not using any forms of real media in teaching and learning of Directed Numbers, curriculum developers should avail literature of types of media and teaching approaches that Mathematics teachers can use for troublesome topics like Directed Numbers.
- Since the study revealed that there a numerous challenges that hamper the effective teaching and learning of Directed Numbers in secondary schools, all the concerned stakeholders (heads, teachers, learners and members of the parent community) should team up to avert them.

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APPENDICES

7.1 APPENDIX A: QUESTIONNAIRE FOR LEARNERS

My name is ChengeFelistus, a student at Bindura University of Science Education (BUSE) studying for a Bachelor of Science Honors Degree in Mathematics Education. I am carrying out a study to establish challenges facing teachers and learners during the teaching and learning of Directed Numbers at secondary school level in Gweru district, Midlands province.

Please assist me by completing this questionnaire. The information that you provide will be used for academic purposes only. Please do not write your name.

Section A: Tick as appropriate.

1. **Sex**: Male Female  2. **Age**:…….

Section B: RESEARCH QUESTIONS

Research Question 1: Which challenges are faced by teachers and learners during the teaching and learning of Directed Numbers?

Possible challenges faced during the teaching and learning of Directed Numbers	**SA %**	**A %**	**D %**	**SD %**
Removing brackets				
Poor application in other related topics				
Applying Directed numbers in real life situations				
Inadequate conceptual understanding				
Poor assessment criteria				
Improper number line visualization				
Use of inappropriate diagrams				
Inconsistent operations with negative numbers				
Inability to interpret word problems				
Lack of practice				
Language barriers				

KEY: SA- Strongly Agree; A- Agree; D- Disagree; SD- Strongly Disagree

OTHERS (SPECIFY)

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Research Question 2: How do challenges on Directed Numbers impact on student comprehension and performance in other mathematics topics and other subject areas?

Possible effect of challenges faced on Directed Numbers	SA	A	D	SD
Failure to apply Directed numbers in other learning areas				
Building connections with other Mathematics concepts				
Challenges in problem-solving and reasoning				
Anxiety and lack of confidence				
Limited teacher confidence and poor instruction				
Flawed curriculum progression				
Lack of student motivation and engagement				

KEY: SA- Strongly Agree; A- Agree; D- Disagree; SD- Strongly Disagree

OTHER (SPECIFY)

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Research Question 3: What strategies can be implemented by teachers and learners to improve the teaching and learning of Directed Numbers at secondary level?

Possible strategies that can be implemented to improve the teaching and learning of Directed Numbers	SD %	A %	D %	SD %

Regular assessment on Directed numbers				
Incorporating real-life scenarios				
Practice and reinforcement				
Use of storytelling				
Using games				
Technology integration				
Collaborative learning				
Using visual aids				
Implementing concrete learning				

KEY: SA- Strongly Agree; A- Agree; D- Disagree; SD- Strongly Disagree

Table 4.5.1 Showing strategies that can be implemented by teachers and learners to improve the teaching and learning of Directed Numbers at secondary level

OTHERS (SPECIFY)

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7.2 APPENDIX B: INTERVIEW GUIDE FOR TEACHERS

Research Question 1: Which challenges are faced by teachers and learners during the teaching and learning of Directed Numbers?

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Research Question 2: How do challenges on Directed Numbers impact on student comprehension and performance in other mathematics topics and other subject areas?

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Research Question 3: What strategies can be implemented by teachers and learners to improve the teaching and learning of Directed Numbers at secondary level?

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7.3 APPENDIX C: OBSERVATION GUIDE

The researcher observed the following:

Research Question 1: Which challenges are faced by teachers and learners during the teaching and learning of Directed Numbers?

1.1 Comprehension of language of Directed Numbers

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1.2 Number line visualization

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1.3 Applying Directed numbers in real life situations

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Research Question 2: How do challenges on Directed Numbers impact on student comprehension and performance in other mathematics topics and other subject areas?

2.1 Ability to apply Directed numbers in other mathematical concepts

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2.2 Amount of confidence in tackling aspects involving Directed Numbers

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2.3 Teacher methodologies when teaching Directed Numbers

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Research Question 3: What strategies can be implemented by teachers and learners to improve the teaching and learning of Directed Numbers at secondary level?

3.1 Teacher-pupil ratios in Mathematics lessons at Ordinary level

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3.2 Use of media in Mathematics lessons at Ordinary level

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3.3 Nature of teaching methods used to teach Directed Numbers

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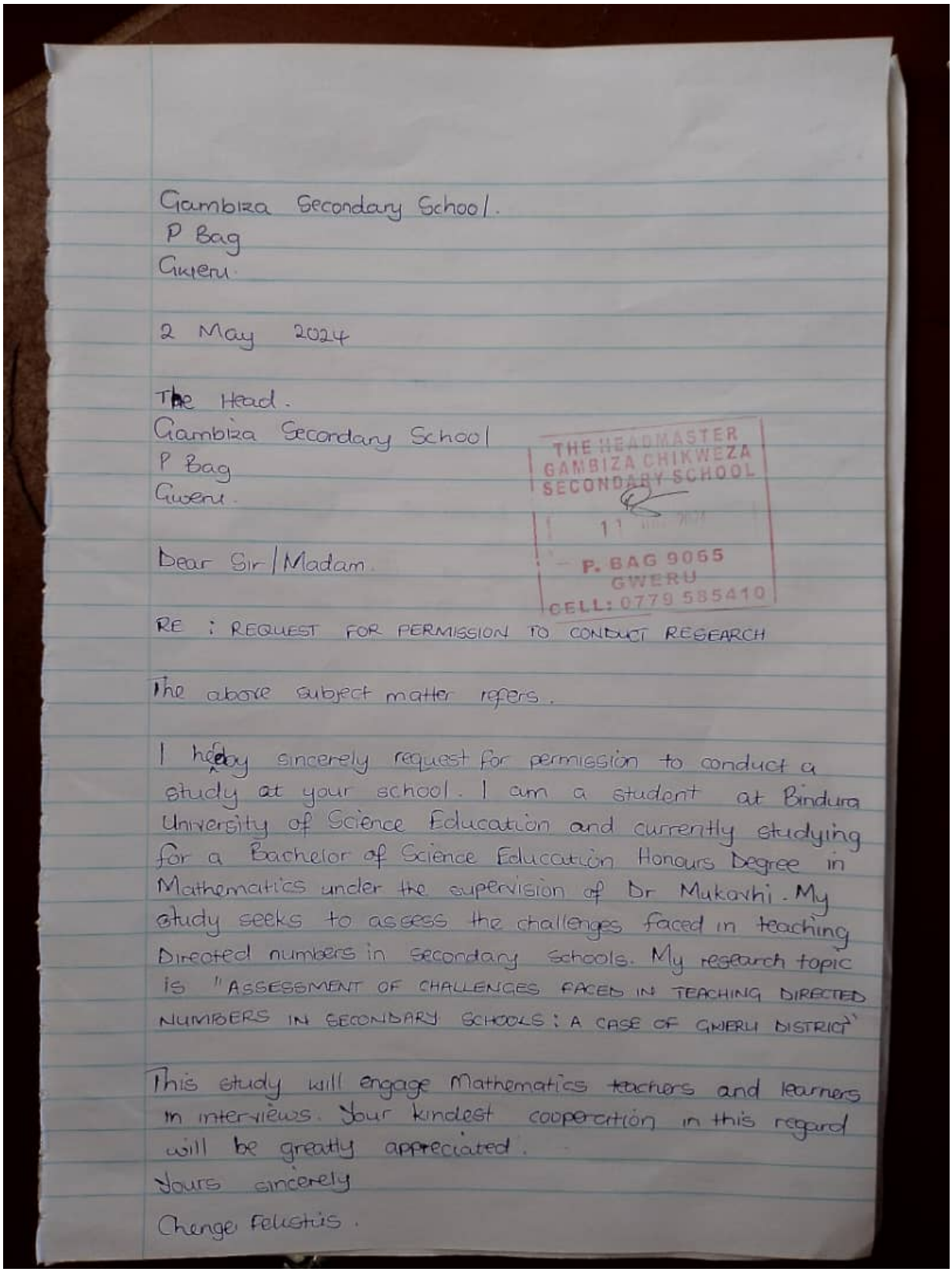
7.4 APPENDIX D: PERMISSION LETTER



Gambiza Secondary School.
P Bag
Gweru.

2 May 2024

The Head.
Gambiza Secondary School
P Bag
Gweru.

THE HEADMASTER
GAMBIZA CHIKWEZA
SECONDARY SCHOOL
P. BAG 9065
GWERU
CELL: 0779 585410

Dear Sir/Madam.

RE : REQUEST FOR PERMISSION TO CONDUCT RESEARCH

The above subject matter refers.

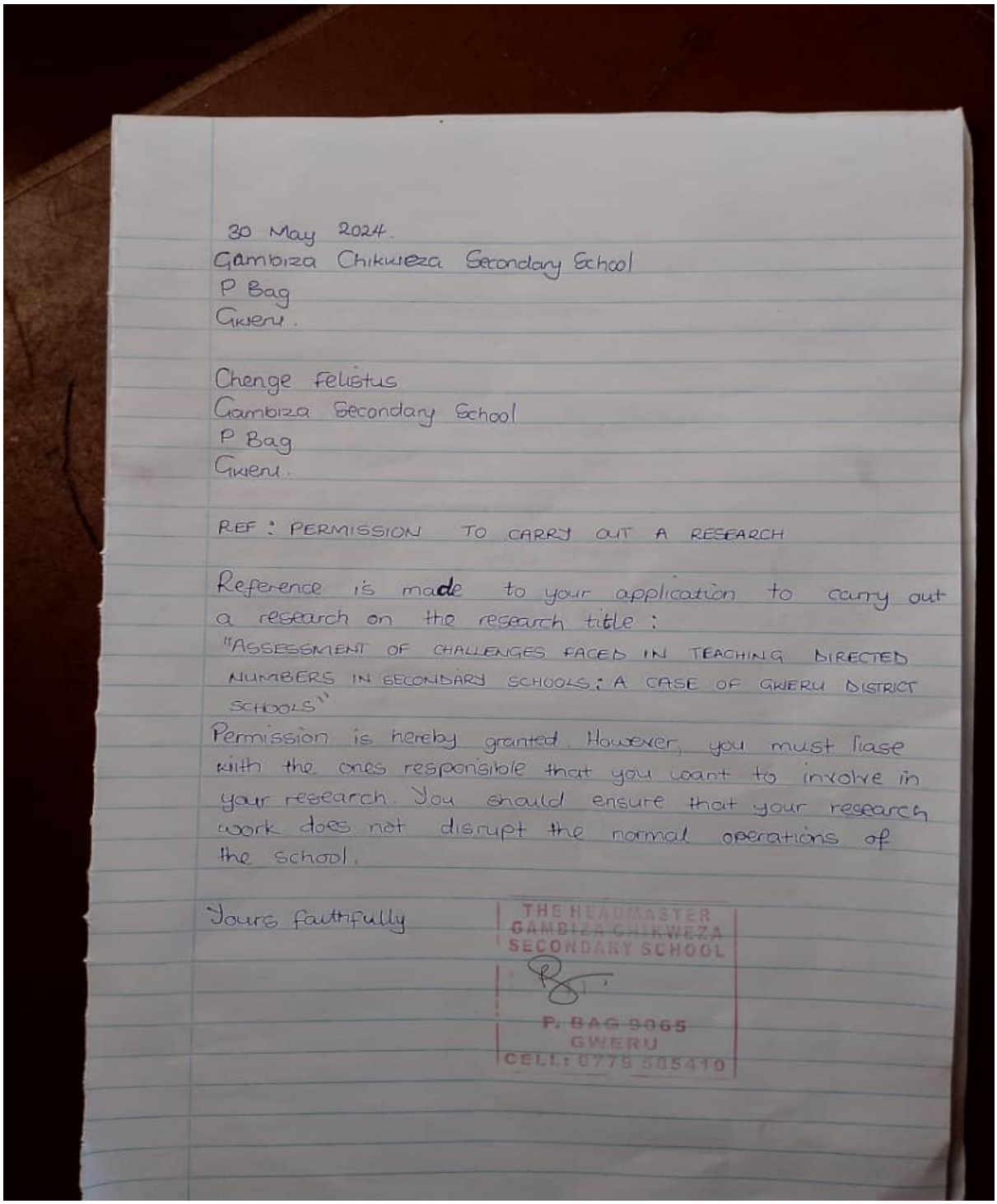
I hereby sincerely request for permission to conduct a study at your school. I am a student at Bindura University of Science Education and currently studying for a Bachelor of Science Education Honours Degree in Mathematics under the supervision of Dr Mukarhi. My study seeks to assess the challenges faced in teaching Directed numbers in secondary schools. My research topic is "ASSESSMENT OF CHALLENGES FACED IN TEACHING DIRECTED NUMBERS IN SECONDARY SCHOOLS : A CASE OF GWERU DISTRICT"

This study will engage Mathematics teachers and learners in interviews. Your kindest cooperation in this regard will be greatly appreciated.

Yours sincerely

Chenge Felistas.

7.5 APPENDIX E: LETTER OF CONSENT



30 May 2024.
Gambiza Chikwieza Secondary School
P Bag
Gweru.

Chenge Felistus
Gambiza Secondary School
P Bag
Gweru.

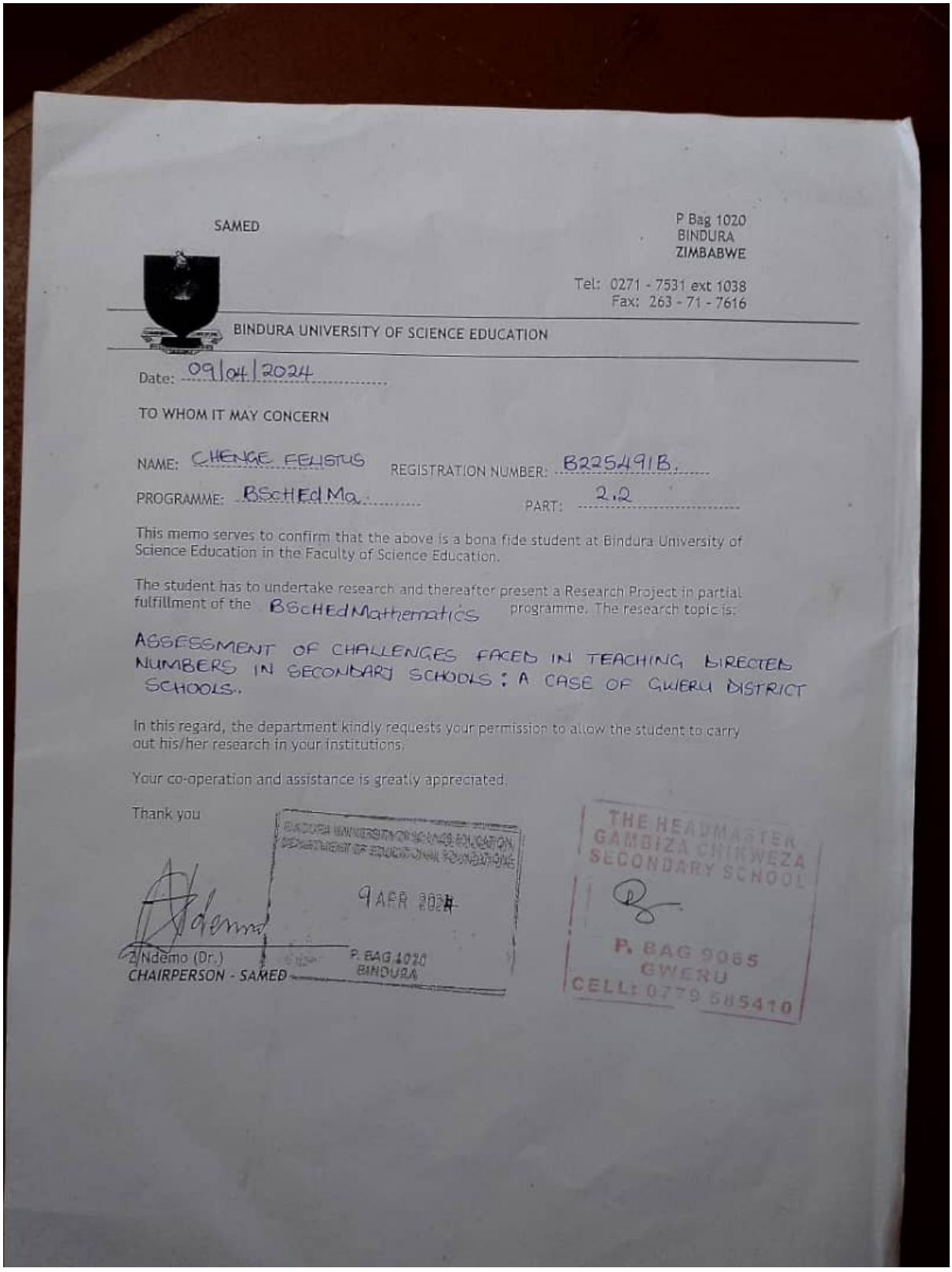
REF : PERMISSION TO CARRY OUT A RESEARCH

Reference is made to your application to carry out a research on the research title :
"ASSESSMENT OF CHALLENGES FACED IN TEACHING DIRECTED NUMBERS IN SECONDARY SCHOOLS: A CASE OF GWERU DISTRICT SCHOOLS"
Permission is hereby granted. However, you must liase with the ones responsible that you want to involve in your research. You should ensure that your research work does not disrupt the normal operations of the school.

Yours faithfully

THE HEADMASTER
GAMBIZA CHIKWIEZA
SECONDARY SCHOOL
P. BAG 9065
GWERU
CELL: 0779 585410

7.6 APPENDIX F: RELEASE FORMS



SAMED

P Bag 1020
BINDURA
ZIMBABWE

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

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 09/04/2024

TO WHOM IT MAY CONCERN

NAME: CHENGE FELISTUS REGISTRATION NUMBER: B2254918.

PROGRAMME: BSc H Ed Ma. 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 BSc H Ed Mathematics programme. The research topic is:

ASSESSMENT OF CHALLENGES FACED IN TEACHING DIRECTED NUMBERS IN SECONDARY SCHOOLS: A CASE OF GWERU DISTRICT SCHOOLS.

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

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
9 APR 2024
P. BAG 1020
BINDURA

Z. Ndemo (Dr.)
CHAIRPERSON - SAMED

THE HEADMASTER
GAMBIZA CHIKWEZA
SECONDARY SCHOOL
P. BAG 9065
GWERU
CELL: 0779 585410

APPENDIX G: PLAGIARISM REPORT

Resubmission by Felistus Chenge. Assessment of challenges faced in teaching directed numbers in Secondary Schools: A Case of Gweru District Schools

ORIGINALITY REPORT

5%	2%	3%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Haji Muhamad Hafizuddin Haji Mohamad Ali, Daniel Asamoah, Masitah Shahrill. "EFFECTIVENESS OF FLIPPED CLASSROOM MODEL THROUGH MULTIMEDIA TECHNOLOGY IN IMPROVING STUDENTS' PERFORMANCE IN DIRECTED NUMBERS", Infinity Journal, 2022 Publication	2%
2	Submitted to Midlands State University Student Paper	1%
3	Chaturuka Sylocious, Chirume Silvanos. "SOLVING FORM TWO STUDENTS' FAILURE TO SUBTRACT DIRECTED NUMBERS IN MATHEMATICS: AN ACTION RESEARCH STUDY", LINEAR: Journal of Mathematics Education, 2023 Publication	1%
4	ir.mu.ac.ke:8080 Internet Source	<1%
5	repository.out.ac.tz Internet Source	<1%