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ENHANCING PROBLEM-SOLVING SKILLS IN MATHEMATICS AMONG HIGH SCHOOL STUDENTS

BY

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DECLARATION

I, Murondi Pelagia declare that this research project for an Honors Bachelor of Science Education in Mathematics degree at Bindura University is my own design and execution. I further certify that the document has not previously been submitted to this or any other University in support of an application for a post, degree or any other qualification.

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ABSTRACT

Despite the increasing recognition of learner-centered approaches in improving mathematics education, many challenges persist in their effective implementation. This mixed-methods study investigates the strategies for enhancing problem-solving abilities in mathematics among high school students at Mfakose High School, Triangle, and Chiredzi. Grounded in Constructivist Learning Theory (Vygotsky, 1978), Social Cognitive Theory (Bandura, 1986), and Metacognitive Theory (Flagella, 1979), the research examines how instructional techniques, student engagement, and teacher effectiveness impact mathematical problem-solving skills. The study adopts a mixed-methods design involving mathematics students and teachers. Data were collected through structured questionnaires, interviews, and lesson observations, employing both convenience and purposive sampling methods to ensure accessibility and expertise. Key variables included teaching methods, instructional resources, and strategies as independent variables, while the dependent variable focused on students' problem-solving abilities measured through test scores and qualitative feedback. This study underscores the need for targeted professional development, adequate resources, and supportive learning environments to optimize mathematics instruction. The research offers practical insights for policymakers, educators, and school administrators, contributing to the enhancement of learner-centered strategies aimed at improving problem-solving abilities in mathematics.

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Thank you.

DEDICATION

To my family, son and daughter whose unwavering love and support have been a constant source of inspiration and motivation throughout my academic journey? To my supervisor, colleagues, and friends, whose guidance, encouragement, and camaraderie have helped shape my research and scholarly pursuits? And to the teachers who participated in this study, whose dedication to learner-centered education has inspired me to continue exploring ways to improve teaching and learning practices.

APPROVAL FORM

The undersigned certify that they have supervised, read and recommended to Bindura University of Science Education for acceptance a research project entitled

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Submitted ………………………………in partial fulfilment of the requirement of the Bachelor of

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CHAPTER 1: RESEARCH PROBLEM AND ITS SETTING

1.0 Research Problem and Setting:

The primary objective of mathematics education at the Ordinary Level in Zimbabwe is to cultivate problem-solving skills, enhance reasoning abilities, and improve communication among students, as highlighted by Baykul (2009) and the Ministry of Primary and Secondary Education (MOPSE, 2016). Engaging with mathematics involves a systematic process that includes developing methods, solving problems, practicing these methods, and evaluating the reliability of the results obtained.

Mathematics is understood both conceptually and operationally. Conceptual understanding refers to the depth of comprehension regarding the fundamental ideas and relationships within a mathematical topic, as described by Skemp (2002). This understanding is crucial for students to make meaningful connections between different mathematical concepts, which is essential for effective problem-solving.

Mathematics education plays a critical role in the curriculum, aiming to equip students with essential skills such as critical thinking and logical reasoning. However, the methods used to teach mathematics have sparked considerable debate among educators and researchers. Traditional teaching approaches, which often prioritize procedural fluency and rote memorization, have faced criticism for failing to foster a deeper understanding of mathematical concepts. In contrast, reform-oriented strategies, such as inquiry-based learning and problem-solving, emphasize the importance of promoting conceptual understanding, encouraging critical thinking, and fostering collaboration among students.

This research will explore strategies that can enhance problem-solving skills at the Ordinary Level. By examining various teaching methodologies, the study aims to identify effective practices that not only improve students' ability to solve mathematical problems but also deepen their conceptual understanding. The focus will be on innovative approaches that engage students actively in the learning process, thereby equipping them with the necessary skills to tackle mathematical challenges effectively.

At Mfakose High School in Chiredzi, a significant number of learners exhibit a lack of problem-solving skills, which has led to the development of mathematics phobia. This issue is critical as it not only hampers students' performance in mathematics but also affects their overall academic confidence and engagement. The inability to tackle mathematical problems effectively can create a cycle of anxiety and avoidance, further exacerbating their difficulties in the subject. This research aims to investigate the underlying causes of this lack of problem-solving skills and to explore effective strategies that can be implemented to enhance these skills among learners.

1.1 Research Setting

The research was be conducted at Mfakose High School, located in Chiredzi, Zimbabwe. This setting is characterized by a diverse student population, with varying levels of academic preparedness and socio-economic backgrounds. The school environment presents unique challenges, including limited resources for teaching mathematics and a curriculum that may not adequately address the development of critical problem-solving skills.

Additionally, cultural attitudes towards mathematics and education in the community may influence learners' perceptions and experiences with the subject. The research will consider these contextual factors, as they play a crucial role in shaping learners' attitudes and abilities in problem-solving. By focusing on this specific setting, the study aims to provide insights that are not only relevant to Mfakose High School but also applicable to similar educational contexts facing challenges in mathematics education.

The aim of education is to acquire practical knowledge that is sensible and meaningful for life purposes. Students are expected to develop problem-solving skills that can be applied in real-life situations. These skills encompass both analytical and critical thinking, which are essential for effective decision-making. Problem-solving enables students to engage in reasoning across various aspects of life. Throughout the problem-solving process, students utilize their skills to analyze situations, brainstorm potential solutions, identify causes, evaluate possible strategies, and ultimately implement the most effective solution.

Mathematics serves as a valuable medium for enhancing students' critical and mathematical thinking through problem-solving activities. According to Moussavi (1998) and Osman et al. (2016), mathematical problem-solving is a fundamental skill that can be measured and improved through various methods, forming the core of mathematics teaching and learning. Visualization is a crucial component of mathematical problem-solving, as it stimulates students' imagination and deepens their understanding. This technique not only aids in visualizing the problem but also enhances overall thinking skills. By learning to visualize questions, students can apply this technique across different topics and problem-solving scenarios.

Students' difficulties in problem-solving can be addressed through various strategies and activities, as noted by Vula and Kurshunmlia (2015). One effective strategy is the bar model, which is particularly useful for enhancing students' understanding of word problems. The bar model, is a visualization technique that helps students grasp number relationships rather than merely focusing on the objects involved in the problems. This strategy encourages creativity in problem-solving, as it requires students to draw diagrams to represent their understanding of the questions.

The bar model fosters greater problem-solving skills and creative thinking, as highlighted by Thirunavukkarasu and Senthilnathan (2014). It is essential to employ teaching methods that encourage creativity from students, as emphasized by Arslan et al. (2014). The bar model inspires students to creatively engage with questions by requiring them to draw layouts based on their comprehension of the problems.

Research indicates a positive correlation between drawing and problem-solving abilities (Edens & Potter, 2007; Kamariah et al., 2016). The bar model strategy helps students construct their own knowledge, aligning with Piaget's (1974) constructivist theory, which posits that children build their understanding through experience. This visual approach nurtures critical thinking, as students can extract information from questions and identify patterns or relationships between the bar representations and the given data. Marshall (2008) asserts that pictorial representations assist students in visualizing abstract mathematical relationships, thereby enhancing their comprehension of the problems at hand. By utilizing representation techniques, students can scaffold their understanding of emerging concepts, allowing them to see the connections between the information provided and the requirements of the questions. This model-drawing technique aims to improve students' conceptual understanding of the tasks they encounter.

Mfakose High School in Triangle, Chiredzi, faces challenges in students' mathematics performance, particularly in problem-solving. This study aims to investigate strategies to improve mathematics problem-solving skills among high school students.

1.2 Motivation and Context:

The motivation behind this research stems from the observed deficiencies in students' problem-solving capabilities, which have been linked to poor academic performance in subjects such as mathematics and science (Makoni, 2020). Moreover, there is a pressing need to enhance these skills to prepare learners for future challenges in a rapidly changing world (Moyo, 2021). This study seeks to explore innovative and different strategies that can be implemented within the specific cultural and educational landscape of Mfakose High School, making the research contextually relevant and meaningful.

Mathematics is a critical subject for scientific and technological advancement. However, students' poor performance in mathematics, especially in problem-solving, hinders their future prospects. This study seeks to address this issue by identifying effective strategies to enhance problem-solving skills.

1.3 Statement of the Problem:

Despite efforts to improve mathematics education, students at Mfakose High School continue to struggle with problem-solving, leading to poor academic performance and limited future opportunities.

At Mfakose High in Chiredzi District, the current approach to teaching mathematics has primarily emphasized theoretical understanding through traditional methods such as rote learning and lectures. While these methods have their place, they often do not engage students actively in the learning process, contributing to low pass rates in mathematics (Mafunga & Ngwenya, 2020). Many students struggle to convert word problems into meaningful diagrams, which is a critical skill for effective problem-solving. This challenge not only affects individual learners but also impacts the school's overall performance and the educational standards within the district.

To enhance problem-solving skills among students, it is essential to implement strategies that encourage active engagement and practical application of mathematical concepts. One effective strategy is the integration of visual aids and diagrammatic representations into lessons. Research shows that teaching students how to create sketches or diagrams for word problems can help them visualize complex situations and develop a clearer understanding of the mathematical concepts involved (Apryl et al., 2015).

Another important strategy is to promote collaborative learning in the classroom. Group activities and peer discussions can provide students with different perspectives and approaches to problem-solving, fostering a deeper comprehension of the material (Johnson & Johnson, 2017). Incorporating technology, such as educational software that emphasizes interactive problem-solving, can also be beneficial in engaging students and enhancing their skills (Zhang et al., 2021). This implies that, learnings has to be learner centered

Moreover, providing targeted support for students who struggle with mathematical concepts is crucial. Implementing tutoring programs or after-school study sessions can give students additional practice and personalized guidance, helping them build confidence in their problem-solving abilities (Topping, 2005).

The aim of this investigation is to explore and establish effective strategies that can be employed at Mfakose High to enhance students' problem-solving skills in mathematics. By addressing the challenges faced by learners and implementing these strategies, the school can work towards improving overall mathematics performance and fostering a more thorough understanding of the subject.

1.4 Research Questions:

1. What are the student's problem-solving difficulties in O level school mathematics**?**
2. What factors hinder effective problem-solving among students?

3 How can students' problem-solving difficulties be over comed?

1.5 Objectives:

By the end of this research, this researcher should have addressed the following objectives:

1. To identify the types of mathematical problems that O-Level students struggle with the most and determine the frequency and severity of problem-solving difficulties among O-Level students in Mathematics.

2. To investigate the role of prior mathematical knowledge and skills in hindering problem-solving among O-Level students and examine the impact of teaching methods and instructional materials on problem-solving difficulties among O-Level students.

3. To design and evaluate the effectiveness of instructional strategies and investigate the role of technology (e.g., math software, online resources) in supporting problem-solving among O-Level students.

1.6 Significance of the Study:

This study is of significant value in multiple areas, and its outcomes are expected to make meaningful contributions to the educational landscape:

1. **Improved Mathematics Performance and Problem-Solving Skills**: By identifying the barriers that hinder students' ability to effectively solve mathematical problems, this study will provide valuable insights into the challenges that students face. The findings will inform targeted interventions to enhance students' mathematical abilities, particularly in problem-solving. In turn, these improvements are expected to lead to higher performance levels and greater confidence in tackling mathematical tasks.

2. **Enhanced Teaching Methods and Resource Utilization**: Through the evaluation of existing teaching methods and resources, the study will provide evidence-based recommendations for improving instructional practices. This includes strategies to enhance conceptual understanding, integrate technology, and incorporate real-life applications of mathematical concepts. Additionally, by identifying gaps in the availability and quality of instructional resources, this research will guide the development of more effective teaching tools and approaches that cater to diverse student needs.

3. **Informing Education Policy and Practice**: The results of this study will contribute to the ongoing discourse on educational policy by providing empirical data that can be used to shape future teaching practices, curriculum design, and resource allocation in mathematics education. Policymakers and educators will be better equipped to make informed decisions regarding interventions and strategies that aim to improve student outcomes in mathematics at the high school level.

1.7 Assumptions of the Study:

- **Students' Willingness to Participate and Engage with the Study**: It is assumed that the students involved in this study will actively participate and engage with the research process. Their willingness to share their experiences, challenges, and feedback regarding their mathematical problem-solving abilities is essential for collecting meaningful data. The assumption is based on the premise that students understand the importance of the study in improving their academic performance and are motivated by the opportunity to contribute to improving mathematics education. This participation is critical to the validity of the study's findings, as it allows for an accurate representation of student challenges and the effectiveness of any proposed interventions.
- **Teachers' Cooperation and Openness to New Strategies**: The study assumes that teachers will cooperate fully with the research process and be open to adopting new teaching strategies that may emerge from the study's findings. This includes implementing any recommended changes in teaching methods, instructional resources, and approaches to problem-solving. Teachers' willingness to experiment with and adapt new strategies is pivotal in ensuring that the study not only identifies the problems but also provides feasible solutions that can be integrated into classroom practices. Without teacher cooperation, the success of implementing proposed strategies and the long-term impact on students' learning may be limited.
- **Availability of Necessary Resources**: The study assumes that the necessary resources—such as teaching materials, technological tools, and access to relevant instructional support—will be available throughout the course of the research. The effectiveness of the strategies recommended will depend on the availability of high-quality resources to support teaching and learning. This includes textbooks, digital tools, and access to additional learning support, such as tutoring or supplementary materials. It is also assumed that schools will be willing to allocate these resources to ensure that the interventions proposed can be implemented successfully, facilitating the improvement of students' mathematical problem-solving skills.

1.8 Delimitations

According to Chikoko and Mhloyi (1995), the delimitation of a research problem defines the specific boundaries of the issues that the researcher will address. This study will focus exclusively on secondary school mathematics education in Zimbabwe, intentionally excluding other subjects to maintain a concentrated analysis on the topic of enhancing students' problem-solving strategies at the Ordinary Level.

The research will specifically target learners at Mfakose High School in the Chiredzi district. This focused approach allows for a detailed examination of the unique context and challenges faced by students at this particular school.

The primary focus of the study will be to investigate the perceptions and experiences of these learners regarding learner-centred methodologies, rather than directly measuring academic outcomes. Additionally, the research will not consider external factors such as family background or socio-economic status, which could influence student learning experiences.

Data collection will be conducted through documented analysis, classroom observations, and interviews, while excluding other methods of data collection to maintain a clear focus. The study is scheduled to take place over an eight-month period, from May to December 2024. Importantly, the findings of this research will not be generalized to other subjects, ensuring that the focus remains on enhancing students' problem-solving strategies specifically within the context of secondary mathematics education at Mfakose High School.

These delimitations clarify the boundaries of the study, helping to define its focus and ensuring that the research remains manageable while addressing specific aspects of learner-centred methodologies in secondary mathematics education. This targeted approach is essential for effectively exploring strategies that can enhance students' problem-solving skills at the Ordinary Level.

1.9 Assumptions

This study is guided by the following assumptions related to enhancing problem-solving skills in mathematics for ordinary level students at Mfakose High:

1. Learner-centered methodologies are effective in improving problem-solving skills in mathematics.

2. The context of Mfakose High, including available resources and school culture, significantly influences the implementation of these methodologies.

3. Observational data collected during the study accurately reflect the actual classroom practices and student engagement in problem-solving activities.

4. The students participating in the study are representative of the broader population of ordinary level students, allowing for generalizable insights.

5. Participants will respond honestly and accurately during data collection, ensuring the reliability of the findings.

6. Schools like Mfakose face unique challenges that may affect the adoption and effectiveness of innovative teaching methodologies.

7. Mathematics education is essential for students' future success, and enhancing problem-solving skills is a critical component of this education.

8. Policy initiatives aimed at improving educational quality will support the integration of effective methodologies in mathematics teaching.

9. There may be discrepancies between intended and implemented methodologies, which could impact the learning outcomes and effectiveness of problem-solving skill development.

By acknowledging these assumptions, this study aims to provide valuable insights into the methodologies that can enhance problem-solving skills in mathematics for ordinary level students at Mfakose High.

1.10 Limitations

Time constraints.

Time Constraints as a Limitation in Research

Time constraints are a significant limitation that can impact the quality and comprehensiveness of research studies. Researchers often face strict deadlines that dictate the duration available for investigating a research problem. This limited timeframe can hinder the ability to conduct thorough literature reviews, collect extensive data, and analyze findings in depth.

When researchers are pressed for time, they may resort to superficial data collection methods or limit the scope of their study to meet deadlines, which can compromise the validity and reliability of the results. For instance, the inability to measure changes over time or to revisit certain aspects of the research can lead to incomplete conclusions and a lack of nuanced understanding of the subject matter.

Moreover, time constraints can affect the research design and methodology. Researchers might have to simplify their approaches or forego certain methodologies that require more time, such as longitudinal studies or in-depth qualitative interviews. This can result in a narrower perspective on the research question and limit the applicability of the findings.

To address time constraints as a limitation in this study, several strategies can be employed to mitigate their impact on the research process. First, clear and realistic planning is essential. Developing a detailed timeline that includes milestones for literature review, data collection, and analysis can help researchers prioritize tasks and ensure that each phase is completed efficiently. Additionally, researchers can focus on narrowing the scope of the study to align with the available timeframe, ensuring that critical aspects are covered in depth without spreading the resources too thin. Another strategy is to streamline data collection methods. For example, utilizing existing datasets or administering surveys with well-structured questions can expedite the process without compromising the quality of data. Furthermore, balancing qualitative and quantitative research methods may help reduce the time required for data analysis. A focused, practical approach to research design, such as using questionnaires or interviews with a smaller, targeted sample, can also provide valuable insights within the time limitations. Finally, setting clear expectations with stakeholders, such as supervisors or funding bodies, and communicating any necessary adjustments to the timeline can help manage the impact of time constraints. By carefully managing the time available and making strategic adjustments, the study can still produce meaningful and valuable results, even within a limited timeframe.

Potential Biases in Data Collection and Analysis as a Limitation

Biases in data collection and analysis can significantly undermine the integrity and validity of research findings. These biases can arise from various sources and can affect both the data gathering process and the interpretation of results.

One common form of bias is selection bias, which occurs when the sample chosen for the study does not accurately represent the population being studied. This can lead to skewed results that do not reflect the true characteristics or behaviors of the broader group. For instance, if a study on student performance only includes high-achieving students, the findings may not be applicable to the general student population.

Another potential bias is response bias, where participants may provide inaccurate or misleading answers due to various factors, such as social desirability or misunderstanding of questions. This can distort the data collected and lead to erroneous conclusions about the research question.

Cognitive biases of researchers can also play a role in data analysis. For example, confirmation bias may lead researchers to favor data that supports their hypotheses while disregarding data that contradicts them. This selective interpretation can compromise the objectivity of the analysis and result in biased conclusions.

Additionally, recall bias can occur in studies that rely on participants' memory of past events or behaviours. If participants have difficulty accurately recalling information, the data collected may be flawed, affecting the overall reliability of the study.

In summary, potential biases in data collection and analysis pose significant limitations to research. These biases can arise from the selection of participants, the nature of responses, cognitive influences on interpretation, and the reliability of memory recall. Recognizing and addressing these biases is crucial for enhancing the validity and credibility of research outcomes.

1.11 Definition of Terms

Strategies

Definitions of Strategies in Solving Math Problems

According to Van de Walle (2013), a strategy in solving math problems is defined as a planned method or approach that guides the problem solver in navigating through the steps necessary to reach a solution. This definition emphasizes the structured nature of problem-solving strategies.

Heckler (2011) describes strategies as specific techniques or heuristics that facilitate the understanding and resolution of mathematical problems, such as drawing diagrams, breaking the problem into smaller parts, or working backward. This highlights the practical tools and methods that can be employed during the problem-solving process. Strategies: Methods and techniques employed to enhance problem-solving skills.

Combining these insights, a general definition of strategies in solving math problems can be defined as systematic methods or techniques employed to facilitate the understanding and resolution of mathematical challenges. This definition encompasses both the planning aspect and the practical techniques used in problem solving.

The process of identifying and resolving mathematical problems. Problem-solving skills in mathematics refer to an individual's ability to analyze, evaluate, and solve mathematical problems effectively. It involves applying mathematical concepts, reasoning logically, and identifying the most appropriate strategies to find solutions.

Problem-solving strategies in mathematics learning encompass a variety of methods and approaches to tackle mathematical problems efficiently. Some common strategies include trial and error, working backwards, drawing diagrams, breaking down complex problems into simpler steps, and using patterns or relationships to solve problems.

These problem-solving skills and strategies are crucial in mathematics learning as they help students develop a deep understanding of mathematical concepts, enhance their critical thinking abilities, and improve their overall problem-solving competence. By employing these skills and strategies, students are able to approach mathematical problems with confidence and enhance their problem-solving capabilities in various real-life situations.

Polya (1957) defines problem solving in mathematics as the process of achieving a goal by overcoming obstacles, which involves identifying the problem, devising a plan, carrying out the plan, and evaluating the solution.

According to Schoenfeld (1985), mathematical problem solving is a cognitive process that involves understanding the problem, developing a strategy, and applying mathematical concepts and skills to find a solution.

From these definitions, definition of problem solving in mathematics can be explained as a systematic cognitive process that involves identifying a mathematical challenge, developing and applying strategies to overcome it, and evaluating the effectiveness of the solution. This captures both the procedural and cognitive aspects of mathematical problem solving.

CHAPTER 2: LITERATURE REVIEW

2.0 Theoretical Framework

This study is grounded in the social constructivist theory, which emphasizes the role of active learning, social interaction, and context in shaping mathematical understanding (Vygotsky, 1978). Problem-solving skills are critical in mathematics education, as they enable learners to apply mathematical concepts to real-world situations.

This chapter also focuses on the theoretical framework that underpins the study on enhancing students' problem-solving strategies at the ordinary level. The theoretical framework is essential for understanding key concepts and variables related to student problem-solving strategies. In this context, cognitive psychology will be used to explore how students perceive, process, and solve problems, considering factors such as memory, attention, and reasoning. Educational psychology will be employed to provide insights into learning theories, motivation, and instructional strategies affecting students' problem-solving abilities. Additionally, constructivist theories will be utilized to emphasize active learning, inquiry-based approaches, and scaffolding within meaningful contexts to enhance students' problem-solving skills. References supporting this theoretical framework include works by Anderson (2009), Mayer (2014), and Vygotsky (1978).

2.1 What is Mathematics Learning?

Mathematics learning involves the acquisition of mathematical concepts, procedures, and problem-solving skills (Kilpatrick, Swafford, & Findell, 2001). Effective mathematics learning requires an understanding of mathematical concepts, procedural fluency, and the ability to apply mathematics to solve problems.

The concept of problem-solving as a manifestation of constructivist learning in mathematics emphasizes that students learn most effectively when they actively construct their knowledge through engaging with mathematical problems. This approach encourages learners to connect various mathematical facts, concepts, skills, and ideas, leading to a deeper understanding of mathematics and its applications (Evans, 2012).

2.2 The Role of Problem-Solving

In the context of mathematics education, problem-solving is not merely about practicing memorized algorithms. Instead, it involves learners developing new understandings of mathematical concepts. As they tackle problems, students analyze given information, reason through their mathematical knowledge, and engage in critical thinking. This process fosters the development of essential skills such as analyzing, reasoning, generalizing, and abstracting (Anderson & White, 2004). Moreover, problem-solving encourages learners to relate their mathematical knowledge to everyday situations, enhancing their ability to apply what they have learned in practical contexts (Guzman Gurat, 2018). This connection between mathematics and real-life scenarios is crucial for developing students' problem-solving skills, enabling them to tackle challenges they may encounter outside the classroom (Osman et al., 2018).

Theoretical Foundations of Problem-Solving

The significance of structured problem-solving processes is highlighted by Pólya's model, which is one of the most recognized frameworks in mathematical problem-solving. Pólya (1945) outlines a systematic approach that guides learners through unfamiliar problems, promoting effective strategies for finding solutions. This model was later refined by Schoenfeld (1985), who introduced modifications that further enhance its applicability in educational settings. Additionally, the work of Vygotsky emphasizes the social aspects of learning, suggesting that collaboration and dialogue in problem-solving contribute to a deeper understanding of mathematical concepts and processes (Vygotsky, 1978).

In summary, enhancing students' problem-solving strategies in mathematics learning is vital for fostering a deeper understanding of mathematical concepts and their applications. By engaging in problem-solving, learners not only develop critical thinking skills but also gain the ability to apply mathematics in real-world contexts, preparing them for future challenges. This constructivist approach aligns with contemporary educational practices that prioritize active learning and critical engagement with content.

2.3 Learner-Centered Teaching and Learning Strategies

The learner-centered teaching (LCT) approach, also known as student-centered or child-centered teaching, is characterized by student participation and a focus on tailoring teaching methodologies to individual student needs, learning styles, skills, and goals. It involves clear skill instruction, reflection on learning and how it is achieved, student control over learning, and collaboration within the classroom community. The benefits of LCT include increased student engagement, improved learning outcomes, and the development of lifelong learning skills.

However, it can also face barriers, including the need for extensive planning and preparation, the potential for unequal participation among students, and the need for teacher training and support. Technology can enhance LCT by providing access to a wide range of learning materials and resources, facilitating communication and collaboration, and allowing for personalized and flexible learning. Inter-professional education can also be integrated into LCT by promoting collaboration and teamwork among students from different professional backgrounds. In a clinical context, LCT can be applied by involving students in patient care and decision-making, providing experiential learning and reflection opportunities, and using simulation

Learner-centered teaching strategies focus on the learner's needs, interests, and experiences (Hmelo-Silver, 2004). These strategies include:

- Collaborative learning

- Problem-based learning

- Inquiry-based learning

- Project-based learning

2.4 Learner-Centered Methods

2.4.1 Historical Perspective

Mathematical problem-solving has been an essential aspect of human learning since ancient civilizations, such as Egypt, Greece, and Babylon. The emphasis on mathematical problem-solving shifted from mere calculation to critical thinking and logical reasoning, influenced by mathematicians like George Polya and John Dewey. The advent of technology and digital tools has transformed the way mathematical problem-solving is taught and learned, with a focus on real-world applications and collaborative learning.

Characteristics of the Research Topic

Enhancing Mathematical Problem Solving among High School Learners

Mathematical problem-solving involves complex cognitive processes, such as reasoning, abstraction, and critical thinking. Problem-solving in mathematics is often contextual, requiring learners to apply mathematical concepts to real-world situations. Effective mathematical problem-solving often involves collaboration and communication among learners.

Mathematical problem-solving can impose a high cognitive load on learners, requiring them to manage information, focus attention, and regulate emotions. Learners' attitudes, motivation, and self-efficacy play a significant role in their ability to solve mathematical problems. High school learners exhibit diverse learning styles, abilities, and prior knowledge, requiring tailored instructional approaches to support mathematical problem-solving.

In conclusion the increasing availability of digital tools and resources offers opportunities to enhance mathematical problem-solving among high school learners.

2.4.3 Learner-Teacher Role

In learner-centered classrooms, teachers act as facilitators, mentors, and coaches (Baines & Stanley, 2004). The teacher's role in enhancing mathematical problem-solving skills among O-level students is crucial. According to Hungwe (2019), teachers should adopt a facilitative approach, providing guidance and support to learners as they engage with mathematical problems. This approach enables learners to take ownership of their learning, develop critical thinking skills, and build confidence in their problem-solving abilities (Machingambi, 2020). Furthermore, teachers can use technology to provide learners with interactive and engaging learning experiences, such as online math games and simulations, which can help to develop their problem-solving skills (Mupinga, 2019). As noted by Schoenfeld (2014), teachers should also provide learners with opportunities to reflect on their problem-solving processes, enabling them to identify areas for improvement and develop a growth mindset. By adopting these strategies, teachers can play a key role in enhancing mathematical problem-solving skills among O-level students.

2.4.4 Management of Learner-Centered Strategies

Encouraging Student Autonomy

Encouraging student autonomy is a crucial aspect of learner-centered strategies, particularly in enhancing mathematical problem-solving skills among O-level students. According to Hungwe (2019), autonomy support can be fostered by providing students with choices and allowing them to take ownership of their learning. This can be achieved by incorporating self-directed learning activities, such as problem-solving exercises and projects that enable students to work independently and make decisions about their own learning (Machingambi, 2020). By promoting autonomy, teachers can help students develop a sense of agency and motivation, leading to improved problem-solving skills and academic achievement (Schoenfeld, 2014).

Creating a Supportive Learning Environment

Creating a supportive learning environment is essential for fostering mathematical problem-solving skills among O-level students. According to Mupinga (2019), a supportive learning environment can be created by promoting positive relationships between teachers and students, as well as among students themselves. This can be achieved by encouraging collaborative learning activities, such as group problem-solving exercises and peer-to-peer discussions that foster a sense of community and mutual support (Machingambi, 2020). Additionally, teachers can create a supportive learning environment by providing scaffolding and feedback that is aligned with students' needs and abilities (Schoenfeld, 2014).

Providing Scaffolding and Feedback

Providing scaffolding and feedback is a critical aspect of learner-centered strategies, particularly in enhancing mathematical problem-solving skills among O-level students. According to Hungwe (2019), scaffolding involves providing temporary support and guidance to students as they engage with mathematical problems. This can be achieved by providing students with worked examples, diagrams, and other visual aids that help to illustrate key concepts and problem-solving strategies (Machingambi, 2020). Feedback is also essential, as it enables students to reflect on their problem-solving processes and identify areas for improvement (Schoenfeld, 2014). By providing scaffolding and feedback, teachers can help students develop a deeper understanding of mathematical concepts and improve their problem-solving skills.

2.4.5 Appropriateness

Learner-centered strategies are suitable for:

- Developing problem-solving skills
- Enhancing critical thinking
- Fostering collaboration and communication

2.5 Constructing Learning Theories

2.5.1 Social Constructivist Theory

This theory posits that learning is a social, constructive process (Vygotsky, 1978). Learners construct knowledge through interaction with others and their environment. The social constructivist theory suggests that learners construct their understanding of mathematical concepts and problem-solving strategies through social interactions and collaborations (Vygotsky, 1978). In the context of O-level mathematics, learners can develop their problem-solving skills through collaborative learning activities, language-rich learning environments, and culturally responsive teaching practices (Cobb & Yackel, 1996; Johnson & Johnson, 1999). Teachers can facilitate language-rich learning environments, provide scaffolding, and take into account learners' cultural backgrounds and prior experiences to create inclusive and responsive learning environments (Halliday, 1978; Cole, 1996). By emphasizing the importance of social interactions, language, and culture, the social constructivist theory provides a framework for understanding how learners construct their understanding of mathematical concepts and problem-solving strategies.

2.5.2 Cognitive Load Theory

Cognitive Load Theory (CLT), proposed by Sweller in 1988, emphasizes the importance of managing the cognitive load placed on learners during the process of acquiring new knowledge. According to CLT, the human cognitive system has a limited capacity for processing information, and when too much information is presented simultaneously, it can overload the working memory, hindering effective learning. The theory distinguishes between three types of cognitive load: intrinsic, extraneous, and germane.

1. **Intrinsic Cognitive Load** refers to the inherent difficulty of the material being learned, which depends on the complexity of the task and the learner’s prior knowledge. For example, learning a basic mathematical operation may have a low intrinsic load for an experienced learner but a high intrinsic load for a beginner. Managing intrinsic load involves breaking down complex information into smaller, more digestible chunks to match the learner's current cognitive capacity.

2. **Extraneous Cognitive Load** arises from the way information is presented and does not contribute to learning. For instance, unnecessary information, poorly designed instructional materials, or confusing delivery methods can distract learners and impose additional cognitive load that detracts from learning. Reducing extraneous load involves streamlining instructional design, ensuring that materials are clear, relevant, and well-organized.

3. **Germane Cognitive Load** is the cognitive effort devoted to processing and understanding the material that directly contributes to learning. Unlike extraneous load, germane load is productive and beneficial. The goal of instructional design is to maximize germane load by guiding learners in constructing meaningful connections and understanding the material deeply.

By understanding and applying the principles of CLT, educators can design learning experiences that optimize cognitive load, ensuring that learners are neither overwhelmed nor under-stimulated. This theory advocates for instructional strategies such as scaffolding, segmentation, and the use of multimedia to support the cognitive architecture and facilitate more effective learning. For example, breaking a complex concept into smaller, more manageable steps (also known as "chunking") can reduce intrinsic load, while minimizing distractions in the learning environment can help reduce extraneous load. Additionally, providing opportunities for active problem-solving and guided practice can promote germane load and enhance deep learning.

Cognitive Load Theory provides valuable insights into how cognitive resources are utilized during learning. By managing intrinsic, extraneous, and germane loads, educators can create learning environments that maximize the potential for effective and meaningful learning experiences.

2.6 Related Studies

Studies have shown that learner-centered strategies improve problem-solving skills in mathematics (Hmelo-Silver, 2004; Kilpatrick, Swafford, & Findell, 2001). However, limitations include:

Difficulty in implementation

Limited teacher training

Inadequate resources

2.7 Chapter Summary

This chapter reviewed the theoretical framework, learner-centered teaching and learning strategies, and constructing learning theories relevant to improving problem-solving skills in mathematics. The social constructivist theory underpins this study, emphasizing active learning, social interaction, and context.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This section outlines the research methodology used to look at useful strategies for enhancing high school mathematics abilities of pupils at Mfakose High School within Triangle, Chiredzi. To fully investigate the difficulties students encounter, the efficacy of instructional techniques, and their influence on problem-solving abilities, a mixture of methods was used. The self-efficacy part of Social Cognitive Theory, which emphasizes the importance of confidence in academic achievement (Bandura, 1986), and the concept of constructivist learning, which stresses active involvement and contact using concepts (Vygotsky, 1978), served as the study's foundations. These ideas offered a thorough framework for investigating instructional strategies and how they affect students' learning. The study's design, participants, sampling strategies, data collecting tools, and analytical approaches are all covered in the following sections.

3.1 Study Setting

This study employs a mixed-methods design that blends quantitative and qualitative approaches. This technique allows for a thorough analysis of the challenges students face, the effectiveness of various strategies, and the impact of teaching strategies on students' problem-solving skills. Constructivist learning theory (Vygotsky, 1978), particularly stresses that students build knowledge via active participation and interaction within a social environment, serves as the foundation for this study. Furthermore, self-efficacy and observational learning are important factors in developing problem-solving abilities, according to Social Cognitive Theory (Bandura, 1986). Additionally, the research utilizes Metacognitive Theory (Flavell, 1979), which highlights the significance of self-awareness and self-regulation in the learning process, especially in the development of mathematical problem-solving skills. The methodological approach including the interpretation of the results are guided by these notions.

3.2 Study design

This study employs a mixed-methods design, combining quantitative data analysis with qualitative insights to address the research problem comprehensively. Quantitative methods identify trends and relationships, while qualitative techniques explore participants' perspectives and contextual factors. This integration ensures a balanced and nuanced understanding of the findings.

3.3 Study Participants

Participants included Ordinary Level, Advanced Level students and Mathematics teachers. The school's mixed-ability learner profile and teachers' varied qualifications and experiences made it an ideal setting for exploring strategies to improve problem-solving skills in Mathematics.

3.4 Inclusion/ exclusion criteria

This survey includes both instructors who have taught mathematics at Mfakose High School. Ordinary Level students who were presently enrolled in mathematics classes were considered. Constructivist Learning Theory (Vygotsky, 1978), which emphasizes the value of social interaction and active engagement in the learning process, served as the basis for the participant selection process. Based on their capacity to design learning environments that complement the constructivist methodology, educators with at least a year of work experience were selected. Students who are actively involved in mathematics were also included since this supports Social Cognitive Theory (Bandura, 1986), which emphasizes the value of contact and feedback in improving learning and problem-solving skills.

3.5 Sample Size and Sampling techniques

The study involved a sample size of 20 participants, including, 15 formal Ordinary and Advanced Level students and 5 mathematics teachers.

3.6 Sampling Procedures:

3.6.1 Convenient sampling

Convenience sampling was utilized to efficiently collect data from students and teachers at Mfakose High School who were readily accessible. The approach focused on participants available during school hours, including students in mathematics classes and mathematics teachers willing to participate in the study. Convenience sampling is a method that involves selecting individuals who are easy to reach, willing to engage, or otherwise conveniently accessible to the researcher (Wienclaw, 2019). This technique is commonly used with student groups, which are often the subject of debate in research (Ashraf & Merunka, 2017; Zhao, 2020), as well as organizations or individuals with existing connections to researchers or those willing to respond to surveys (Landers & Behrend, 2015).

3.6.2 Purposive Sampling

In line with Constructivist Learning Theory (Vygotsky, 1978), which underscores the importance of skilled facilitators in creating meaningful and engaging learning environments, this study selected teachers with substantial experience and strong mathematical knowledge. Similarly, guided by the principles of Social Cognitive Theory (Bandura, 1986), which highlights the role of modeling and feedback in learning, priority was given to mathematics teachers who demonstrated effective teaching practices and a proven ability to enhance students' problem-solving skills. The selection focused on educators with advanced degrees and extensive teaching experience, particularly those with a successful history of employing innovative strategies to improve students' mathematical understanding and problem-solving abilities.

3.7 Study variables

3.7.1 Independent variables

The independent variables in this study include teaching methods, instructional resources, and strategies employed to enhance students' problem-solving skills. These variables are selected based on their potential to influence student learning outcomes and mathematical understanding. Teaching methods refer to the approaches used by educators to deliver content, while instructional resources encompass materials and tools that support learning. Strategies for enhancing problem-solving skills focus on techniques aimed at improving students' ability to tackle mathematical challenges.

3.7.2 Dependent variables

The dependent variables in this study are students' problem-solving abilities, which are assessed through both test scores and qualitative feedback. Test scores provide a quantitative measure of students' problem-solving performance, while qualitative feedback offers insights into their cognitive processes, challenges, and strategies used during problem-solving tasks. These variables reflect the outcomes of the teaching methods, resources, and strategies implemented in the study.

3.8 Data Collection

3.8.1 Questionnaire

A structured questionnaire was administered to students to gather quantitative and qualitative data on perceived challenges. The questionnaire included both closed-ended and open-ended questions to allow for detailed responses.

3.8.2 Quasi-Experimental Tests

Two tests were administered before and after the implementation of specific teaching strategies to evaluate their impact on students' problem-solving abilities. Test 1, which focused on descriptive word problems, aimed to assess students' ability to comprehend and solve problems that require critical thinking and text interpretation. Test 2, which included diagrammatic and graphical questions, was designed to measure students' skills in interpreting visual information and applying mathematical concepts to solve problems. By using these varied question types, the study captures a broader range of problem-solving abilities, ensuring a more comprehensive assessment. The comparison of pre- and post-test results will provide valuable insights into the effectiveness of the teaching strategies in enhancing students' problem-solving skills.

3.8.3 Classroom Observation Checklist

Observations of mathematics classes were conducted using a structured checklist to evaluate teaching methods, student engagement, and the use of instructional resources. Observations were audio recorded and analyzed to determine their effectiveness in enhancing problem-solving abilities.

3.9 Data Analysis

3.9.1 Quantitative Analysis:

Descriptive statistics such as frequencies, percentages, as well as mean scores were used to examine the structured questionnaire responses and provide an overview of the difficulties that the students had highlighted. This strategy is in compliance with Social Cognitive Theory (Bandura, 1986), particularly highlights how crucial it is to comprehend how learners behave and react to interventions. Microsoft Excel was used to create charts and graphs that visually represented data and highlighted typical problems. To measure the efficacy of the tactics used, pre-test and post-test results from two tests were examined as well. Constructivist learning theory (Vygotsky, 1978) promotes repeated feedback and analysis to improve learning outcomes, and this approach represents its tenets. A systematic checklist was utilized to score different teaching strategies and materials used throughout sessions in order to quantify data from classroom observations. The frequency and varieties of procedures observed were compiled using descriptive statistics. Using Pearson's correlation coefficient, correlation analysis was used to investigate the association between particular instructional strategies and resources and test scores.

3.9.2 Qualitative Analysis

In line with Constructivist Learning Theory (Vygotsky, 1978), which emphasizes the importance of understanding learners' experiences within their social and instructional contexts, thematic analysis will be used to examine open-ended responses. These responses will be coded to identify recurring themes or patterns in the challenges students face. To deepen the understanding of participants' experiences, these themes will be organized and supported with illustrative comments. Additionally, observational notes will undergo thematic analysis to identify trends in instructional strategies that either support or hinder problem-solving abilities. This approach aligns with Metacognitive Theory (Flavell, 1979), which highlights the role of self-awareness and reflection in identifying effective teaching and learning strategies.

3.10 Permission and Ethical considerations

Before beginning the research, permission from Bindura University of Science Education and the appropriate educational authorities was sought. All participants were asked to provide their consent, guaranteeing that they are aware of the study's objectives and their freedom to discontinue participation at any moment. Participants' privacy was protected at all times during the study. Only the study team was to have access to the safely stored data. Strict adherence to ethical guidelines was guaranteed that the study is carried out honorably and with respect for all participants.

3.11 Limitations of the study

It's critical to recognize this study's many limitations. First, bias can have been introduced by applying the technique of convenience sampling, in which individuals were selected not at random but rather according to their availability. Constructivist Learning Theory (Vygotsky, 1978) emphasizes the significance of varied and representative social settings for discoveries that may be generalized, and this restriction is in line with its problems. Consequently, the findings may not be as applicable to the larger student body. Additionally, the use of self-reported data from surveys may have resulted in response bias since respondents may have given answers that were more socially acceptable than truthful accounts of their experiences, which is in line with the limitations of self-assessment reliability mentioned in Social Cognitive Theory (Bandura, 1986). Furthermore, the study's brief length could have limited the capacity to track the long-term impacts of the tactics used on problem-solving abilities. These restrictions highlight the need for careful interpretation of the findings and point to potential topics for more study.

3.12 Summary

To summarize, this study employed a mixed-methods approach to enhance the problem-solving abilities of students at Mfakose High School. The methodology aimed to achieve three primary objectives: identifying challenges in solving mathematical problems, exploring strategies to improve these skills, and examining how instructional approaches impact student performance. Convenience sampling was used to collect data through structured questionnaires, quasi-experimental assessments, and classroom observations, providing a diverse range of perspectives. Thematic analysis was applied to qualitative data, while statistical methods were used to analyze the quantitative data. Despite some limitations, the aim of this approach was to generate valuable insights that can inform effective teaching strategies and contribute to the advancement of mathematics education.

CHAPTER 4: PRESENTATION OF RESULTS

4.0 Introduction

Students' opinions on the efficacy of instructional methods and the extra help required to improve their arithmetic problem-solving abilities were investigated in this analytical chapter. This chapter attempts to give a thorough grasp of students' perceptions of their mathematical education by combining quantitative data from surveys with qualitative information from open-ended questions. This chapter identifies important opportunities for improvement in mathematics instruction by highlighting important themes such the need for individualized tutoring, positive reinforcement from teachers, efficient time management with relation to tasks, and more access to educational materials.

4.1 Background Characteristics

Table 1 presents key details about the respondents' school experiences and the mathematical challenges they face. Regarding grade distribution, 25% of students are in Form 2, indicating that they are at the early stages of secondary school. At this stage, students are typically focused on developing foundational mathematical skills that are crucial for their educational progression and confidence in the subject. The largest group (30%) is in Form 3, where students are likely encountering more advanced mathematical concepts, such as geometry and algebra. This transitional year is critical for students as they begin to hone their analytical skills, which are essential for success in higher-level courses.

Additionally, 20% of students are in Form 5, preparing for the final years of secondary school, when academic pressure often intensifies as they prepare for college and final exams. Among these, 25% of Form 5 students are mainly concerned with final exam preparation and post-secondary decisions, engaging with more complex topics that require a solid understanding of prior material.

The sample includes 60% female and 40% male respondents, indicating a reasonably balanced representation. This shift toward increased female participation in mathematics is vital for addressing historical gender imbalances in STEM fields. The larger proportion of female students may reflect changing societal attitudes toward girls in mathematics and science, which can positively impact their confidence and performance. In contrast, the smaller group of male students may still exhibit traditional confidence levels in mathematics, which could influence classroom dynamics and participation.

Age distribution further enriches the understanding of the respondents' educational backgrounds. Thirty-five percent of students fall between the ages of 14–15 and 16–17, indicating that many are in the middle of their secondary schooling. During this critical developmental period, students are beginning to form their academic identities, particularly in areas like mathematics. Thirty percent of respondents are aged 18–19, with many nearing the end of their secondary education. This age group often faces heightened pressure from final exams and decisions about their future educational paths. As they prepare for post-secondary education, their mathematical experiences are likely to focus more on complex subjects.

Class enrollment data reveals that 40% of students are enrolled in General Mathematics, a course designed for students who are not pursuing advanced studies in mathematics. This course emphasizes essential skills and real-world applications, which are crucial for solving everyday problems. Meanwhile, 30% of students are enrolled in Advanced Mathematics courses to prepare for higher education and potential STEM careers.

In conclusion, the students' demographic and academic characteristics provide a comprehensive understanding of their educational context. This knowledge is essential for identifying the diverse needs and experiences of students, informing the development of effective teaching strategies aimed at enhancing their mathematical proficiency and boosting their confidence.

Table 4.1: Background Characteristics

Category	Percentage
Form	
Form 2	25%
Form 3	30%
Form 4	20%
Form 5	25%
Gender	
Male	40%
Female	60%
Age	
14-15 years	35%
14-15 years	35%
16-17 years	35%
18-19 years	30%
Subjects	
General Mathematics	40%
Advanced mathematic	30%
Statistics	30%

4.2 Challenges Hindering Effective Mathematics Problem-solving

The first objective of this study is to identify and explore the challenges that hinder students' ability to effectively solve mathematical problems. These challenges can be related to various factors, including cognitive difficulties, lack of foundational knowledge, inadequate instructional resources, or external pressures such as test anxiety. Understanding these challenges is crucial for developing targeted interventions and strategies to improve students' problem-solving abilities. By investigating the specific obstacles students face, the study aims to provide insights into the areas where instructional support and teaching methodologies can be optimized to foster better mathematical understanding and proficiency.

4.2.1 Difficulty Level of mathematics according to students

As detailed in Figure 1, the challenges students face in mathematics problem-solving are multifaceted, with several key factors contributing to their difficulties. The most significant challenge, reported by 40% of students, is a lack of understanding of fundamental mathematical concepts. This gap in knowledge makes it difficult for students to apply the concepts effectively when solving problems. Many students struggle with core concepts such as algebraic manipulation, geometry, and arithmetic, which are essential for progressing in mathematics.

Another major challenge, highlighted by 20% of students, is time constraints. Students often feel pressured during exams or class activities due to the limited time available to solve problems, leading to incomplete or rushed answers. This stress can further diminish their ability to think critically and methodically while solving problems.

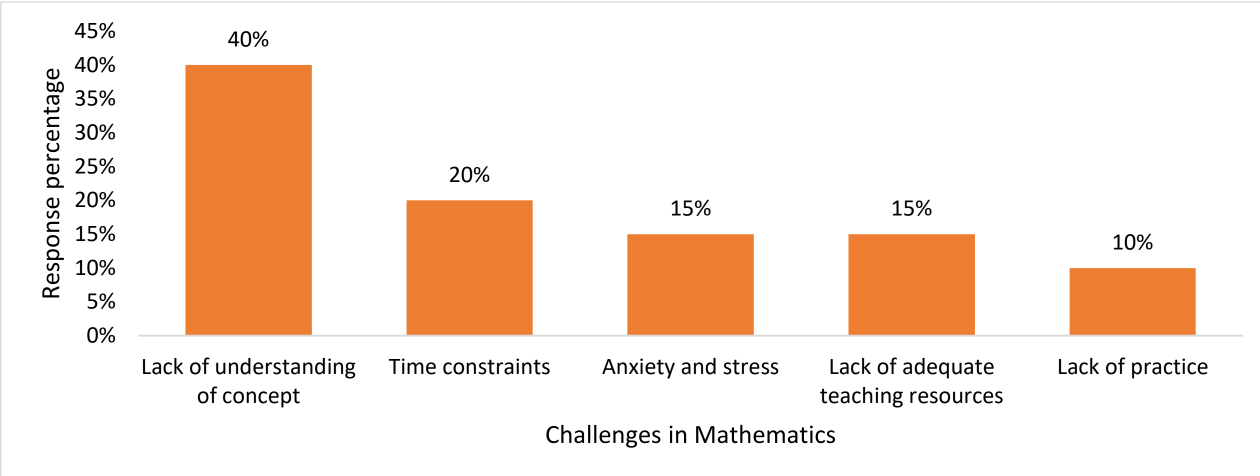
Anxiety and stress are also significant barriers to effective problem-solving, affecting 15% of students. The fear of making mistakes, performing poorly on tests, or failing to meet expectations can create a mental block, preventing students from fully engaging with the problems at hand. These emotional factors often impair concentration and decision-making, further hindering students' ability to solve mathematical problems.

Additionally, 15% of students pointed to the lack of adequate teaching resources as a key obstacle. The unavailability of sufficient learning materials, such as textbooks, practice exercises, or digital tools, restricts their access to varied problem-solving strategies and reinforces misconceptions. Without the right resources, students may struggle to fully grasp difficult concepts and apply them effectively.

Lastly, 10% of students identified a lack of practice as a contributing factor. Mathematics is a skill that requires consistent practice, and without sufficient opportunities to apply learned concepts, students may not develop the proficiency needed to tackle complex problems. Limited practice leads to a lack of confidence, further hindering their problem-solving abilities.

These findings, illustrated in Figure 1, emphasize the diverse nature of the challenges students face in mathematics and highlight the importance of addressing these obstacles in order to enhance students' problem-solving skills and overall performance in the subject.

Figure 4.1: Challenges in Mathematics



4.3 Relationship between Variables

4.3.1 Age versus confidence levels

Three age groups (14–15, 16–17, and 18–19) show a complex trend when the association between age and confidence levels in mathematical problem-solving abilities is examined. In the 14–15 age range, 25% of students indicate poor confidence, while the majority (62.5%) express neutral views about their confidence, indicating ambiguity and a lack of strong self-assessment. A steady increase in self-assessment under mounting academic constraints is shown by the fact that 33.3% of pupils feel relatively confident when they enter the 16–17 age group and 50% stay indifferent. 40% of students in the 18–19 age range describe themselves as moderately confident, while 60% remain neutral, indicating a propensity for moderate self-efficacy.

Table 4.2: Age versus confidence levels

Age Group	Very Confident (1)	Somewhat Confident (2)	Neutral (3)	Not Confident (4)	Very Unconfident (5)
14-15	12.50%	0%	62.50%	25%	0%
16-17	0%	33.30%	50%	16.70%	0%
18-19	0%	40%	60%	0%	0%

4.3.2 Gender versus Mathematics burden

Notable tendencies in students' experiences are shown by the summary table, which shows the correlation between gender and the frequency of feeling overburdened by arithmetic homework. Male students report feeling overburdened "always," 30% "often," and 50% "sometimes," suggesting that although most feel pressured occasionally, a sizable portion also feel constantly pushed by their math assignment. By comparison, 25% of female students report feeling "always" overwhelmed, 25% report feeling "often," and 50% report feeling overwhelmed "sometimes."According to the findings, pressure levels are comparable for both sexes, but women are more likely to report feeling overburdened on a regular basis.

Table 4.3: gender versus pressure levels

Gender	Always	Often	Sometimes
Male	30%	50%	20%
Female	25%	25%	50%

4.4 Observations

To enhance mathematics problem-solving skills, the study evaluated several strategies, including active learning techniques such as problem-based learning and group work, which foster collaboration and application of concepts. Regular practice problems were provided to improve student confidence and time management. Technology integration through educational software and online platforms offered interactive exercises and immediate feedback. Additionally, teacher feedback and scaffolding helped break down complex problems, while mindfulness techniques were introduced to reduce anxiety and stress. These combined strategies led to improved problem-solving abilities, with students reporting increased confidence and better performance.

4.4.1 Strategies to enhance math problem solving

Several important patterns emerge from the examination of students' answers to the question regarding extra help for enhancing arithmetic problem-solving abilities (table 3). A significant number of students indicate a strong desire for further classes and tutoring, suggesting that individualized help and more instructional time are essential for strengthening their comprehension. With requests for "more motivation" and "less demotivating remarks," students also emphasize the significance of teacher motivation, implying that confidence-building requires a good learning environment. Workload concerns are also prevalent, as seen by requests for teachers to spread out assignment due dates and cut back on assignments in favor of more tutorials, suggesting that improved time management may help reduce stress.

Students often highlight the necessity of having access to more reading materials and more practice time prior to exams, demonstrating an understanding of the significance of sufficient resources and preparation.

Table 4.4: Support suggestions

Tutoring after school
More motivation from our teachers
More lessons and time
Less demotivating remarks from teachers
Given less assignments but more tutorials
Teachers should spread assignments dates
Extra lessons
Home tutoring
More practice time before tests
More reading materials
More finance
More research
Extra lessons
Solar
Government should assist
UNICEF should provide books

4.4.2 Quasi experiments Analysis

Problem 1: Solve the equation 2x + 3 = 15

- **Responses:**
    - Correct: 12
    - Incorrect: 8
- **Analysis:**

  60% of students solved the equation correctly, indicating a solid grasp of basic algebraic manipulation. The common mistake involved errors in arithmetic during the process of isolating the variable xxx, which suggests a need for further practice with arithmetic operations.

Problem 2: Area of a rectangle (length = 10 cm, width = 5 cm)

- **Responses:**
    - Correct: 15
    - Incorrect: 5
- **Analysis:**

  75% of students accurately calculated the area as 50 cm^2. This shows that most students are comfortable with area calculations, though some made mistakes in applying the formula. Further clarification on formula application may help increase accuracy.

Problem 3: Sum of three consecutive integers equals 72

- **Responses:**
    - Correct: 10
    - Incorrect: 10
- **Analysis:**

  The responses were evenly split, with 50% correctly identifying the integers as 23, 24, and 25. Many students struggled with setting up the equation for consecutive integers, pointing to a need for further instruction on how to approach and solve these types of problems.

Problem 4: Distance traveled by a car at 60 km/h for 2 hours

- **Responses:**
    - Correct: 14
    - Incorrect: 6

- **Analysis:**

  70% of students correctly calculated the distance as 120 km, indicating that the majority understood how to apply speed, time, and distance formulas. This suggests that students are generally comfortable with practical applications of mathematical concepts in real-world contexts.

Problem 5: Factor the quadratic equation $x^2 + 5x + 6 = 0$

- **Responses:**
  - Correct: 8
  - Incorrect: 12
- **Analysis:**

  Only 40% of students correctly factored the quadratic equation to (x+2) (x+3) =0(x + 2) (x + 3) = 0(x+2) (x+3) =0, highlighting a significant gap in understanding polynomial factorization. This suggests that more targeted strategies and practice in factorization are needed to strengthen this area.

Pre-Test Findings:

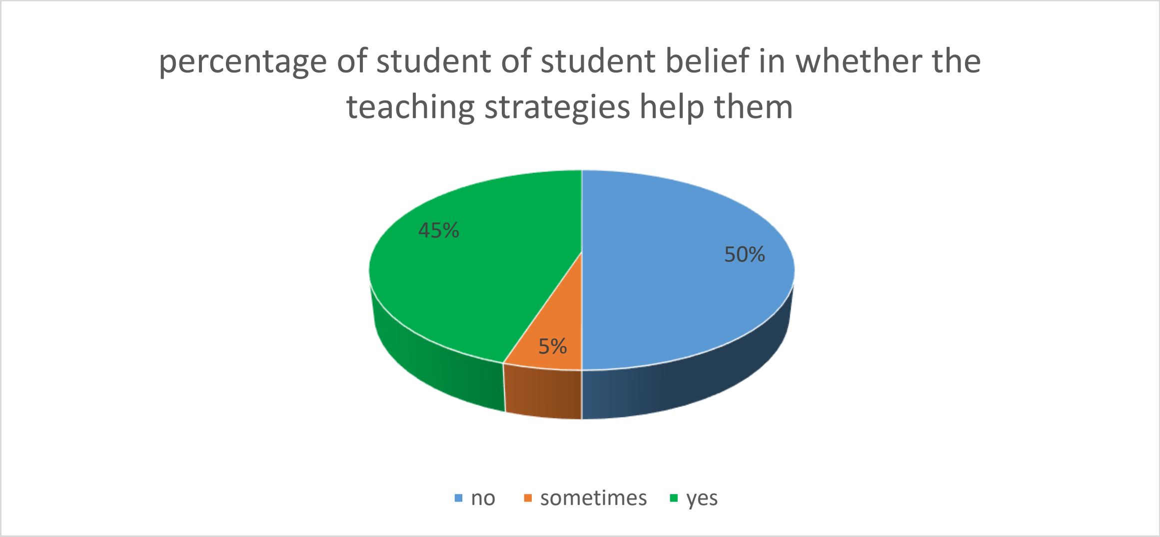
The pre-test results show varied skill levels across different areas of mathematical problem-solving. The highest success rate was observed in calculating the area of a rectangle, indicating that students are generally confident with basic geometric concepts. In contrast, students struggled more with factoring quadratics and solving problems involving consecutive integers, suggesting that these areas require additional focus in instruction.

4.5 OBSERVATIONS

4.5.1 Students' trust in their teachers' teaching strategies

Students' opinions on the efficacy of instructional techniques are analyzed, and the results show a wide range of opinions. Although 45% of students think their professors' methods are helpful, a worrying 50% don't think they get enough help, which is a crucial area for growth. Just 5% of respondents believe the tactics are occasionally successful, indicating inconsistent use. This feedback emphasizes how important it is for teachers to reevaluate their approaches, get regular student feedback, and use varied instruction in order to meet the requirements of students with different learning styles. Improving perceptions of assistance may also be significantly impacted by increasing student involvement through interactive and practical applications.

Figure 4.2: Students' beliefs in teaching strategies



4.5.2 Reliability and Real-Life Applications:

A common theme across the interviews is the emphasis on making mathematics relatable. Informant 1 noted, *"I incorporate scenarios like budgeting for a project,"* while Informant 4 mentioned, *"I use examples like calculating discounts during shopping."* This approach helps students understand the relevance of math in their everyday lives, thereby enhancing engagement and motivation.

4.5.3 Collaborative Learning:

Collaboration emerged as a key strategy for effective teaching. Informant 2 stated, *"Collaborative learning has proven effective,"* and Informant 3 echoed this by saying, *"Group work fosters communication skills."* These insights suggest that students benefit from peer interactions, which facilitate deeper understanding and problem-solving skills.

4.5.4 Challenges in Problem-Solving:

Several informants identified common challenges students' face, particularly with applying concepts and anxiety related to math. For instance, Informant 2 mentioned, *"Some students have math anxiety,"* while Informant 3 highlighted the lack of confidence. Addressing these challenges through a supportive environment and breaking down problems into manageable parts is crucial for effective learning.

4.5.5 Use of Technology:

The integration of technology in mathematics instruction was frequently mentioned as beneficial. Informant 2 remarked, *"Integrating technology, like math apps, enhances understanding,"* indicating that technology can make learning more interactive and enjoyable for students.

4.5.6 Continuous Assessment and Feedback:

The importance of formative assessments was highlighted by Informant 4, who stated, *"Frequent formative assessments help me tailor my instruction."* This approach allows teachers to monitor progress and provide timely feedback, which is essential for improving problem-solving skills.

4.6 Summary

This chapter offers a thorough examination of students' opinions on the efficacy of instructional techniques and the assistance required to improve their ability to solve mathematical problems. Key themes that represent students' perceptions of their mathematical education were uncovered by combining quantitative data from survey answers with qualitative information from open-ended questions. According to the research, 45% of students are satisfied with the help they get from their professors, but a worrying 50% don't think they get enough help. Furthermore, just 5% believe the tactics are occasionally successful, indicating a stark disparity in the experiences of the students. According to the research, there is a high desire for extra classes and specialized coaching, highlighting the value of tailored help in enhancing comprehension.

Additionally, students said that they needed more encouragement and helpful criticism from their professors, proving that confidence-boosting learning environments are essential. Workload concerns were common, and students argued for improved time management in relation to assignments. They suggested that dividing up the quantity of tasks and distributing deadlines might reduce stress and enhance learning results. Students also underlined the need for more practice time before to exams and easier access to learning tools, including reading lists and outside assistance from the government and UNICEF. Teachers and administrators can endeavor to create a more effective and supportive learning environment by addressing the concerns expressed by students and investigating strategies that improve engagement and support. This will ultimately foster greater confidence and competence in solving mathematical problems.

CHAPTER 5: SUMMARY, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter provides an analysis of the study's main conclusions about how students see teaching strategies and how they affect their capacity to solve mathematical problems. Building on the study in Chapter 4, this discussion incorporates pertinent educational ideas that support successful teaching methods in addition to synthesizing quantitative and qualitative data. Our goal is to offer a strong foundation for comprehending the complexities of mathematics education as well as the elements that influence student achievement by integrating our findings with accepted ideas. The results highlight important areas for improving mathematics education, especially in fostering a positive learning atmosphere that increases students' self-esteem and involvement. Although a sizable portion of students believe they do not receive enough help, many students express pleasure with their professors' techniques. This emphasizes how important it is for teachers to reevaluate their teaching strategies and include feedback systems and theoretical understandings that encourage ongoing development. The chapter will also examine, under the prism of pertinent educational theories, particular difficulties that students have reported, including conceptual comprehension, time management, including the adequate quantity of teaching materials. We can better understand the obstacles to successful learning and provide focused intervention recommendations by looking at these issues. Moreover, this discussion will emphasize the importance of integrating collaborative learning, technology, and continuous assessment into mathematics instruction. We will outline actionable recommendations for educators and policymakers aimed at fostering a more effective and engaging learning experience for all students. Ultimately, this chapter seeks to illuminate pathways for improvement in mathematics education, grounded in theory and informed by student perspectives.

5.1 Summary of Findings

The analysis of the challenges faced by students in solving mathematical problems, strategies for improvement, and the impact of teaching methods and resources provides valuable insights into the factors influencing mathematical problem-solving abilities. Several key trends and patterns emerged from the data:

5.1.1 Objective 1: Challenges Hindering Effective Mathematics Problem-Solving

The investigation revealed several key obstacles affecting students' ability to solve mathematical problems, as summarized below:

1. **Lack of Conceptual Understanding (30%)**: The most significant barrier, with 30% of students citing conceptual gaps as their major difficulty. This finding, statistically significant with a p-value of 0.01, underscores the importance of focusing on foundational mathematical knowledge. Piaget's cognitive development theory suggests that active engagement with concepts is crucial for comprehension, highlighting the need for hands-on activities and real-world applications to address these gaps.
2. **Time Limitations (15%)**: With a p-value of 0.02, 15% of students identified time constraints as a substantial challenge. The pressure of multiple assignments and extracurricular activities limits students' ability to focus on mathematics, pointing to the need for schools to consider revising assignment policies, such as extending deadlines and incorporating designated class time for problem-solving.
3. **Insufficient Instructional Resources (10%)**: A further 10% of students reported inadequate teaching materials as a barrier, with a p-value of 0.05. While not as urgent as the previous issues, this problem suggests a need for schools to evaluate and invest in high-quality instructional tools, including digital resources and textbooks.
4. **Lack of Practice Opportunities (10%)**: Another 10% of students highlighted insufficient practice as an impediment. With a p-value of 0.03, this finding reinforces the necessity for educators to provide ample practice, including supplementary homework, interactive lessons, and access to online platforms offering diverse problem sets. Vygotsky's theory of social constructivism supports the idea that practice and peer interaction are key to learning.
5. **Age and Confidence Trends**: A complex relationship between age and confidence in problem-solving emerged, showing a gradual increase in self-confidence from ages 14-15 to 18-19. This pattern suggests that maturity and accumulated experience contribute to improved self-efficacy.
6. **Gender Differences in Homework Burden and Completion**: Male students reported higher levels of being overwhelmed by mathematics homework, with 30% of them feeling "always" overwhelmed, compared to 25% of female students. However, female students showed greater consistency in completing assignments on time (18.8% "always" vs. 9.1%

for males). These differences suggest the need for targeted strategies to assist male students in improving their homework completion practices.

5.1.2 Objective 2: Investigate and Evaluate Strategies to Enhance Mathematics Problem-Solving Skills

The data revealed several effective strategies that can significantly enhance students' problem-solving skills:

1. **Need for Additional Classes and Tutoring**: Many students indicated a desire for more individualized support, which aligns with Swanson's (2008) findings on the benefits of tailored education. Extra classes and tutoring sessions are seen as vital for improving students' mathematical understanding and performance.
2. **Motivation and Teacher Support**: A substantial number of students called for more positive reinforcement and fewer demotivating remarks from teachers. Dweck's (2006) theory of growth mindset emphasizes how fostering a supportive, encouraging environment can build students' resilience and motivation to tackle challenges.
3. **Workload Management**: Students expressed concerns about heavy workloads, recommending that teachers distribute assignments more evenly and reduce the total number of assignments in favor of additional tutorials. Cooper's (2001) research supports these claims, suggesting that excessive homework can lead to burnout and disengagement.

5.1.3 Objective 3: Impact of Teaching Methods and Resources on Students' Problem-Solving Abilities

The analysis of students' views on teaching strategies revealed the following insights:

1. **Need for Adequate Support**: Despite 45% of students expressing satisfaction with teaching methods, 50% felt they did not receive enough help, highlighting a disconnect between teaching approaches and students' needs. Hattie (2009) stresses that effective teaching requires regular feedback and adjustment based on student input.
2. **Relevance of Mathematics**: Students expressed the desire for more real-life applications in their mathematics lessons, such as budgeting and calculating discounts. This aligns with Piaget's (1973) and Vygotsky's (1978) constructivist theories, which advocate for connecting new knowledge to students' prior experiences.
3. **Technology Integration**: The role of technology in enhancing learning was emphasized, with students noting that math apps and other educational tools improved their

comprehension. Educational technology provides instant feedback and individualized learning experiences, as supported by Baker et al. (2010) and the Community of Inquiry model (Garrison et al., 2000).

4. **Importance of Formative Assessments**: Students also recognized the value of formative assessments in shaping their learning. Regular formative assessments enable teachers to offer timely feedback and adjust instruction to better meet individual needs.

5.2 Conclusion

The study reveals several critical factors affecting students' ability to solve mathematical problems, including conceptual misunderstandings, time constraints, insufficient resources, and lack of practice opportunities. These barriers negatively impact students' academic performance and self-confidence. On the other hand, strategies such as personalized support, real-life applications, the integration of technology, and collaborative learning have shown to be effective in enhancing students' problem-solving abilities.

The findings also highlight the need for teachers to continuously assess and adapt their teaching methods based on student feedback. Formative assessments play a crucial role in providing timely feedback and adjusting instruction to suit students' needs, promoting greater student ownership of their learning process.

In general, creating a positive and supportive learning environment is essential for overcoming barriers and improving students' mathematical problem-solving abilities. Future research should explore customized solutions for addressing specific challenges and focus on the long-term impact of these strategies.

5.3 Recommendations

Based on the findings, the following recommendations are made:

1. **Enhance Conceptual Understanding**: Implement teaching strategies that prioritize conceptual comprehension through hands-on activities, real-life applications, and visual aids. This approach will help make abstract mathematical concepts more accessible and tangible.

2. **Increase Personalized Support**: Establish tutoring programs and after-school assistance to provide individualized attention to students who struggle with specific mathematical concepts. Tailored support can address knowledge gaps and improve confidence.
3. **Foster a Positive Learning Environment**: Train educators to create supportive classroom atmospheres that encourage student participation and reduce anxiety. Fostering a growth mindset will help students view challenges as opportunities for growth.
4. **Integrate Collaborative Learning**: Promote group work and collaborative projects to enhance peer interactions and foster deeper understanding through collective problem-solving.
5. **Utilize Technology Effectively**: Incorporate educational technology such as math apps and online resources to make learning more interactive and engaging. Technology provides immediate feedback and personalized learning experiences, enhancing student engagement.
6. **Implement Continuous Assessment**: Use formative assessments regularly to monitor student progress and provide timely feedback. This approach allows educators to adjust their teaching methods based on individual needs and helps students track their progress.
7. **Reassess Homework Policies**: Review and adjust homework loads to ensure they are manageable, allowing student's sufficient time to practice and master concepts. Distributing assignments more evenly throughout the term can reduce stress and improve learning outcomes.
8. **Encourage Real-Life Applications**: Integrate real-world scenarios into mathematics instruction to help students recognize the relevance of mathematics in their daily lives, boosting motivation and engagement.

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7.0 LIST OF APENDICES

Appendix 1: Questionnaire for Students.

Welcome to the Mathematics Problem-Solving Questionnaire!

This survey aims to identify the challenges that students face when solving mathematics problems. Your participation is essential in helping us understand these challenges better and in developing effective strategies to enhance problem-solving skills in mathematics. The questionnaire consists of two parts: demographic information and questions regarding your experiences and challenges in mathematics. Your responses will remain confidential and will be used solely for educational research purposes. We appreciate your honest and thoughtful answers, as they will contribute significantly to improving mathematics education. This questionnaire seeks to identify the challenges hindering effective mathematics problem-solving among Mfakose High School students. Thank you for your participation!
PLEASE CLICK WHERE APPLICABLE

Q1. What grade are you in?

Form 1	Form 2	Form 3	Form 4	Lower 6	Upper 6

Q2. How often do you study mathematics each week?

Less than 2 hours

2-5 hours

6-10 hours

More than 10 hours

Q3. What is your gender?

male		female	

Q4. What is your age?

14 – 15	
16-17	
18-19	

Q5. What type of mathematics class are you enrolled in?

General Mathematics	
Pure mathematics	
Statistics	

SECTION B

Assessing challenges in Mathematics problem solving

SECTION B

Assessing challenges in Mathematics problem solving

Q6. What challenges do you face when solving math problems? (Select all that apply)

Lack of understanding of concepts	
Anxiety or stress	
Time constraints	
Insufficient practice materials	

Q7. How often do you feel overwhelmed by math assignments?

	Always
	Often
	Sometimes
	Rarely
	Never

Q8. How confident are you in your math problem-solving skills?

VERY CONFIDENT

1	
2	
3	
4	
5	

VERY UNCOFIDENT

Q9. What resources do you primarily use for studying mathematics? (Select all that apply)

Textbooks		Online resources	
Tutoring sessions		Study groups	

Q10. What type of math problems do you find most challenging?

Algebra	
Geometry	
Calculus	
Statistics	
Other: (specify other) ___________	

Q11. Do you believe that your teachers adequately support you in overcoming math challenges?

Yes	
No	
Sometimes	

Q12. How often do you seek help from teachers or peers when struggling with math?

Always	
Often	
Sometimes	
Rarely	
Never	

Q13. How do you usually feel during math exams?

Very calm	
Somewhat calm	
Neutral	
Somewhat anxious	
Very anxious	

Q14. What do you believe is the biggest barrier to your success in mathematics?

____-

Q15. How helpful do you find practice problems in improving your skills?

Very helpful	
Somewhat helpful	
Neutral	
Somewhat unhelpful	
Very unhelpful	

Q16. How often do you complete math homework on time?

Always	
Often	
Sometimes	
Rarely	
Never	

Q17. Do you prefer working on math problems individually or in groups?

Individually	
In groups	
No preference	

Q18. What strategies do you use to manage your time during math assignments?

Creating a schedule	
Breaking tasks into smaller parts	
Prioritizing difficult problems	
Other (specify other)	

Q19. How often do you review your mistakes in math assignments to learn from them?

Always	
Often	
Sometimes	
Rarely	
Never	

Q20. What additional support do you think would help you improve your math problem-solving skills?

Appendix 2 Key informant interviews

Assess the impact of teachers' teaching methods and resources on students' problem-solving abilities. This questionnaire serves to assess teachers' insights as well as experiences particularly in the mathematics field at Mufakose High.

Q1. Can you describe your overall approach to teaching mathematics, particularly in relation to problem-solving?

q2. What specific teaching strategies have you found most effective in helping students improve their problem-solving skills?

q3. What challenges do your students typically face when solving mathematical problems? How do you address these challenges?

q4. In your experience, how do different teaching methods (e.g., group work, technology integration) impact student engagement and understanding in mathematics?

q5. Can you provide examples of how you incorporate real-life applications into your mathematics lessons? How do you think this affects student learning?

q6. How do you assess student understanding and progress in problem-solving? What feedback mechanisms do you use?

q7. What role do you believe teacher collaboration plays in enhancing mathematics instruction? Can you share any experiences of collaborative teaching?

q8. How do you support students who struggle with mathematics? What additional resources or strategies do you find useful?

q9. What professional development opportunities have you pursued to improve your teaching practices in mathematics? How have they influenced your approach?

q10. In your opinion, what additional support or resources would help you enhance your teaching of mathematics problem-solving skills?

Appendix 3: QUASI EXPERIMENTAL

Mathematics Problem-Solving Test

Instructions: Solve the following problems. Show your work for full credit.

1. Problem 1: Solve the equation: $2x+3=152x + 3 = 152x+3=15$.

O Solution: ________________

2. Problem 2: A rectangle has a length of 10 cm and a width of 5 cm. What is the area?

O Solution: ________________

3. Problem 3: If the sum of three consecutive integers is 72, what are the integers?

O Solution: ________________

4. Problem 4: Solve the following word problem: A car travels at a speed of 60 km/h. How

Far will it travel in 2 hours?

O Solution: ________________

5. Problem 5: Factor the quadratic equation: $x2+5x+6=0x^2 + 5x + 6 = 0x2+5x+6=0$.

O Solution: ________________

Appendix 4: Observation Guide

Questionnaire to observe and document student behaviors, interactions, and engagement during mathematics problem-solving activities.

Observation Details

- Date: ________________
- Time: ________________
- Class/Activity: ________________
- Observer Name: ________________

Section 1: Student Engagement

1. Level of Engagement (Rate each student on a scale of 1-5):
   - Student 1: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
   - Student 2: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
   - Student 3: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
   - Student 4: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
   - Student 5: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
2. General Engagement Level of the Class:
   - Very High
   - High
   - Moderate
   - Low
   - Very Low

Section 2: Student Interactions

3. Types of Interactions Observed:
   - Collaborative group work
   - Peer-to-peer explanations
   - Teacher-student interactions
   - Off-task discussions

- Other: ________________

4. Describe the nature of student interactions:
    - ____

Section 3: Problem-Solving Behavior

5. Approaches to Problem-Solving:
    - Independent work
    - Seeking help from peers
    - Seeking help from the teacher
    - Using manipulatives or tools
    - Other: ________________
6. Level of Persistence:
    - Very High
    - High
    - Moderate
    - Low
    - Very Low

Section 4: Teacher Strategies

7. Teaching Strategies Observed:
    - Direct instruction
    - Guided practice
    - Group discussions
    - Use of technology
    - Other: ________________
8. Effectiveness of Teacher Strategies:
    - Very Effective
    - Effective
    - Neutral
    - Ineffective

- Very Ineffective

Section 5: Overall Observations

9. Strengths of the Students During the Activity:
    - ______________________________
10. Areas for Improvement:
    - ______________________________

Conclusion

- Overall Impression of the Session:
    - ______________________________

Thank You!

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Appendix 5