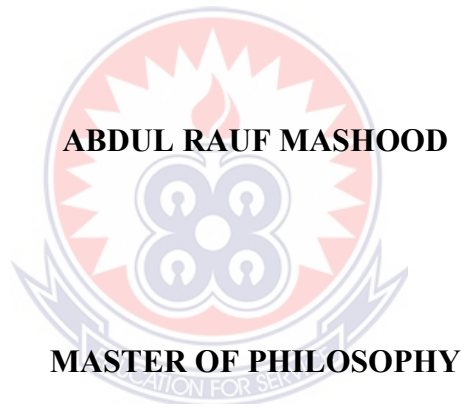


UNIVERSITY OF EDUCATION, WINNEBA

**Junior High School teachers experience in teaching non-routine mathematics
problem-solving in the Wa Municipality**



2024

UNIVERSITY OF EDUCATION, WINNEBA

**JUNIOR HIGH SCHOOL TEACHERS EXPERIENCES IN TEACHING NON-
ROUTINE MATHEMATICS PROBLEM-SOLVING IN THE WA
MUNICIPALITY**



**A thesis in the Department of Basic Education, School of
Education and Life-long Learning, submitted to the School of
Graduate Studies, in partial fulfilment
of the requirements for the award of the degree of
Master of Philosophy
(Basic Education)
in the University of Education, Winneba**

MAY, 2024

DECLARATION

Student's Declaration

I, Abdul Rauf Mashood, declare that this thesis, with the exception of the quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, it has not been submitted, either in part or whole, for another degree elsewhere.

Signature:

Date:

Supervisors' Declaration

We hereby declare that the preparation and presentation of this work were supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

Principal Supervisor: Professor Michael Johnson Nabie (PhD)

Signature:

Date:

Co-Supervisor: Professor Clement Ali (PhD)

Signature:

Date:

DEDICATION

I dedicate wholeheartedly this thesis to my dear mum (Osman Memunatu), my beloved wife (Imoro Amina) and my entire family.



ACKNOWLEDGEMENTS

First and foremost, I am grateful to the Almighty God for His continuous mercies and for taking me this far. I am highly indebted and thankful to my supervisors Prof. M. J. Nabie (Principal Supervisor) and Prof. Clement Ali (Co-Supervisor), for their guidance, patience and advice that they have given me throughout this period of writing my thesis.

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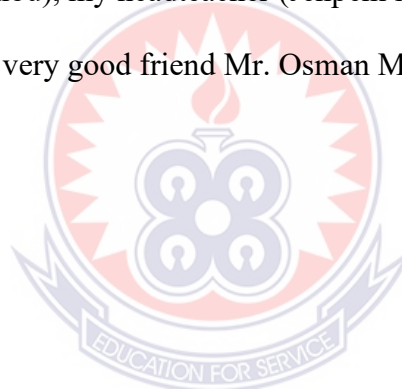
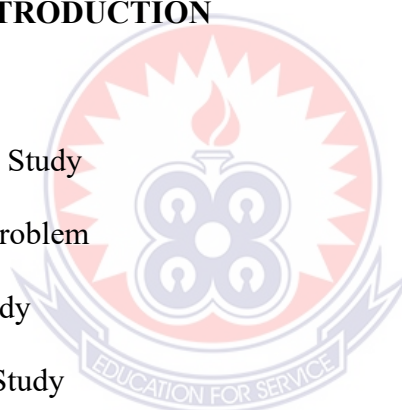


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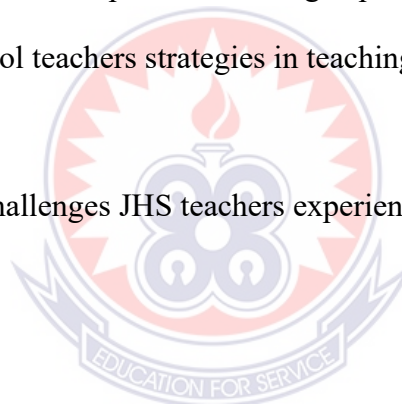
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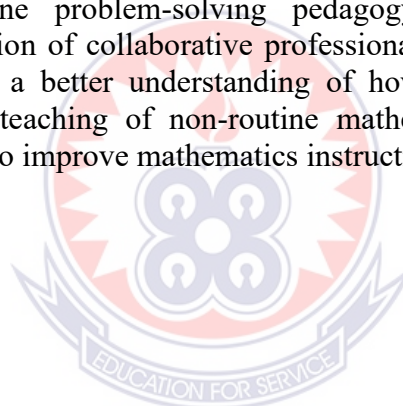
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ABSTRACT

This study explored Junior High School (JHS) teachers' experiences in teaching non-routine mathematics problem-solving in the Wa Municipality of Ghana. Using a sequential explanatory mixed methods design, the research was conducted in two phases. The first phase involved the collection and analysis of quantitative data from 34 JHS mathematics teachers using structured questionnaires to assess their exposure, understanding, strategies, and challenges related to non-routine problem-solving. In the second phase, qualitative data were gathered through semi-structured interviews with a purposively selected sample of teachers to explain and deepen the interpretation of the quantitative findings. The results revealed that although teachers reported frequent exposure to non-routine problems, many held misconceptions about their definition and exhibited limited confidence in teaching them effectively. Common strategies included peer collaboration, online resource utilisation, and seeking professional guidance. However, challenges such as insufficient time, unclear problem statements, and difficulty selecting appropriate strategies were prevalent. Qualitative insights further illuminated how institutional constraints, lack of continuous professional development, and limited access to instructional resources hinder effective teaching of non-routine problems. The study recommends enhanced training in non-routine problem-solving pedagogy, provision of instructional materials, and integration of collaborative professional learning communities. These findings contribute to a better understanding of how contextual and instructional factors influence the teaching of non-routine mathematics problems and suggest targeted interventions to improve mathematics instruction at the JHS level.



CHAPTER ONE

INTRODUCTION

1.0 Overview

The study was developed to explore JHS teachers experiences in teaching non-routine mathematics problem-solving in the Wa municipality. This chapter presents the background to the study, including the statement of the problem, the purpose of the study, research objectives, research questions, significance of the study, delimitations, limitations, and the organisation of the study.

1.1 Background to the Study

Mathematics education has long been recognized as a critical component of the overall educational experience, playing a crucial role in developing pupils' analytical and problem-solving skills (National Research Council, 2001). The Ministry of Education has emphasized the value of problem-solving in its educational policies, highlighting it as a fundamental objective within the mathematics curriculum to enhance pupils' critical thinking abilities. This emphasis is evident in the integration of problem-solving across the Junior High School (JHS) mathematics curriculum, where pupils engage with a variety of problems that stimulate their cognitive development. In recent years, there has been an increasing emphasis on teaching non-routine mathematics problem-solving to foster deeper understanding and application of mathematical concepts (Schoenfeld, 2010). Non-routine problems are those that do not have a straightforward or memorized solution, requiring pupils to engage in higher-order thinking and creative problem-solving strategies (Silver, 1997). Additionally, routine problems, which involve the application of standard procedures and techniques, are also incorporated to ensure a balanced approach to mathematical learning. The essence of problem-solving extends beyond the classroom, as it equips

pupils with essential skills to address real-life challenges, thereby contributing to the overall progress and development of the community.

The Wa Municipality, like many other regions, faces challenges in the effective teaching of mathematics, particularly in Junior High Schools (JHS). Teachers' experiences and approaches to teaching non-routine problem-solving can significantly impact pupils' learning outcomes and their attitudes towards mathematics (Stigler & Hiebert, 1999). Understanding these experiences is crucial for developing interventions and professional development programs that can enhance the teaching and learning of mathematics in this context.

In the Ghanaian education system, mathematics is a core subject from primary to secondary education, and its importance is reflected in national education policies and curricula (Ministry of Education, 2010). Despite the efforts of independent thinkers, quality of teachers and performance indicators, pupils' performance in mathematics has often been suboptimal, as evidenced by national examination results and various educational assessments (Aboagye 2021). One contributing factor is the traditional emphasis on rote learning and routine problem-solving at the expense of fostering critical thinking and problem-solving skills (Akyeampong, 2003).

Research has shown that traditional rote-learning methods dominate the mathematics classrooms and are less effective in developing pupils' conceptual understanding and problem-solving abilities (Boaler, 2002). In contrast, non-routine problem-solving has been linked to improved mathematical reasoning and the ability to apply mathematical concepts in novel situations (Cai & Lester, 2010). This shift in learning is supported by studies indicating that pupils who engage in non-routine problem-

solving are better prepared for real-world challenges and are more likely to develop a positive attitude towards mathematics (Lesh & Zawojewski, 2017).

Moreover, the successful teaching of non-routine problems requires teachers to possess strong pedagogical content knowledge (PCK) and the ability to create a supportive classroom environment (Ball, Thames, & Phelps, 2008). Professional development programs that focus on enhancing teachers PCK have been shown to improve their instructional practices and student outcomes in mathematics (Desimone, 2009). For instance, research indicates that when teachers receive targeted training on non-routine problem-solving strategies, they are more confident and effective in facilitating such activities (Schmidt, et al., 2011).

The educational context in Ghana also presents unique challenges and opportunities. Limited resources, large class sizes, and insufficient professional development opportunities are common issues faced by teachers (Osei, 2006). However, there is a growing recognition of the need to reform mathematics education to better prepare pupils for the demands of the 21st century (Anamuah-Mensah, Mereku, & Ghartey-Ampiah, 2004). Initiatives such as the Ghana National Mathematics and Science Education Programme (GMP) aim to support teachers in problem-solving and improve student achievement in these critical subjects (MOE, 2015).

The shift towards incorporating non-routine problem-solving in mathematics education aims to address longstanding shortcomings by encouraging pupils to explore, conjecture, and reason logically. However, the successful implementation of this pedagogical approach relies heavily on teachers' abilities to effectively facilitate such learning experiences. Teachers need to be well-equipped with the necessary skills, knowledge, and resources to create an environment conducive to non-routine

problem-solving (Ball, Thames, & Phelps, 2008). Understanding the specific experiences and challenges faced by JHS teachers in the Wa Municipality is essential for developing targeted interventions that can enhance the teaching and learning of non-routine mathematics problems.

1.2 Statement of the Problem

Everyone understands the value of problem-solving in our modern age since it helps people become more logical (Kavkler, Magajna & Babuder, 2014). So, Ghana Education Service needs to want to see teachers develop their ability to teach non-routine problem-solving (Mereku, 2003), even though this goal is still far off. Teachers' achievement in non-routine mathematics in problem-solving is generally low in Ghana due to the results that came out from Trends in International Mathematics and Science Study (TIMSS).

This low performance in non-routine problem raises some fundamental questions, “Are we really producing teachers equipped with non-routine mathematics problem-solving techniques to contribute to effective teaching envisaged in the mathematics curriculum? How prepared is the next generation to deal with ordinary life, which unquestionably demands a good understanding of non-routine mathematics problem-solving, if teachers continue to demonstrate such severe weaknesses in teaching non-routine mathematics in problem-solving, Problem-solving holds increasing significance in the curriculum, supported by the Ministry of Education's emphasis on its importance (Ministry of Education, 2020). It is well-integrated into the JHS mathematics curriculum, balancing routine, and non-routine problems to develop comprehensive skills (Ghana Education Service, 2018). This approach prepares pupils to address real-world challenges, enhancing their community contributions

(Schoenfeld, 2011). The trend towards emphasizing non-routine problem-solving is likely to continue, reflecting its value in fostering deeper understanding and application of mathematical concepts (National Research Council, 2001).

Several diligent scholars have conducted extensive research over the years to resolve a typical challenge due to their deep concern over such matters. For instance, the constructivist approach was examined by Atteh, Andam, Obeng Dneteh, Okpoti, and Johnson (2014) to see if it might improve teachers problem-solving skills in teaching. Nyala, Assuah, Ayebo, and Tse (2016) also examined how frequently the problem-solving method is used to teach mathematics in Ghanaian classrooms. Armah (2015) explored problem resolution from the viewpoint of instructors' attitudes, motivations, and actions. Finally, Atteh, Andam, and Obeng-Denteh (2017) focused on a four-step framework to support teachers' advancement in their contribution to the improvement of teaching problem-solving methods. In Ghana, little attention has been placed on how teachers themselves experience teaching non-routine problems to inform policy and practice.

1.3 Purpose of the Study

The purpose of the study was to explore JHS teachers experiences in teaching non-routine mathematics problem-solving, their challenges, and the strategies to minimize them in the Wa Municipality.

1.4 Objectives of the Study

The study sought to:

1. Determine Junior High School teachers experiences teaching non-routine mathematics problem-solving in the Wa Municipality.

2. Ascertain the dominant strategies Junior High School teachers experience in teaching non-routine mathematics problems in the Wa Municipality.
3. Unstitch the most prevalent challenges Junior High School teachers face in teaching non-routine problems in the Wa Municipality.
4. Identify ways to minimize the challenges Junior High School teachers face in teaching non-routine mathematics problems in the Wa Municipality.

1.5 Research Questions

The following questions were stimulated to guide the study:

1. What are Junior High School teachers experience teaching non-routine problem solving in the Wa Municipality?
2. What strategies do Junior High School teachers mostly use in teaching non-routine mathematics problems in the Wa Municipality?
3. What are Junior High School teachers most prevalent challenges in teaching non-routine problems in the Wa Municipality?
4. How can the challenges Junior High School teachers experience in teaching non-routine mathematics problems be minimized in the Wa Municipality?

1.6 Significance of the Study

There is no way to overstate the study's importance. In terms of the teaching and learning of non-routine mathematical problems, one of its major benefits will be to policymakers and authorities in the field of education (Ministry of Education, 2020) who will have access to the findings on their experiences, strategies, and challenges in teaching non-routine problems to policy and curriculum development. For instance, this research will motivate them to design routine in-service training for teachers, create mathematics manuals that concentrate on effective teaching methods, and plan

mathematics conferences where the sharing of best practices among mathematics teachers will be shared. The findings of the research will give teachers more insight into effective non-routine problem-solving teaching approaches to foster learners' progress, offer them insight into strategies that can be adopted to build teachers confidence and knowledge when working on non-routine problems, and enable them to become conversant with key methodologies they could adopt or consider when delivering the curriculum to make the process of teaching and learning more effective. Finally, it will add to the body of literature, providing more possibilities for specialists, particularly in the field of mathematics education, to gain a thorough grasp of how teachers approach complex issues and ways to effectively support them as they learn mathematics.

1.7 Delimitations of the Study

According to Simon and Goes (2013), the delimitations of a study are those characteristics that arise from limitations in the scope of the study defining the boundaries of the study. The study focused exclusively on teachers in the Wa Municipality of the Upper West Region of Ghana, limited to only the Junior High School Mathematics teachers. Also, the study's data will be collected during the 2023-2024 academic year, limiting the study to that specific period.

1.8 Limitations of the Study

The study was limited to 34 public Junior High School mathematics teachers in the Wa Municipality, which restricts the generalizability of the findings to other regions of Ghana. The small sample size and the gender imbalance (predominantly male teachers) may not fully capture the diverse perspectives and teaching experiences of mathematics teachers nationwide. Secondly, the scope of the research was

geographically narrow, focusing solely on the Wa Municipality. Educational practices and challenges in non-routine problem-solving may differ significantly in other districts or regions due to variations in resources, teacher training, and socio-cultural factors. Finally, the use of self-reported data through questionnaires and interviews introduces the possibility of bias. Teachers may have over- or under-reported their experiences, strategies, or challenges due to social desirability or personal perceptions. Additionally, time constraints during interviews may have limited the depth of responses obtained.

1.9 Organisation of the Study

Chapter one examined the background to the study, statement of the problem, purpose of the study, objectives of the study and research questions, The emphasis in Chapter two will dwell on adequate review of related literature. In addition to this, the theoretical framework falls under this section. Chapter three gives attention to the research methodology intended to be used for this study. This covers the research paradigm, research approach, research design, study population, sample and sampling procedures, sources of data, data collection instrument, field study and data processing and analysis. Chapter four focuses on the analysis and interpretation of data. It will also highlight the main findings of the study and the experiences of teachers when working on non-routine exercises. Chapter five, the final chapter summarizes the main findings, draw conclusions from the findings and ends with some recommendations.

1.10 Chapter Summary

Chapter one examined the background to the study, the statement of the problem, the purpose of the study, the objectives of the study, research questions, the significance

of the study including the organisation. The next chapter focuses on review of relevant literature including the theoretical framework.



CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter review literature on Junior High School teachers experiences in teaching non-routine problems. Areas that will receive a lot of attention include observing Junior High School teachers views of non-routine problems, observing Junior High School teachers' attitudes and problem-solving skills, and researching Junior High School teachers logical and reasoning skills. Three categories in total will be highlighted; they are conceptual framework, review of the empirical literature, and definition of concepts. While the empirical portion will also evaluate pertinent literature focusing on the theme areas, the concept definitions will provide additional insight into what non-routine situations and problem-solving skills involve. The theoretical framework will next go into greater detail about the theory that is pertinent to the study.

2.1 Non-Routine Mathematics Problems Solving: Conceptions, Meanings and Processes

Non-routine mathematics problem-solving remains a subject of ongoing debate among researchers, as there is no universally agreed-upon definition for these types of problems (Mamona-Downs & Downs, 2015). Milgram (2017) distinguishes non-routine problems from exercises by emphasizing that they lack predetermined solution approaches. This characteristic underscore the necessity for problem solvers to employ their creativity and imagination, particularly in complex tasks.

According to Mullis, Martin, Ruddock, O'Sullivan, and Preuschoff (2019), non-routine mathematics problems represent novel challenges for teachers, demanding

additional cognitive effort even when requisite knowledge and skills are acquired. Gilfeather and Regato (2019) describe these problems as heuristic exercises, offering hints rather than direct solutions, which may lead to new discoveries. This description underscores the inherent complexity of non-routine problems, making it challenging for teachers to adopt simplistic teaching methods.

Furthermore, non-routine mathematics problems often lack obvious solution processes, necessitating critical thinking skills from both teachers and pupils (Ang, 2019). This complexity implies that there can be multiple valid solution paths, requiring teachers to have a deep understanding of problem-solving strategies. For instance, a problem like determining the number of hens and pigs based on given heads and feet in a barnyard scenario (Bassarear, 2017) illustrates the varied approaches that can be employed, reflecting the open-ended nature of non-routine problems.

The process of solving non-routine problems involves several stages, beginning with careful analysis and interpretation of the problem (McGinn & Boote, 2015). Teachers must guide pupils in deciphering relevant information and identifying the problem's overarching goal. This initial step lays the foundation for formulating a coherent strategy for problem resolution. Subsequently, problem solvers engage in strategic planning, organizing their approach based on the problem's requirements (Bruder & Collet, 2017). This phase involves selecting appropriate problem-solving heuristics and techniques, such as categorisation, interpretation of aims, and resource assessment (McGinn & Boote, 2015). Teachers play a crucial role in modelling these strategies and providing explicit instruction on problem-solving techniques.

Moreover, mathematical modelling emerges as a powerful tool for visualizing complex mathematical structures and simplifying problem-solving processes (Cirillo, Pelesko, Fellon-Koestler, Rubel, 2016). By representing mathematical concepts using tangible models, pupils gain deeper insights into abstract mathematical ideas. However, effective problem-solving instruction goes beyond modelling to encompass fostering mathematical reasoning and creativity (Francisco & Maher, 2015). Problem-solving occupies a central role in mathematics education, promoting deeper engagement and understanding of mathematical concepts (NCTM, 2000). Brenner, Herman, Ho, and Zimmer (2019) highlight the significance of problem-solving skills in enhancing mathematical proficiency among pupils. Moreover, problem-solving activities foster collaborative learning environments, where pupils actively participate and share diverse problem-solving strategies (Rigelman, 2017).

2.2 Characteristics of Non-Routine Mathematics Problems Solving

Notwithstanding the scholarly differences in the definition of non-routine mathematics problem-solving questions mentioned above, one thing is certain: non-routine problem-solving demands that teachers guide pupils deeply into the field of logical thinking. Lester and Kehle (2013) emphasize that reasoning and higher-order thinking are necessary processes when responding to non-routine problem queries. This implies that for teachers to effectively teach pupils to work competently on such problems, they must ensure that pupils are aware of the traits of non-routine problem-solving, as doing so will help them distinguish complicated questions from regular questions more quickly and respond to them more effectively.

Non-routine problem questions are characterized primarily by the difficulty they present for pupils to reason logically. Lester and Kehle (2013) caution that when

working on non-routine mathematics problems, profound thought processes cannot be avoided. This implies that for teachers to effectively guide pupils on these issues, they must prepare them to engage in in-depth critical thinking processes, which frequently result in solutions. Effective teaching also requires teachers to encourage learners to use their applicable knowledge to think creatively, forcing them to conceptualize what they have learned previously.

Non-routine mathematics problem-solving issues are also characterized by the opportunity they give pupils to use a variety of approaches to problem-solving. Baroody (2013) believes that this flexibility allows one to understand that what has been learned in one situation and applied to one problem will not necessarily fit another situation or be appropriate for another problem. This introduces the idea of diversity when working on non-routine mathematics problems. Demetriou (2014) further emphasizes that the usage of flexibility cannot be disregarded when it comes to non-routine mathematics problem-solving exercises because it seems to be closely related to problem-solving and performance. Civil (2017) and Gustein (2016) affirm that teachers can focus more on non-routine mathematics problem-solving tasks using problem-solving techniques by getting pupils to understand mathematics more deeply and personally by connecting to, including, and building on pupils' community-based problem-solving knowledge. This can entail giving pupils extra time to learn the ability of non-routine mathematics problem-solving itself and putting them through several activities that will give them more chances to practice non-routine mathematics questions.

Some important traits of non-routine mathematics problem-solving tasks were categorized as open, rich in critical thinking processes, and innovative in a Ministry of

Education article in Jamaica (2010). These questions were classified as “open” considering the possibility that different pupils will approach the challenges in different ways or come up with different solutions at the conclusion of the process. Second, because pupils had to come up with rational approaches to find the answers, these were deemed critical thinking questions. This suggests that when pupils are given non-routine mathematics problem-solving problems, they are frequently placed in uncertain situations. These types of mathematical questions are also referred to as new because they are not always connected to the topic in the same way as typical routine problems are. For instance, a pupil may solve a challenging problem while unknowingly utilizing one of the curriculum's core concepts. Due to its puzzle-like nature, O'Brien and Moss (2017) also reveal another important aspect of non-routine mathematics problem-solving situations. From their viewpoints, these issues fall under cognitive tasks that necessitate a strategic mindset and an intelligent approach to the issue at hand. Clearly, this implies that non-routine mathematics problem-solving exercises require more than just the simple application of an algorithm, formula, or method.

2.3 Learner Attitude and Solving Non-Routine Mathematics Problems

Francisco and Maher (2015) emphasize that non-routine mathematics problem-solving prioritizes pupils' production of knowledge, which inherently pushes them to pursue exploratory paths and critically evaluate their own methodology, answers, and inventions in the most suitable and logical ways. Another important aspect of the learner's responsibility in solving non-routine mathematics problems is highlighted by Lesh and Zawojewski (2007). They contend that several iterations of the issue must be tried to find a workable solution before learners may engage in meaningful work in non-routine situations. This is admirable because it frequently becomes necessary to

employ procedures to solve non-routine mathematics problems. Repetition of a particular operation sequence could produce the necessary outcomes and help the learner move closer to the goal. However, Weber (2015) cautions that it is wise to allow learners a longer period to try out a variety of procedures, some of which may require repetition of operations if they need to take on this function more effectively. This will allow pupils to complete their assignment accurately and in a more reasonable amount of time.

The attitude of the pupil devoted to the job, which has been defined as “a disposition to respond favourably or unfavourably to an object, person, institution, or events,” is also crucial. This is in addition to allowing learners adequate time to work on non-routine mathematics problem-solving tasks (Ajzen, 2015, p. 3). Considering Ajzen's description, it is evident that pupils with a positive outlook, devotion, and passion for their work may tend to perform better on non-routine mathematics problem-solving tasks than pupils with negative attitudes about mathematics, particularly non-routine exercises. Attitudes are founded on ideas and can either be conscious or unconscious, claim Gerrig and Zimbardo (2022). As a result, even with more interested participants, one cannot inquire about opinions on certain topics. Instead, one should inquire about beliefs since when they are joined, they reveal some details about these attitudes (Gerrig & Zimbardo, 2022).

It is important to remember that attitudes impact both behaviour and attention. For instance, if a group of pupils finds difficulty in non-routine mathematics questions, they might not give their all in a usual class on problem-solving. On the other hand, if pupils demonstrate greater dedication and enthusiasm for challenging exercises, they will inevitably display a willingness to work on non-routine mathematics problem-

solving and a readiness to participate in more complicated critical thinking and reasoning processes. Both researchers assert that attitudes are made up of three components: “beliefs or cognitions, an appraisal, and a behavioural disposition” (Delamater & Myers, 2019, p. 145). They point out that the involved beliefs are frequently impossible to prove to be true or wrong. They further stated that the rating is composed of “a direction (positive or negative) and an intensity (ranging from very weak to very powerful).” Instead, attitudes could be rated from 1 to 9, with 1 denoting a strong negative feeling, 5 denoting a neutral feeling, and 9 denoting a strong positive feeling. The behavioural disposition entails engaging in or refraining from behaviours that are consistent with that attitude. Since a learner with a strong attitude may be more likely to exhibit behaviours resulting from those sentiments that could negatively influence others, it may be crucial to assess not only the content but also the intensity of pupils’ attitudes (Holland, Verplanken, & Van Knippenberg, 2022).

According to Centingoz & Ozkal (2019), a pupil's attitude has a significant impact on how they interact with those around them, which may include friends, families, classmates, and even teachers. They continue by saying that given this, pupils’ attitudes toward complex problems remain crucial since they can decide whether they succeed or fail when faced with difficult non-routine mathematics problem-solving tasks. Sadly, most pupils do not exhibit good attitudes regarding this part of mathematics, and it is because of this that Effandi and Namah (2019) vehemently support efforts to combat the pervasiveness of pupils’ negative attitudes. This may imply that underperformance in non-routine mathematics problem-solving will undoubtedly improve if pupils are instructed to adopt a positive attitude toward unconventional problems. This is because pupils will develop better work habits that will increase their commitment and self-worth. Strand and Mills (2014) similarly hold

the opinion that instructors who focus on non-routine mathematics problem-solving need to have a strong foundation in curriculum delivery because it is their goal to help pupils develop a better understanding of how to solve complicated problems on their own. If teachers lack the confidence to carry out this aspect of their job, it will be difficult for pupils to fully demonstrate positive attitudes.

2.4 Non-Routine Mathematics Problem-solving Strategies

According to Fülöp (2015), strategy is the planning component of organizing a battle, winning a game, or keeping a business organisation moving in a purposefully determined route. Surprisingly, there is little consensus over what a strategy is for tackling mathematical problems. It is important to remember that when solving mathematical problems, using the right strategies is essential for pupils to advance. This implies that the choice of approach used to solve a given problem is crucial. Many studies in mathematics education emphasize the importance of strategy in solving mathematical problems (Pape and Wang, 2016). As a result, learners or problem solvers must possess in-depth knowledge of a variety of effective tactics that can aid understanding when working on complex challenges. By looking into how strategy thinking is learned, we can see that it is a skill that can be acquired through time and that at least three components are crucial to its growth (Sloan, 2016; Cassey and Goldman, 2014). Sloan (2016) emphasizes the value of communication for the creative and cognitive learning processes and views strategy thinking as a mental process. This highlights the significance of peer learning, mentoring, and the encouragement of pupil conversation where they will be able to thoroughly consider challenges and be able to adopt the best methods to solve them.

Because practice makes perfect, thinking, according to Goldman (2012), should place a greater emphasis on instructiveness and dynamism than on practicality. His viewpoint is in line with the variation theory, which shows that there is a distinction between knowing something and expressing it (Marton & Tsui, 2014). Naturally, the learning environment of problem-based learning fosters a positive environment where kids can learn more through social interactions; as a result, if kids have more opportunities to participate in frequent group discussions, their comprehension of how to competently handle complex problems will advance. The suitability of activities for learners is particularly crucial to promote effective learning of strategic thinking, since this might result in good experiential mathematics learning or creative dialogues (Fülöp, 2015). This means that an issue should be suitable for the learner's age and be able to reasonably test the problem solver's mental capacity. Well-selected context issues, in the words of Gravemeijer and Doorman (2019: p.33), “provide possibilities for the learner to build informal highly situation specific solution strategies”.

What holds true for general problem-solving also holds true for mathematical problem-solving (Kolovou, 2015). Many studies in mathematics education place the use of strategies at the center of solving mathematical issues (Pape & Wang, 2016). This directly implies that selecting a strategy is important for tackling complicated issues, and that the person solving the problem must be convinced that the strategy they choose is the right one. Flexibility should be encouraged when choosing a technique, especially when it comes to problem-solving (Kolovou, 2015). He thinks that people may adapt their behaviour to changing circumstances and settings and work in a flexible manner. This would imply that the learning methodologies adopted by pupils allow for adjustments as and when needed.

Demetriou (2014) emphasized that more adaptable thinkers can create thoughts that are more refined and better adapted to unique aspects of the environment, as well as more original and useful solutions to issues. It is important to think about the techniques that will be implemented into the solution or working out process to make sure that one is on the right road with regards to accuracy and expertise at problem-solving. According to Cai (2014), pupils' usage of problem-solving techniques is directly related to their ability to solve a mathematical problem. This necessitates a thorough comprehension of the issue to choose the most potent solutions. Again, when doing this, pupils should think about being flexible in this circumstance.

2.4.1 Using Assessment Strategies to Foster the Non-Routine Mathematics

Problem-Solving Process

The process of teaching and learning includes assessments. They identify the learners' advantages and disadvantages and determine how to proceed. It also makes sure that the instructor has time for self-reflection and offers some important insights into what must be done, such as how well one uses teaching tactics. Regardless of the problem-solving activities and strategies teachers employ in the classroom, according to Anderson (2020), there is evidence to suggest that until problem-solving is incorporated into the evaluation process, pupils will not value such activities and will not commit to them. This may imply that there needs to be some level of communication where pupils are informed about areas, they will be assessed on for them to be more challenged and dedicated to problem-solving assignments. For instance, if it is a word problem, teachers could let the pupils know that their method of calculation, accuracy of the calculations, and presentation will be evaluated. This will enable pupils to concentrate themselves more fully to their work in class. Assessment procedures should be carefully addressed, especially when mathematical

problems and questions contain multiple possible answers, according to Tsamir, Tirosh, Tabach, & Levenson (2010).

Moreover, problem solving may need to be incorporated into classroom activities as well as more official school and state evaluation methods if it is to be appreciated by both pupils and teachers. To improve this, it is therefore necessary to examine pupils' problem-solving skills more frequently. This will help pupils become more familiar with the skills they will most likely be tested on at the external level.

2.4.2 Non-Routine Mathematics Problem-Solving Skills through Online Game

Generated Feedback

The focus of Junior High School mathematics courses continues to concentrate on the development of fundamental abilities, particularly those related to doing basic computations. However, other studies (Goldenberg, Shteingold, & Feuzerg, 2019) have emphasized that the study of the subject at the fundamental level should also entail innovative thinking, encourage pupils to explore patterns, and help them come up with solutions to problems that are not typically addressed. Giving pupils non-routine exercises allows them to use these talents to a significant extent. For instance, asking kids questions that do not have obvious answers would encourage them to investigate, seek solutions, and test out various patterns or pathways to arrive at the answers.

According to Kaput, Carraher, & Blanton (2017), algebraic activities could give Junior High School pupils opportunities to acquire more complex thinking abilities. This is since by doing such challenging exercises, pupils will be forced to employ more in-depth logical thinking to arrive at an answer. Given this, it is accurate to say that adding algebra to the elementary school curriculum is necessary. According to

Kilpatrick, Swafford, & Findell (2021), algebra strengthens and expands pupils' arithmetic skills. Thus, the National Council of Teachers of Mathematics (NCTM) claimed that algebra is a subject that is covered from kindergarten through grade 12 at all academic levels of instruction (NCTM, 2000). According to Carraher & Schliemann (2017), these experiences are essential to creating rich problem-solving settings because pupils may be able to generate abstract knowledge by using reasoning in specific circumstances. Function tables (Schliemann, Carraher, & Brizuela, 2021), function machines (Warren, Cooper, & Lamb, 2016), and patterning activities (Moss & Beatty, 2016) have all been successfully used over the years to support this reasoning in Junior High school pupils, but new technologies may bring even more advancements for encouraging the development of algebraic concepts. According to Roschelle, Pea, Hoadley, & Means (2020), integrating computers into algebra work can perform computations and lighten the workload so that pupils can concentrate more on discovering the relationships between the quantities in algebra.

Computer technologies can also go beyond the limitations of activities done with paper and pencil by generating dynamic environments that offer immediate feedback. As a result, the burden of performing additional tasks will be reduced, allowing the learner to devote their complete attention and time to the task that calls for critical thinking.

2.5 Mathematical Knowledge through Non-Routine Problem Solving

By problem solving, it is crucial for pupils to acquire solid mathematical understanding. As a result, when working on challenges, pupils will be able to articulate processes, tactics, and techniques. When pupils are given projects that test them in this way, they are forced to think critically, mathematically, and about the

best techniques to use, including the ability to explain procedures. So, the pupil's primary objective should be to have a thorough comprehension of mathematical facts (Eduafo, 2014). Nonetheless, the teacher must play a significant role if pupils are to improve their mathematical understanding. The teacher must ensure that there is a fair balance in terms of how pupils are engaged if they are to have a deeper comprehension of the subject through problem solving. Eduafo (2014) asserts that to achieve this, the tasks chosen must be both highly significant to the pupil and entertaining and engaging.

According to Marcus and Fey (2014), selecting engaging activities that will keep pupils actively engaged is typically simple, but ensuring that they truly help pupils learn mathematics effectively is far more challenging. Based on this, experts claim that teachers face an even greater challenge in selecting the projects that will engage pupils. Marcus and Fey (2014) offer four essential questions that teachers should be asking themselves to help them choose these projects successfully. Will the assignments chosen help teachers better comprehend mathematical facts and techniques? Will the selected activities keep pupils' attention long enough while they find the questions tolerable? Will answering the questions help pupils' mathematical thinking grow? and can doing these exercises help pupils' better grasp and relate mathematical concepts?

According to Bair and Haesbroeck (2014), problem solving should be viewed as the successful completion of a process of solving a math problem, whether it is a pure mathematics problem or a problem with a practical application and should be subject to a positive way of thinking of the pupil involved in a successful project. According to Jacobs et al (2016), when we give people these possibilities, profound

comprehension will gradually grow. Yet, the teacher's involvement is vital for pupils to gain a grasp of mathematics through a problem-solving approach, as competent supervision enhances understanding and puts the pupil in a better position to take control of his or her learning.

Sadly, when asked to apply information in different contexts, pupils frequently struggle. Given this, if our goal is to enable them to master the process of problem-solving, we must provide them with the finest assistance so that they may gradually master the ability of information transfer. This should comprise educating pupils on problem-solving techniques, providing direction on the process, and providing education on a range of problem-solving tactics. They could also include thoroughly comprehending the concerns, formulating a suitable response to the issues, and assessing the solution. These methods also provide pupils more chances to discover different routes that lead to the solutions they want since they allow them to experiment with a range of problem-solving techniques and produce good results.

According to Vygotsky (in Slavin, 2021), a person will be able to handle challenges that are more complex than their fundamental competence after receiving help from someone more skilled or capable. Assistance may be provided by way of directions, inspiration, the breakdown of difficulty into manageable parts, or by way of an example. Scaffolding is the name for this type of help. Anghileri (2016) has described three layers of scaffolding: (1) environmental provisions; (2) explaining, reviewing, and restructuring; and (3) improving conceptual understanding. These three levels of scaffolding are what this study uses.

The drawback of this approach is that it might turn problem-solving into an activity rather than a process (Anderson, 2020). The teacher's role should include maintaining a balance when engaging pupils in solving difficult problems, looking into better solution methods, and giving pupils the information, they need at the right time for them to develop an understanding of mathematics through a problem-solving approach (Hiebert et al, 2017). Therefore, it is crucial that teachers employ top-notch approaches to help pupils improve their problem-solving abilities. This is so that pupils can have a deeper comprehension of concepts thanks to the teacher's effective approach to an issue.

2.6 The Teacher's Role and Beliefs about Non-Routine Mathematics Problem-Solving

According to Anderson (2020), the attitudes and methods used by instructors while handling problems differ greatly. According to him, teachers have a wide range of opinions about the concept of a problem, issue solving, and problem-solving instructional techniques. Anderson asserts that among teachers, reported beliefs and practices are consistent, as are reported practices and what takes place in classrooms. The claimed practices of some teachers, however, are not easily seen; this reflects either a lack of reflection or the likelihood of limiting constraints that might be negatively affecting teachers plans. If this is the case, it essentially means that different teachers have different perspectives on the topic of problem-solving.

To learn more about teachers' perspectives on problem-solving, Funkhouser (2019) interviewed several of them. The responses they provided were varied. Funkhouser claimed that two-thirds of the answers fell into the category of being too general, such as: "Problem-solving is finding a solution to an issue and problem-solving is applying

thinking skills.” According to him, only one-third of teachers were able to give a precise definition that involved either reference to strategies or skills such as ‘problem-solving is identifying the problem issue, determining the steps, then solving the problem.’ To learn more about teachers’ perspectives on problem-solving, Grows, Good, & Dougherty (2019) also conducted interviews with teachers. According to Funkhouser (2014), a variety of perspectives were noted. These perspectives include: solving problems as practical, and solving problems as conceptual. It was observed that teachers provided their opinions on the definitions based on what was occurring in their classrooms.

According to Phipps (2017), instructors' perspectives on learning and teaching have a significant impact on the pedagogical choices they make. Because of this, what pupils deem suitable is closely related to classroom routines. According to Haflu (2018), teachers should have a strong problem-solving mindset, and to achieve this, they must select challenges that will hold pupils’ attention. If this classroom activity is executed properly, pupils will embrace the fear frequently connected with the problem-solving process, especially when working on non-routine exercises, with eagerness and great devotion. Also, educators must provide an atmosphere that encourages pupils to explore, take calculated chances, discuss their failures and accomplishments, and engage in critical thinking (Haflu, 2018). It is thought that in such a setting, pupils are better able to increase their self-esteem and confidence while also developing an eagerness to investigate issues and the capacity to adapt their problem-solving techniques (NCTM, 2000). Again, a teacher will be more inclined to ask more open-ended questions if, as part of their beliefs, they support the development of problem-solving abilities.

Also, a teacher's perspective on the value of employing problem-solving teaching techniques and their proficiency in doing so have a major impact on pupils' accomplishment and problem-solving behaviour (Thompson, 2019). Successful teaching of problem-solving as a process, especially using heuristics, which are general rules of thumb and procedural skills lines that help the problem solver to understand and find solutions for a given problem, will be tagged by the classroom environment if teachers hold the belief that problem-solving is teaching (Good & Brophy, 2019).

Nonetheless, it is important to remember that teachers' methods and attitudes about teaching come from their own perceptions of the learning process. Teachers must take on more responsibility during the problem-solving process to help pupils understand techniques and processes. When there are more opportunities for professional growth, development, and training, teachers will be more valuable in society. According to Kaur (2021), one technique that can address the dearth of problem-solving teaching methodologies is raising the amount of support for instructors through appropriate learning experiences. Kaur explains that, specifically about Singapore, where instructors place a lot of emphasis on problem-solving, the government makes sure that teachers receive 100 hours of in-service training every year to help them be well-versed in the delivery of the curriculum. This certainly puts the instructors in a good position to be more assured in the classroom and have more in-depth expertise in the field of selecting amicable solutions to seemingly complex challenges.

The ability of facilitators to go into what Jaworski (2019) referred to as investigative teaching is another crucial area where the teacher's role in assisting pupils in developing the necessary problem-solving abilities is focused. She also referred to this

as the “teaching triangle”, which she defined as instruction that gives pupils the ability to examine issues through fruitful pupil engagement.

2.7 The Importance of Non-Routine Mathematics Problem-Solving for Learners

Learning through problem-solving has several advantages, especially when pupils have the chance to work on non-routine problems that, by their very nature, provide a good pace for the growth of learners' mathematical skills. In the first place, the way these challenges are presented gives pupils a good opportunity to experiment with and come up with novel approaches to problem-solving. According to D'Ambrosio (2020), problem-based learning should be used to encourage pupils to apply their conceptual knowledge in relevant ways. For instance, pupils should be able to create solutions to new issues using previously learned information. For instance, they frequently employ a variety of techniques and strategies when given the chance to work on word problems. This encourages a learning environment where new learning opportunities are constantly sought for. But it is crucial to remember that the teacher must provide direction for the pupils' search to find new routes to be truly relevant.

The teachers must focus on a few crucial aspects in addition to finding a reasonable amount of time that will allow pupils to participate in conversations. They include how to carry out a working out plan, what questions to pose to pupils keeping in mind differentiated questioning tactics, and brilliantly mentoring pupils without taking away from their own capacity for critical thought (NCTM, 2009). Yet, according to Ball and Bass (2020), there are not any precise, evidence-based recommendations that teachers may employ to strike the right balance between teacher-directed and teacher-guided education.

Teachers still need to have precise ideas regarding how to carry out their roles, but they also need real-world examples to help them in their practice. Problem solving is essential for improving pupils' capacity to evaluate their own reasoning. As a result, pupils are better able to take control of their education by experimenting with different approaches, evaluating the suitability of accepted techniques, digging deeper into their own selection of approaches, and growing in responsibility throughout the process. Discussions in both large and small groups provide pupils the chance to practice their thinking skills. Small group projects and conversations of this sort increase concept knowledge for those pupils who really benefit from peer coaching. Also, pupils take on additional responsibility as they collaborate to develop effective problem-solving strategies to arrive at solutions.

According to Schoen and Charles (2014), problem solving aids in the development of pupils' understanding, which is a requirement for widening one's perspective on mathematical ideas. It also plays a significant part in the initial learning of mathematical concepts and skills. This is so that pupils' thinking and reasoning about mathematical concepts is further stimulated. It does this by introducing concepts and skills in contexts of problem solving. Another advantage of problem solving for pupils is its capacity to start engaging, focused classroom conversations (Lester & Charles, 2013). The chance afforded to pupils to explain how they arrived at solutions or the methods they used to sort things out frequently sparks fruitful debates aimed at enhancing their comprehension of the ideas.

One other benefit of problem solving in school mathematics, according to Lesh and Zawojewski (2007), is the relationship between the curricula and pupils' levels outside of the classroom. The two claim that “there is growing acknowledgement that there is

a serious mismatch between the kind of understanding and abilities that one needs for success beyond school and the low-level skills that are emphasized in test driven curricular materials” (Lesh & Zawojewski, 2007, p. 764). Hence, they think that problem-solving enhances creativity, adaptability, and metacognitive thought control, all of which are in line with projections and post-secondary expectations. Given this, learning problem-solving skills helps children prepare for a variety of facets of life after school, including vocations and trades.

Several studies have shown that in-depth talks improve pupils' capacity to assess their own mathematical proficiency because they allow them to develop a thorough comprehension of the material they are studying (Corden, 2021; Nystrand, 2019; Weber, Maher, Powell, & Lee, 2018). Pupils can persevere and give their utmost when completing tasks thanks to discussions in both large and small groups (Corden, 2021; Matsumura, Slater, & Crosson, 2018). Pupils' participation in in-depth conversations and interaction during the problem-solving process frequently broadens their knowledge because they learn from one another and are better able to comprehend the procedures involved in working on a particular issue.

2.8 Challenges in Non-Routine Mathematics Problem Solving for Teachers

The use of the necessary support systems, imagery, mathematical notation, planning, and organisation are essential components of problem-solving if it is to be an effective process (Goldin, 2018). Teachers typically find challenges in imparting a strong foundation in these skills to pupils, making it difficult for them to identify practical solutions that would aid in achieving desired outcomes. For instance, teachers should focus on teaching pupils how to master number facts, tables, mathematical principles, arithmetic skills, which include accuracy and logarithms in computational and

mathematical working procedures, information skills, which is the capacity to link information to a concept, operational, and experience, and language skill (Tambychik & Meerah, 2010).

Also, according to Geary (2014), the inability to solve problems stems from a lack of procedural and conceptual knowledge, two crucial abilities. He thinks that cognitive mechanisms that manage attention and information processing should support these abilities. According to Zalina and Norlia (2015), most teachers face challenges in ensuring that pupils grasp problems in the way that they should be understood, which contributes to difficulties in math problem-solving. They think that questions should, first and foremost, be properly comprehended, but regrettably, pupils often find inquiries to be less meaningful due to lengthy phrases and frequently included material. For instance, individuals could experience challenges with having a thorough understanding of the phrases used and the language.

For most teachers, facilitating the entire problem-solving process can be challenging, particularly when assigning pupils to work on hard problems. While most pupils can follow exact pathways to solve common problems with outstanding precision, not all of them can demonstrate the same competence when choosing a problem-solving strategy to complete challenging assignments. Even though addressing problems requires a variety of mathematical skills, according to Mohd Nizam and Rosaznisham (2014), many pupils still lack the fundamental mathematical knowledge they require.

According to Hill (2018), these subpar abilities frequently displayed by the pupils differ and can thus be categorized into a few important areas. They include weaknesses in the areas of math, informational skills, language, and visual-spatial abilities. As a result, many children struggle with mathematics, especially when it

comes to problem-solving (Heong, 2015). If this is the case, then improving effective teaching techniques is necessary to improve pupils' learning abilities. This will help them gain a deeper grasp of problem-solving techniques, particularly those that are effective for handling non-routine issues. While many pupils can do an exceptional job applying the right problem-solving techniques to routine problems, many of them struggle to apply the best strategies to non-routine situations, which frequently test conceptual comprehension.

According to Stendall (2019), learning must be able to make use of cognitive capacities if it is to be meaningful. It is important to draw the conclusion that many pupils are not working as hard as they could if they are failing to employ their cognitive capacities. According to Tarzimah (2015), such learners have trouble forming precise perceptions and interpretations, remembering, and recalling data, paying attention, and using logic.

Since they essentially fail to apply and integrate mathematical concepts and abilities during the process of making decisions and solving problems, it is apparent that a lack of mathematics skills continues to provide challenges in problem-solving (Tambychik & Meerah, 2010). Garderen (2016) adds that a lack of visual-spatial ability may make it difficult to distinguish between, relate to, and organize information meaningfully. Garderen claims that as a result, pupils may encounter a variety of challenges, including a lack of proficiency with number facts, weaknesses in computational tasks, an inability to connect mathematical concepts, inefficiency in knowledge transfer, a lack of ability to make meaningful connections regarding information, an inability to transform information mathematically, a lack of proficiency with mathematical terms, a lack of proficiency with mathematical language, and difficulty in transferring knowledge.

2.9 Non-Routine Mathematics Problem Solving in the classroom

Teachers frequently use a variety of strategies they believe are essential in advancing pupils' mathematical abilities while assisting pupils in learning and developing problem-solving skills. Three methods for teaching problem-solving have been emphasized by Siemon and Booker (2019), including teaching for, teaching about, and teaching via problem-solving. The conventional method of teaching mathematics, where pupils study the material so they may use it to solve issues pertaining to that field, is most like teaching for problem-solving (Anderson, 2020). This may literally imply that for pupils to solve problems effectively, they must first have a solid grasp of the relevant material. This calls for the instructor to proceed cautiously and introduce the pupil to progressively challenging tasks over time. So, it is thought that acquiring such fundamental information will support and aid the pupil in applying the notion learnt. Anderson (2020) also thinks that one of the main challenges teachers face when utilizing this strategy is that a problem must have a blockage, which can be addressed if pupils can adhere to a rehearsal technique. Tripathi (2019) cautions, however, that if the instructor takes on a more useful position as a facilitator, this facilitator will be able to push pupils more effectively with critical thinking without giving away the solutions. Tripathi (2019) claimed that the instructor may guide pupils through knowledge reviews and construct new connections. Teaching about problem-solving also involves giving instructions on the method of problem-solving as well as various problem-solving techniques.

They can involve thoroughly comprehending the questions, formulating a suitable fix for the issue, and assessing the fix. The drawback of this approach is that it might turn problem-solving into an activity rather than a process (Anderson, 2020). According to Stacey and Chick (2014), providing learners with clear opportunities for critical

thinking throughout the foundational stage of their learning is crucial to help them avoid these potential occurrences. This suggests that issues are employed as the learning vehicle or the context in which the learning of mathematical ideas take place, as opposed to pupils learning new ideas and skills with certain applications and problems thrown on at the end. This method encourages pupils to participate more since it helps them understand the mathematical processes required to solve the problem. To find a solution, the learner must delve farther into dissecting the problem and applying more critical thinking techniques.

Hiebert and Wearne (2016) found that compared to classrooms with a primary focus on problem-solving, those with a primary focus on teaching through a problem-solving strategy utilized fewer problems and spent more time on each of them. This explains how in a typical classroom where pupils are given more non-routine exercises, the teacher tends to spend more time giving pupils thorough explanations, giving them more opportunity to comprehend the steps required in accomplishing a problem. Such instructional possibilities can help pupils in this typical class increase their level of mathematical proficiency. A problem-solving method to teaching mathematics creates a learning environment where pupils can investigate challenges and come up with solutions on their own (Eduafo, 2014).

D'Ambrosio (2014) claims that proponents of teaching mathematics through problem-solving base their approach on the idea that pupils confront challenging circumstances and use their prior knowledge to solve them while also creating new information and new understanding in the process. This forces pupils to expand their knowledge by finding new ways to solve the issue at hand. D'Ambrosio (2014) also provides three examples of problem-solving-based mathematics instruction in action, utilizing pupils

from elementary, middle, and high schools. It is important to note that none of the study's participants received formal instructions on how to approach the problems.

They were, however, prepared to use mathematical reasoning and consider all alternatives to find solutions. In this sense, it can be said that they were able to explore mathematical reasoning in greater depth and that their abilities and inventiveness were greatly stretched. According to the study, problem-solving-based instruction gives pupils a chance to advance in their education. Without a doubt, it can be said that giving pupils problem-solving assignments gives them the chance to be autonomous issue solvers, laying the groundwork for the correct solutions, and fostering a deeper comprehension of mathematical concepts.

2.10 Non-Routine Mathematics Problem-Solving through Co-operative and Collaborative Learning

The construction of a learning environment that allows pupils the chance to participate in cooperative and collaborative tasks is one of the best practices strongly supported by 21st-century teaching and learning. Cooperative learning, according to Siegel (2015), is when pupils are challenged to work in groups to complete tasks. Pupils “show higher level thinking and problem-solving dialogue when they work on high-level cooperative activities,” according to research (Gillies, 2014, p.134).

The teacher's job is to ensure that the environment is created for higher level thinking problem solving to occur as well as to establish responsibilities and expectations. The teacher discovered that creating a solid environment for cooperative learning makes discipline problems less likely. The benefits for pupils who are given the chance to speak, listen, share, and ask questions of one another are significantly higher than typical “sit and get” lessons. According to Gillies (2014), cooperative, small-group

learning benefits pupils in both the academic and social realms. Considering this, cooperative learning will be more beneficial for pupils who do not progress in a larger group. Compared to learning in a larger group, these pupils will be able to find learning to be more worthwhile and meaningful. Hence, according to Johnson, Johnson, and Stanne (2020), cooperative learning can enhance pupil accomplishment.

Gillies and Ashman (2018) contend that learning in smaller groups also fosters several social advantages, such as increased task-on-task behaviour and cooperative group relationships. Others include raising one's sense of self-worth, developing more friends in the classroom, allowing pupils to participate more fully in lessons, and changing attitudes toward learning (Lazarowitz, Baird and Bolden, 2016). As a result, it may help other pupils who would normally find it difficult to work alone to feel more at home in the classroom. For example, those who excel in mathematics may use explanations, idea sharing, and suggestions to help poor achievers make some progress.

According to Johnson and Johnson (2019), there is sufficient evidence to conclude that pupils who consistently participate in collaborative work experience a variety of advantages. An excellent illustration is the great levels of accomplishments they may claim, and once more, more development is produced in their learning. This results from their ability to provide one another with efficient support. In a study by Gokhale (2015) comparing the effectiveness of individual learning and collaborative learning, it was shown that pupils who participated in collaborative learning more frequently fared better. According to his research, co-operative learning allows pupils to work well in groups and promotes greater accountability because each pupil is expected to

play an important role. On the other side, collaborative learning encourages cooperative groups to find solutions to mathematical issues.

2.11 Theoretical Framework

This study's theoretical framework highlights social constructivism, which emphasizes the active role of learners in constructing knowledge through social interaction. Several academics view social constructivism as a development of what is frequently referred to as individual learning. Thus, it is not surprising that social constructivism holds that the only real knowledge is that which a person has created for themselves in a setting where there is abundant opportunity for interaction (Jones, 2016).

Further supporting this, Ernest (2019) argues that culture and society are always woven into the fabric of knowledge. These perspectives imply that learners deepen their understanding when they build new knowledge through interactions with others. In such environments, dialogue, shared reasoning, and collaborative exploration play crucial roles in meaning-making. The implication for educators is clear: teaching should create opportunities for learners to engage in cooperative and collaborative learning. Particularly in mathematics education and non-routine problem-solving, encouraging pupils to share ideas, justify reasoning, and work together supports the development of higher-order thinking skills and deeper conceptual understanding.

2.12 The Belief of Social Constructivists

This study is underpinned by social constructivism, a theory of learning advanced by Lev Vygotsky (1978), which emphasizes the critical role of social interaction, cultural tools, and language in the development of cognition. Vygotsky's concept of the Zone of Proximal Development (ZPD) posits that learners achieve higher levels of

understanding when they engage in collaborative tasks under the guidance of a more knowledgeable person typically the teacher or more competent peers. This theoretical perspective is particularly relevant to mathematics education, where meaning is often constructed through dialogue, shared problem-solving, and guided exploration (Ernest, 1994; Cobb & Yackel, 1996).

In a social constructivist mathematics classroom, learning occurs as pupils actively participate in cooperative and collaborative tasks that require negotiation of meaning, exchange of strategies, and reflection on others' perspectives (Mercer & Littleton, 2007). The teacher's role is to scaffold learning by facilitating structured group interactions and creating opportunities for discourse around mathematical ideas (Wood, Bruner, & Ross, 1976). This pedagogical model aligns closely with the demands of non-routine mathematics problem-solving, which requires higher-order thinking, persistence, and the exploration of multiple solution pathways (Silver, 1997).

Engagement with non-routine tasks is enhanced when pupils are encouraged to articulate their reasoning, justify their strategies, and collaboratively evaluate possible solutions. Social interactions in such contexts help pupils clarify their thinking and deepen their conceptual understanding (Sfard, 1998). In this regard, social constructivism provides a robust theoretical foundation for investigating how Junior High School teachers facilitate the teaching of non-routine problems, and how pupils engage in problem-solving through interactive learning processes.

The theory also supports the use of qualitative data-gathering methods such as interviews to explore how frequently and effectively pupils participate in collaborative dialogue aimed at enhancing mathematical comprehension (Vygotsky,

1978; Boaler, 2002). The adoption of social constructivism, therefore, aligns strongly with the study's purpose, research questions, and analytical framework by offering insights into the social and cognitive processes that underpin the teaching and learning of non-routine mathematical problems.

2.13 Conceptual Framework

The conceptual framework for this study centers on the key factors that influence the teaching of non-routine problem-solving in mathematics. It outlines how teacher and pupils' practices ultimately affect pupils' problem-solving outcomes. The framework also highlights the indirect roles of the school environment and community, which serve as contextual backdrops for teaching and learning.

Teacher factors such as qualifications, professional training, experience, and pedagogical approaches are central. These influence how effectively teachers design and deliver instruction that supports critical thinking and flexibility skills which are essential for solving non-routine problems. Student factors, including prior knowledge, learning styles, motivation, and resilience, also directly impact the teaching process. Pupils' readiness to engage with challenging mathematical tasks influences how teachers plan lessons, differentiate instruction, and select problem-solving strategies.

School environment such as administrative support, resources, and classroom conditions and community influences such as parental involvement and cultural attitudes do not directly determine daily teaching decisions, but they form the broader context within which teacher and student interactions occur. These elements influence the conditions under which effective teaching can happen, but they are treated as

indirect factors in this model to maintain focus on instructional practices and learner engagement.

In summary, this framework emphasizes the direct paths from teacher and student factors to teaching practices, and from teaching practices to problem-solving outcomes. It recognizes school and community influences as important contextual elements rather than immediate instructional drivers. This structure aligns with the study's goal of identifying the most immediate and actionable influences on non-routine mathematics teaching.

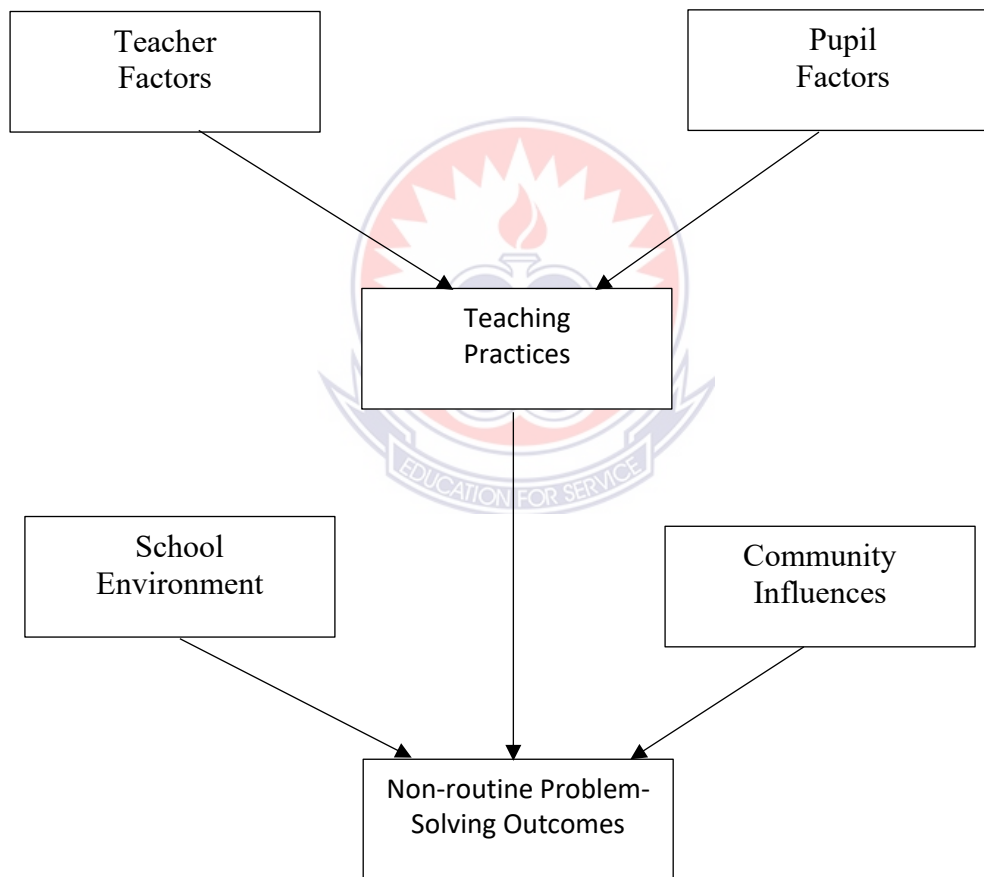


Figure 2.1: Conceptual Framework for Analyzing Influences on Non-Routine Problem-Solving in Mathematics Education.

Source: Author's Construct (2024)

2.14 Chapter Summary

The literature review in this chapter has delved into the roles of both the teacher and learner in the problem-solving classroom. Teachers play a crucial role in creating an environment conducive for learners to develop a solid understanding of problem-solving exercises by modelling exercises, selecting problems thoughtfully, and guiding learners on the right paths. Additionally, key elements that enhance problem-solving competence, such as the integration of technology, the use of games, and effective teaching and learning approaches, have been uncovered. The concept of problem-solving itself, including its key features, has also been examined.

According to the literature review, adopting methodologies that are more socially child-friendly can make the process of problem-solving more beneficial. This supports the belief system of constructivists, who argue that learners construct their own knowledge by interacting cooperatively and collaboratively in both small and large groups. Finally, the theoretical framework has focused on social constructivism as the baseline theory for this study.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents the methodology for the study. It covers the research paradigm, research approach, research design, population, the area of study, sample, sampling techniques, research instruments, pilot testing of instruments, methods of data collection, reliability and validity, trustworthiness, methods of data analysis and ethical considerations.

3.1 Research Paradigm

This section presents the fundamental ideology of the study. The philosophical framework that guides the research. It serves as a guiding force for the underlying assumptions underpinning the study subject under scrutiny, the way the study will be conducted, and the methods and ethical principles to be embraced. Scientific research philosophy refers to the cognitive framework of the researcher, which enables the acquisition of new and reliable knowledge pertaining to the research subject. In essence, it serves as the foundation of the research, encompassing the selection of research strategy, problem formulation, data collection, processing, and analysis. The scientific research paradigm on the other hand, encompasses the ontology, epistemology, methodology, and axiology.

According to Bryman (2012), social science researchers have different viewpoints regarding whether theory steers research (deductive approach) or theory is a product of research (inductive approach). These viewpoints give rise to different paradigms based on their epistemological and ontological standpoint (Bryman, 2012; Mouton, 1996; Creswell, 2009; Neuman, 2014; Bhatacherjee, 2012). The main paradigms

frequently discussed are Positivism/Post-positivism, Interpretivism/Constructivism, and Pragmatism (Creswell, 2009; Neuman, 2014; Bryman, 2012).

Positivism advocates the utilisation of methods derived from natural science for the exploration of social reality (Bryman, 2012). The logical positivist school of thought perceives science as axiomatic, grounded in deductive reasoning (Mouton, 1996). Consequently, the assumptions hold more validity in the realm of quantitative research rather than qualitative research (Creswell, 2009). This ideology postulates that there exist laws or theories that govern human behaviour, which are subject to verification or falsification. It implies that research must commence with a theory because theories provide a framework through which social phenomena can be comprehended and research findings can be interpreted (Bryman, 2012). The methodology employed by this ideology is based on quantitative analysis.

The interpretive school of thought apprehends the subjective meaning of social action and acknowledges that the subject matter of social science diverges from that of natural science (Bryman, 2012). Their epistemology is founded on an empathetic understanding of social reality, thus employing inductive reasoning. Social constructivists argue that reality is context-specific, rendering generalisation to a shared reality implausible. Consequently, individuals may form subjective meanings of their experiences (Creswell, 2009). Researchers who embrace this ideology often consider the social context of the population under study and meticulously analyse their subjective perspectives on the matter under investigation. The methodology employed by this paradigm is typically based on qualitative analysis.

The pragmatist integrates both positivists/post-positivists and interpretivists/constructivists ideas. This ideology emerges from actions, situations, and consequences (Creswell, 2009). Pragmatism does not pledge allegiance to any philosophical system or reality but rather combines paradigms to address a research question. Its primary features stipulate that individual researchers possess the flexibility to blend methods, techniques, and procedures due to the social, historical, and political influences on human behaviours. The foundation of this stream of thinking is rooted in a combination of various approaches. The current investigation will embrace this philosophy as a fundamental tenet in the exploration of teachers approach to unconventional mathematical problem-solving. The research is being carried out in some selected chosen Junior High Schools located in the Upper West Region.

In this study, the pragmatist philosophy was fundamental because it emphasizes a practical approach to exploring real-world experiences and problem-solving strategies, which align well with the objectives of understanding Junior High School (JHS) teachers experiences in teaching non-routine mathematics problems. Pragmatism values outcomes and the usefulness of ideas in practice, focusing on actions and solutions rather than merely theoretical perspectives. This makes it especially suitable for examining how teachers navigate, apply, and adapt strategies in their classrooms, as well as for identifying the tangible challenges they face and potential ways to address them. Therefore, adopting a pragmatist perspective, the study prioritizes insights that are grounded in teachers lived experiences and can directly contribute to actionable improvements in mathematics education within the Municipality.

3.2 Research Approach

Creswell (2009) established three fundamental research approaches: qualitative, quantitative, and mixed methods. The selection of an approach is contingent upon the intent of the study. A qualitative methodology delves into participants perspectives and interpretations of circumstances. It adopts an inductive, all-encompassing approach to data analysis, focusing on themes and trends. Moreover, it scrutinizes a method, action, operation, individual, or community in its natural habitat.

Quantitative methodology, on the other hand, is a distinct approach that utilizes informative and inferential statistical tools to elucidate the intricacies of a study employing quantitative measures (Creswell, 2009). This methodology empowers researchers to quantitatively gather and interpret data to achieve their objectives. Consequently, it enables the examination of the intensity and magnitude of relationships between components by assessing their impact on one another. Mixed research, as implied by its name, necessitates the implementation of both quantitative and qualitative research methodologies for the purpose of selection, interpretation, and integration. Such an approach proves more effective in elucidating scientific issues than relying solely on one methodology (either qualitative or quantitative).

This research made use of the mixed method approach which Creswell (2003) highlights as a two-phased design. According to Creswell (2011), a mixed-method approach is valuable when neither qualitative nor quantitative methods alone provide a full understanding of the research problem. With regards to this study, therefore, the adoption of the sequential mixed method is deemed fit to attain a systematic build-up of results commencing from the quantitative phase which will examine teachers knowledge and understanding of non-routine problems. The sequential mixed-method

approach begins with a quantitative phase to assess teachers' knowledge of non-routine problems, followed by a qualitative phase that explores their teaching experiences in-depth, highlighting challenges and strategies. Through the initial quantitative phase, this study will assess teachers' knowledge and strategies in teaching non-routine problems (Objective 1-3). The subsequent qualitative phase will provide deeper insights into their experiences, challenges, and strategies (Objectives 4)

This study's design is grounded in ontological and epistemological perspectives, which encourage exploring teachers' perceptions and experiences. Ontologically, the mixed-method approach allows insights into how teachers view and interact with their teaching environment, while epistemologically, it is based on constructionism, meaning insights are constructed through their lived interactions (Crotty, 2003). For the qualitative aspect of this study, some questions were therefore targeted for teachers to express their experiences on non-routine mathematics problem-solving.

3.3 Research Design

This study adopted a sequential explanatory mixed methods design, which involves collecting and analysing quantitative data first, followed by qualitative data to help explain or elaborate on the quantitative findings. The rationale for this design is to obtain a broad understanding of Junior High School (JHS) teachers' experiences with non-routine mathematics problem-solving through quantitative analysis and then use qualitative insights to gain deeper explanations of the observed patterns.

In the first phase, quantitative data were gathered through structured questionnaires distributed to Junior High School mathematics teachers. This phase allowed for the measurement of trends and relationships regarding teaching strategies, challenges, and

experiences related to non-routine problem-solving. The second phase consisted of qualitative data collection through semi-structured interviews with a selected subset of participants. These interviews provided detailed narratives that clarified and expanded on the statistical patterns identified in the quantitative phase. This approach was chosen to strengthen the validity of the study's findings, ensure triangulation of data sources, and provide a comprehensive understanding of the multifaceted experiences of teachers in the Wa Municipality.

3.4 Population

Kusi (2012) defines a population as a group of individuals who share common characteristics and are of interest to the researcher. Similarly, Banerjee and Chaudhury (2010) describe a study population as all individuals or elements that possess specific attributes relevant to a particular investigation. For this study, the target population comprised all 53 public Junior High School (JHS) mathematics teachers in the Wa Municipality, consisting of 50 males and 3 females. These teachers were drawn from 53 public Junior High Schools across various educational circuits, each school having at least one assigned mathematics teacher, as documented by the Wa Municipal Education Directorate (2022) (see Appendix C).

3.5 Study Area

The study was conducted in the Wa Municipality of the Upper West Region of Ghana. Wa serves as the administrative and economic capital of the region and functions as a central hub for social services, education, and governance (Odoom, 2020). Geographically, it is bounded by the Nadowli District to the north, Wa East District to the east and west, and Wa West District to the south. It lies between latitudes 1°40'N to 2°45'N and longitudes 9°32'W to 10°20'W. The municipality

exhibits both urban and rural characteristics, with agriculture as a dominant economic activity. It is also ethnically diverse, providing a rich social context for examining educational issues (Odoom, 2020).

The selection of Wa Municipality as the study area was strategically informed by several factors. The municipality continues to face challenges in mathematics education, including limited teacher professional development, large class sizes, and inadequate teaching resources (Ministry of Education, 2020). These conditions create a realistic and relevant setting for investigating how teachers experience and respond to non-routine mathematics problems. The Wa Municipality has been a focal point of several educational interventions by the Ghana Education Service. Yet, gaps remain in the implementation of problem-solving-oriented pedagogy. Studying this area therefore offers the opportunity to generate context-specific recommendations that can inform both local and national policies.

Despite its strategic importance, Wa Municipality has seen relatively limited empirical research on mathematics instruction, especially on non-routine problem-solving. This study contributes to filling that gap, making it valuable for stakeholders in education and curriculum reform. Also, as the home municipality of the researcher, Wa was also chosen for logistical convenience, including ease of access to schools, teachers, and administrative support, which facilitated timely and cost-effective data collection. In light of these factors, Wa Municipality was purposefully selected as the study site to yield rich, relevant, and actionable insights that address both theoretical concerns and practical challenges in mathematics education at the Junior High School level.

The study aims to investigate teachers' experiences, ascertain dominant teaching strategies, identify prevalent challenges, and explore potential solutions to enhance their teaching practices. According to Sasso and Ross (2019), a representative sample ensures the findings can be generalized to the broader population, enhancing the validity of the study's conclusions.

3.7 Sampling Techniques

To obtain a representative sample for this study, a combination of stratified random sampling, simple random sampling, and purposive sampling was employed. For the quantitative phase, stratified random sampling was first applied to ensure proportional representation of Mathematics teachers across all educational circuits within the Wa Municipality. The municipality consists of fourteen (14) educational circuits, each with a varying number of Junior High School (JHS) Mathematics teachers. The population of 53 Mathematics teachers was stratified based on these circuits, and from each stratum, a proportionate number of teachers was selected.

This approach allowed for balanced representation and improved the generalisability of the findings by capturing the diverse experiences of teachers from different geographical and administrative zones. After the proportional allocation, simple random sampling was used within each stratum to select individual teachers. For instance, if a circuit had four teachers and three were to be selected, three were randomly drawn using a lottery method or random number generator. This step eliminated selection bias and ensured that each teacher within a stratum had an equal chance of being included in the sample. Through this dual approach, a total of 34 Mathematics teachers were selected for the quantitative phase of the study, as shown in Table 3.1.

For the qualitative phase, purposive sampling was employed to select 10 teachers from among those who participated in the survey. The purposive sampling approach was informed by the need to gain deeper insights and richer contextual understanding of the patterns identified in the quantitative data. Participants were selected based on specific criteria such as their level of teaching experience, gender, challenges faced in teaching non-routine problems, and innovative strategies used in problem-solving instruction. This deliberate selection enabled the researcher to engage with teachers who could provide detailed, reflective accounts of their practices and experiences in teaching non-routine mathematics problems.

Table 3.1: Distribution of Mathematics Teachers and Sample Size Allocation by Circuit

S/N	Circuit	Number of Teachers	Sample Size Allocation
1.	Boli	4	3
2.	Busa	3	2
3.	Charia	3	2
4.	Dobile	4	2
5.	Jonga	3	2
6.	Kabanye	4	3
7.	Kambali/Nakore	5	3
8.	Bamahu/Konta	5	3
9.	Kperisi	3	2
10.	Kpongu	3	2
11.	Mangu	3	2
12.	Sawaba	3	2
13.	Tampaalipaani	3	2
14.	Tendamba	3	2
Total		53	34

3.8 Research Instruments

When selecting a research instrument, it is crucial to choose one that is unbiased, contextually and culturally appropriate, provides clear usage guidelines, is valid and reliable, and is based on a theoretical framework or the researcher's understanding of variable relationships (Afolayan & Oniyinde, 2019). For this study, primary data was essential to explore Junior High School (JHS) teachers experiences in teaching non-routine mathematics problem-solving in the Wa municipality. The primary data collection tools employed were questionnaires and comprehensive interviews.

A questionnaire is a structured instrument comprising a series of questions designed to gather information from respondents. It is commonly used in surveys to collect quantitative and qualitative data from a large group of people within a short timeframe (Thomas, 2003). Questionnaires can include closed-ended questions, such as multiple-choice, and open-ended questions, allowing respondents to elaborate on their answers. Comprehensive interviews, on the other hand, are qualitative data collection tools that involve in-depth, face-to-face, or virtual conversations with participants. They provide detailed insights into participants' experiences, opinions, and perceptions, allowing the researcher to explore the complexities of the subject matter (Creswell, 2017).

The choice of these tools was based on their suitability for achieving the study objectives and their strengths as highlighted in contemporary literature. Questionnaires were chosen because they allow for the collection of large amounts of data in a relatively short time, facilitate broad geographical sampling, and are cost-effective (Leung et al., 2019). They are particularly advantageous for obtaining a wide variety of information from participants, especially through multiple-choice questions,

and can be administered even in the absence of the researcher (Thomas, 2003). However, despite their strengths, questionnaires are prone to low response rates and response biases (Creswell, 2017).

Comprehensive interviews were selected to complement the questionnaires by providing richer, more detailed data that would allow for a deeper understanding of the teachers' experiences. They offer the flexibility to probe further into participants' responses, enabling the exploration of nuanced perspectives and capturing the complexities of teaching non-routine mathematics problem-solving. Grounded in contemporary literature, the use of both tools ensures a robust approach to data collection. Questionnaires provide breadth by covering a large sample, while comprehensive interviews offer depth by uncovering detailed insights, creating a balanced methodology that aligns with best practices in mixed-methods research.

3.8.1 Description of the Questionnaire

The questionnaire was developed by the researcher based on the RQ of the study. The study employed a structured questionnaire as the primary tool for collecting quantitative data. This type of questionnaire comprised closed-ended questions designed to gather specific, measurable information from the respondents. The questionnaire was designed to collect quantitative data addressing RQ1 to 3, which focus on teachers' experiences, strategies, and challenges in teaching non-routine mathematics problem-solving. It was developed by the researcher and consisted of four main sections (A–D) with a total of 26 items.

Section A contained 4 items on demographic information, including age, gender, academic qualification, and the form taught. This section provided important background data for understanding variations in teachers' responses. Section B

addressed RQ1 by exploring teachers' experiences in teaching non-routine mathematical problems. It included 10 items measured on a five-point Likert scale (Strongly Agree to Strongly Disagree), capturing aspects such as exposure to non-routine problems, conceptual understanding, emotional responses (e.g., anxiety or motivation), and coping mechanisms like peer collaboration or resource use. Section C focused on RQ2, examining the challenges teachers encounter when teaching non-routine mathematics problems. It contained 10 items designed to assess perceptions of problem complexity, difficulties with strategy selection, time constraints, and clarity in understanding problem statements. Section D addressed RQ3, with 6 items on the strategies teachers employ in teaching non-routine problems. These items examined common approaches such as breaking problems into smaller parts, trial-and-error techniques, identifying patterns, and reflecting on the effectiveness of strategies.

The structured design of the questionnaire allowed for efficient data collection from a large group of teachers and ensured alignment with the study's objectives. Sections B, C, and D directly addressed the first three research questions, providing a quantitative basis for understanding teachers' experiences, strategies, and challenges.

3.8.2 Description of the Interview Guide

The guide was designed based on the issues emerging from the results of the quantitative data. The interview questions were centred on the following themes: teachers perceived knowledge of problem-solving, problem-solving instructional strategies, pupils' engagement, and measures to improve the teaching of problem-solving (see Appendix B). The interview was conducted on a one-on-one basis in the school setting and stored on a tape recorder. This enabled the participants to express their views and concerns freely and explicitly. The detailed nature of face-to-face

interview helped the researcher to obtain from interviewees, such information they were unable to give using a questionnaire; thereby helping to complement the quantitative data obtained by the questionnaire.

For RQ4, the study utilized a semi-structured interview guide to collect qualitative data. The interview guide was designed to elicit in-depth insights into the teachers perspectives and experiences, allowing for exploration beyond the scope of the structured questionnaire. The qualitative data gathered through the interviews helped to contextualize and complement the quantitative findings, particularly by delving into the personal, nuanced experiences of the teachers regarding their approaches to teaching non-routine mathematics problem-solving. This method was crucial for uncovering underlying factors, motivations, and strategies that might not be captured through closed-ended questions, thereby providing a richer understanding of the research problem.

3.9 Pilot Testing of Instruments

Wilkinson and Birmingham (2003) assert that it is common to construct a questionnaire with ambiguous layouts and mistakes in items. It is possible to design a questionnaire that is reliable but invalid due to inconsistencies in responses and failure to measure exactly what the scales are intended to measure. As a result, the instruments for the study were pilot-tested to minimize mistakes and errors and to increase reliability and validity. Piloting research instruments is a procedure in which a researcher tries the instruments on a small number of individuals and makes necessary changes to improve the instruments, based on feedback from those involved in the trial (Creswell, 2014).

The instrument was piloted in the Wa West District, which shares comparable characteristics with Wa Municipality, making it a suitable context for the pilot study. These characteristics include the demographic and professional profiles of Junior High School (JHS) Mathematics teachers, such as their qualifications, teaching experiences, and challenges encountered in teaching mathematics. Additionally, both districts exhibit similarities in the school environment, including infrastructure, availability of teaching and learning materials, and the general conditions under which teaching occurs, ensuring the pilot study closely mirrors the conditions of the main study.

Ten (10) Junior High School Mathematics teachers from the Wa West District were conveniently sampled for the pilot testing. Convenience sampling was used to select teachers who were readily available and willing to participate, ensuring practical and timely completion of the pilot. The tools were pilot-tested by administering the questionnaire to the sampled teachers to evaluate its clarity, relevance, and ease of use. The semi-structured interview guide was also tested by conducting mock interviews with a subset of the sampled teachers. These processes allowed the researcher to identify and address any ambiguities or issues with the instruments, refine the questions, and ensure their appropriateness for collecting valid and reliable data for the main study. Also, it enabled the researcher to modify and change some of the statements that looked inappropriate and difficult to understand. This helped to reduce ambiguity and misinterpretation. According to Awanta and Asiedu-Addo (2008), piloting a test enables the researcher to modify items that are difficult to understand, ambiguous and incorporate new categories that could be relevant to the study. Two days were used to distribute the questionnaire to the teachers. A teacher used a maximum of ten (10) minutes to complete the questionnaire.

3.10 Data Collection Procedure

The data collection followed a sequential explanatory mixed methods approach, where quantitative data were collected and analysed first, followed by qualitative data collection and analysis. This design allowed for the initial quantitative results to inform the development of the qualitative phase, thereby deepening the interpretation of the overall findings. The first phase involved the administration of structured questionnaires to all 34 selected Junior High School (JHS) Mathematics teachers in the Wa Municipality. The researcher began by seeking permission from headteachers of the respective schools and explaining the purpose of the study to the participants.

Once informed consent was obtained, the questionnaires were distributed in person to the teachers, who were given sufficient time to complete them. The researcher remained available on-site during this period to provide clarification where necessary. Completed questionnaires were immediately reviewed to check for completeness and address any missing responses. This phase aimed to gather data on teachers' knowledge, strategies, and challenges in teaching non-routine mathematics problem-solving (addressing Objectives 1–3).

After analysing the quantitative data, the second phase was initiated to explore and explain patterns and themes that emerged from the questionnaire responses. In this phase, semi-structured interviews were conducted with 10 purposively selected teachers. These participants were chosen based on criteria derived from the quantitative results. Appointments for interviews were scheduled at times convenient to the participants to minimize disruption to teaching duties. The interviews were conducted in quiet settings within the school environment or other agreed-upon locations to ensure comfort and confidentiality. Each interview was audio-recorded

with the participant's consent and supplemented with handwritten notes to capture additional contextual information. The interviews focused on deepening the understanding of teacher practices, challenges, and contextual influences related to non-routine mathematics problem-solving (addressing Objective 4).

This two-phased data collection approach ensured that the qualitative data explained and enriched the quantitative findings. The sequential structure allowed the researcher to build upon the initial results and provide a more comprehensive understanding of Junior High School mathematics teachers' experiences with non-routine problem-solving.

3.11 Reliability and Validity

Reliability in the quantitative phase refers to the consistency and dependability of the data collected using the questionnaire. After refinement through a pilot study (previously discussed in Section 3.9), internal consistency was statistically assessed using Cronbach's alpha, which yielded a value of 0.79. This score exceeds the 0.70 threshold suggested by Sekaran (2003), indicating that the items on the questionnaire were reliably measuring related constructs. Furthermore, standardized administration procedures were followed during data collection to minimize measurement errors and enhance consistency across respondents. All participants were given the same instructions, environment, and time to respond, which strengthened the reliability of the quantitative results.

Validity in this phase focuses on whether the instrument accurately measured the intended constructs (i.e., teachers' experiences, strategies, and challenges related to non-routine problem-solving). Content validity was established through expert review and alignment with the study's research objectives. The questionnaire items were

mapped directly to the research questions to ensure relevance, clarity, and coverage of key concepts.

In qualitative research, trustworthiness encompasses credibility, dependability, confirmability, and transferability (Lincoln & Guba, 1994). These criteria were addressed to ensure the integrity of the data and findings. Credibility was enhanced through the purposive selection of interview participants based on quantitative findings, allowing for rich and relevant narratives.

Member checks were conducted by summarizing interview responses to participants for validation during or immediately after the sessions. Dependability was addressed by maintaining a detailed audit trail of all procedures, including transcription, coding, and theme development. The researcher also followed a structured interview protocol to ensure consistency across participants. Confirmability was ensured by triangulating data sources where the findings from the interviews were compared with patterns from the questionnaire results to reduce researcher bias and strengthen objectivity. Lastly, Transferability was enhanced by providing thick descriptions of the study context (Wa Municipality), participant demographics, and settings, allowing readers to judge the applicability of the findings to similar contexts.

3.12 Methods of Data Analysis

The data generated for this study were both quantitative and qualitative, collected through the use of structured questionnaires and semi-structured interviews. The structured questionnaires provided numerical data related to the first three research questions, while the semi-structured interviews generated textual data to address the fourth research question. Each data set was analysed using appropriate methods to answer the specific research questions.

For the quantitative data, which were obtained through the structured questionnaires, descriptive and inferential statistical methods were employed. The data were first coded and entered into a statistical software package (SPSS version 27) for analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize the characteristics of the participants and their responses. This analysis helped to answer RQ1 to 3, which focused on identifying patterns and relationships in teachers responses.

For the qualitative data, which were derived from the semi-structured interviews, thematic analysis was used. The interview recordings were transcribed verbatim, and the transcripts were carefully read to identify emerging themes related to the fourth research question. The thematic analysis involved coding the data, categorizing responses based on similar ideas or topics, and organizing the data into broader themes. The qualitative data analysis in this study followed the thematic analysis approach adapted from Abdulai et al. (2023) as indicated in Table 3.2.

It began with familiarisation, where the researcher read and noted key aspects of the interview transcripts. In the coding phase, important words and phrases were highlighted and assigned codes, such as "technology use" and "professional growth." These codes were then grouped into broader themes, including "Availability and Integration of Technological Tools" and "Professional Development and Support." The themes were reviewed for relevance and clarity, ensuring they reflected the research objectives.

After refining the themes, they were clearly defined and named to represent their significance. Finally, the results were written up, discussing the findings and providing recommendations to improve teaching practices in non-routine mathematics

problem-solving. This rigorous, structured approach ensured that the qualitative findings were comprehensive and closely aligned with the study's goals, providing meaningful insights into the strategies teachers employ and the support they need in teaching non-routine mathematics problem-solving.

However, the results from both quantitative and qualitative analyses were integrated to provide a holistic view of the research problem. Triangulation was employed to compare findings from the surveys and interviews, enhancing the validity of the results. This mixed-methods approach not only enriched the analysis but also fostered a deeper understanding of the complexities involved in teaching non-routine mathematics problem-solving in junior high schools.



Table 3.2: Phases of Thematic Analysis and Means of Establishing Trustworthiness for Identified Themes

Phase	Means of Establishing Trustworthiness	Outcome
Familiarisation (Phase 1)	This entailed getting to know the data before delving into the topics. It involved repetitive reading of the transcripts to gain an overview of the data.	Notes were taken on the topics and data context to help the researcher gain a comprehensive picture before commencing the search for codes to facilitate progress through the subsequent phases.
Coding (Phase 2)	This involved highlighting and assigning codes to certain words, groups of words, and phrases in the data that indicate key ideas.	The researcher derived codes from the data, which included: technology use, material access, teaching support, curriculum demands, and professional growth.
Generating Themes (Phase 3)	This entailed generating themes from the codes (Phase 2) by combining codes that express similar ideas.	The themes generated included: Availability and Integration of Technological Tools, Utilisation of Technology and Resources, Access to Learning Materials, Professional Development and Support, and Curriculum and Time Allocation.
Reviewing Themes (Phase 4)	This involved checking the themes to determine whether some data were missing or irrelevant results were included.	The researcher compared the themes with the initial data to identify any omitted points or irrelevant results, ensuring that only relevant themes related to the study objectives were included.
Defining Themes (Phase 5)	This involved naming the themes based on their representation and meaning within the context of the study.	The themes were renamed to clearly represent their significance in the study, such as "Access to Learning Materials" and "Professional Development and Support."
Writing (Phase 6)	The results of the study were presented, and conclusions were reached based on what the analysis generated.	The final report included the results, discussion, conclusions, and recommendations for enhancing teaching practices in non-routine mathematics problem-solving among JHS teachers.

Source: Adopted from Abdulai et al. (2023)

3.13 Ethical Considerations

There are several types of ethical issues, which the researcher must take into consideration for this study. The most important one is related to the informed consent of the participants. All the participants including the Head Masters are informed in advance about the purpose of this research and following an explicit explanation, one hopes that they will give their informed consent. The identity of teachers was kept in strict confidentiality, thus meeting the requirements of the code of ethics of the University. For instance, teachers are given special codes to identify each one of them rather than having them write down their names on the worksheets. Also, all the information collected during this thesis is used only for the purposes of the study and is kept confidential and I must add that prior to carrying out this research, permission is sorted from the Ethics Committee of the University.

3.14 Chapter Summary

Chapter Three outlines the methodology used in this study, detailing the research paradigm, approach, design, population, sample, and instruments. The research adopts a pragmatist philosophy, emphasizing practical solutions grounded in real-world experiences. This approach aligns with the study's goal of exploring Junior High School (JHS) teachers experiences in teaching non-routine mathematics problems. A mixed-method approach is used, starting with a quantitative phase to assess teachers knowledge, and followed by a qualitative phase to explore their challenges and strategies. This converges mixed-method design enables a comprehensive understanding by combining structured questionnaires for quantitative data and semi-structured interviews for qualitative insights.

The study targets 34 mathematics teachers across 53 public Junior High Schools in the Wa Municipality, with a predominantly male population. The sampling techniques include stratified random sampling to ensure representation from various school circuits and purposive sampling for selecting interviewees who can provide rich insights into the research topic. The research instruments include structured questionnaires for quantitative data and interview guides for qualitative data. Pilot testing of both instruments ensured their reliability and validity, with feedback incorporated to refine the instruments before data collection.

Data collection followed a systematic procedure, with questionnaires administered to teachers after obtaining permission and consent. Reliability and validity were assessed through pilot studies, where Cronbach's alpha for the questionnaire indicated strong internal consistency. The qualitative data gathered from interviews was analyzed thematically to identify key themes related to teaching non-routine problems. Ethical considerations, such as informed consent and confidentiality, were rigorously followed throughout the study, ensuring the integrity and ethical standards of the research.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

This chapter analyses and discusses data on Junior High School (JHS) teachers experiences in teaching non-routine mathematics problem-solving in Wa Municipality, Ghana. Guided by four research questions, the study explored teachers' experiences, strategies, challenges, and potential solutions using a mixed-method design. 33 of the 34 questionnaires that were issued were returned; this represents about 96.3% of the total. The questionnaires were error-free and appropriate for analysis. As seen in Table 4.1, the participant demographic data are displayed in tabular form. Findings are presented according to the research questions, supported by tables and figures, with a 100% response rate achieved from all distributed questionnaires.

4.2 Demographic Characteristics of Respondents

This section discusses the demographic data on the teachers sex, age group, academic qualification, and class taught by the respondents. The inclusion of this demographic data is important as it helps to understand the representation of male and female teachers who participated in the study. This information is relevant in assessing the generalisability of the study's findings and identifying any potential gender-related patterns or differences in Junior High School teachers experiences in teaching non-routine mathematics problem-solving in selected schools in the Wa Municipality.

Tables 4.1 to 4.4 summarize the demographic data of the respondents.

Table 4.1: Sex Distribution of Respondents

Sex	Frequency	Percent
Male	32	94.1
Female	2	5.9
Total	34	100.0

Source: Field Data, 2023

The sex distribution of respondents, as presented in Table 1, indicates a significant gender disparity among the teachers surveyed. Out of the 34 respondents, 32 were male, representing 94.1% of the sample, while only 2 were female, representing 5.9%. This disproportionate representation of male teachers suggests that the experiences and perspectives captured in this study are predominantly from male teachers. The high percentage of male respondents may influence the study's insights into pedagogical approaches and challenges, given that male and female teachers might have different experiences and strategies in the classroom.

Table 4.2: Age Distribution of Respondents

Age Group	Frequency	Percent
20-29 Years	7	20.6
30-39 Years	24	70.6
40-49 Years	2	5.9
50 Years and above	1	2.9
Total	34	100.0

Source: Field Data, 2023

The age distribution of the respondents, as shown in Table 4.2, reveals that most of the teachers are within the 30-39 years age group, accounting for 70.6% of the sample. Teachers aged 20-29 years make up 20.6% of the respondents, while those aged 40-49 years and 50 years and above represent 5.9% and 2.9% of the sample,

respectively. This distribution suggests that most of the teachers are relatively young, with a substantial portion being in their early to mid-career stages.

The dominance of the 30-39 age group implies that many teachers are likely to be in a phase of professional growth where they have accumulated some experience but are still actively developing their teaching practices. The smaller percentages of teachers in the 20-29 and 40-49 age groups, along with the very low representation of those aged 50 and above, indicate a potential gap in the representation of both very early-career and more experienced educators.

Table 4.3: Academic Qualification of Respondents

Qualification	Frequency	Percent
Diploma	2	5.9
Bachelors	26	76.5
Master	6	17.6
Total	34	100.0

Source: Field Data, 2023

The data in Table 4.3 reveal that a significant majority of the respondents, 26 (76.5%), hold a bachelor's degree. This indicates that most teachers have a substantial level of higher education, which could enhance their teaching capabilities and their ability to implement non-routine mathematics problem-solving strategies. The prevalence of bachelor's degree holders suggests a solid foundation in educational theories and pedagogical techniques among the teaching staff. In addition to the bachelor's degree holders, 6 (17.6%) of the respondents have attained a master's degree. This higher level of education reflects a deeper specialisation and expertise, which can contribute to more advanced teaching methods and a comprehensive understanding of complex

educational challenges. Teachers with a master's degree are likely to employ innovative strategies and address diverse student needs effectively.

However, only 2 (5.9%) of them have a diploma as their highest qualification. Although diploma holders can still be effective teachers, the relatively low percentage indicates that the teaching staff is predominantly composed of individuals with higher academic qualifications. This distribution underscores a commitment to quality education within the surveyed schools, as higher academic qualifications often correlate with better teaching performance and student outcomes.

The combination of frequencies and percentages shows that the teaching workforce is well-educated, with a strong emphasis on bachelor's (76.5%) and master's degrees (17.6%). This high level of academic preparation is likely to positively influence the study's findings, suggesting that teachers possess the necessary knowledge and skills to effectively teach non-routine mathematics problem-solving. The diversity in qualifications allows for a range of perspectives and approaches, enriching the educational experience for pupils.

Table 4.4: Class Taught by the Respondents

Class	Frequency	Percent
JHS 1	6	17.6
JHS 2	8	26.5
JHS 3	20	5.9
Total	34	100.0

Source: Field Data, 2023

The data indicate that most of the respondents, 20 out of 34 teachers (55.9%), are teaching JHS 3 classes. This substantial percentage suggests a focus on the final year

of Junior High School, which is critical as pupils prepare for their transition to Senior High School. The emphasis on JHS 3 could reflect the importance placed on ensuring pupils are well-prepared for their final exams and future academic pursuits. In contrast, 8 (26.5%) are teaching JHS 2, and 6 (17.6%) of them are teaching JHS 1. The smaller percentages in JHS 1 and JHS 2 indicate that fewer teachers are assigned to the earlier years of Junior High School. This distribution could be due to various factors, including staffing allocations, class sizes, and the specific needs of pupils at different educational stages.

The concentration of teachers in JHS 3 (55.9%) may have implications for the teaching of non-routine mathematics problem-solving. Teachers in the final year of JHS might face additional pressures to cover the curriculum thoroughly and prepare pupils for exams, which could influence their teaching strategies and the integration of non-routine problem-solving techniques. Conversely, teachers in JHS 1 and JHS 2 might have more flexibility to experiment with innovative teaching methods, as they are not immediately preparing pupils for high-stakes assessments. The distribution of teaching assignments across the different JHS levels highlights the varying focus and potential challenges faced by teachers at each stage.

4.3 Teachers Experiences with Non-Routine Problem-Solving

This section presents the findings related to Junior High School (JHS) teachers' experiences with non-routine mathematics problem-solving, as guided by the first research question. Ten questionnaire items were designed to assess teachers' exposure to non-routine problems, their conceptual understanding, emotional responses, and coping mechanisms. Data were analysed using means and standard deviations, offering insights into the frequency, exposure, and nature of their experiences.

Table 4.5: Non-routine mathematics problem-solving experienced by teachers

Item	N	M	SD
I am often exposed to non-routine mathematical problems in my classes.	34	4.1	0.6
Non-routine mathematical problems are mathematical tasks that involve standard procedures and are commonly encountered in textbooks.	34	4.3	0.5
Non-routine mathematical problems are tasks that do not follow established algorithms and often involve real-world scenarios or unfamiliar contexts.	34	3.9	0.6
I am not sure or do not have a clear understanding of what is meant by “non-routine mathematical problems.	34	3.8	0.5
I feel anxious when faced with a non-routine mathematical problem	34	3.5	0.5
I seek guidance when faced with a non-routine problem.	34	3.4	0.6
I collaborate with my peers to discuss and solve the problem together.	34	3.7	0.6
I use online resources or additional materials to help me understand and solve the problem.	34	3.6	0.6
I lack motivation or interest in tackling challenging mathematical tasks.	34	3.5	0.6
I feel motivated to engage with non-routine mathematical problems?	34	3.4	0.5
Mean of means		3.6	0.6

N = Number of respondents; M =Mean; SD =Standard Deviation

Source: Field Data, 2023

The analysis above revealed that teachers are frequently exposed to non-routine mathematical problems during their instructional activities. This is reflected in the item “I am often exposed to non-routine mathematical problems in my classes”, which recorded a high mean score of 4.1 with a standard deviation of 0.6. This suggests that, on average, teachers encounter non-routine problems regularly, highlighting its relevance in their instructional context.

Teachers also showed a strong understanding of what constitutes non-routine problems. The item “non-routine mathematical problems are mathematical tasks that involve standard procedures and are commonly encountered in textbooks” had the highest mean score of 4.3 (SD = 0.5), indicating widespread agreement with this description. It technically describes routine problems. In contrast, the item correctly describing non-routine problems as “tasks that do not follow established algorithms and often involve real-world scenarios or unfamiliar contexts” had a slightly lower mean of 3.9 and a standard deviation of 0.6, suggesting some degree of conceptual confusion or variability in teachers’ understanding.

Some teachers surprisingly indicated uncertainty about the concept of non-routine problems. The item “I am not sure or do not have a clear understanding of what is meant by non-routine mathematical problems” received a mean score of 3.8 (SD = 0.5), showing that despite frequent exposure, clarity of definition may still be lacking for some teachers. Affective responses to non-routine problems also varied. For the statement “I feel anxious when faced with a non-routine mathematical problem”, the mean was 3.5 (SD = 0.5), suggesting moderate levels of anxiety among respondents. Related to this, teachers also expressed their tendency to seek help, with “I seek guidance when faced with a non-routine problem” scoring a mean of 3.4 and a standard deviation of 0.6, highlighting the collaborative or dependent nature of their response to such tasks.

Collaboration appears to be a common strategy among teachers when solving non-routine problems. The item “I collaborate with my peers to discuss and solve the problem together” garnered a mean score of 3.7 (SD = 0.6), indicating that peer interaction is a preferred means of navigating challenges in problem-solving.

Similarly, resourcefulness was evident in the use of supplementary materials; the item “I use online resources or additional materials to help me understand and solve the problem” had a mean of 3.6 (SD = 0.6), underscoring the growing reliance on digital tools and external references.

Teachers’ motivation and attitudes toward non-routine problem-solving revealed a mixed picture. For example, the item “I lack motivation or interest in tackling challenging mathematical tasks” recorded a mean of 3.5 (SD = 0.6), suggesting a mild disinterest or disengagement among some teachers. Conversely, the statement “I feel motivated to engage with non-routine mathematical problems” had a mean of 3.4 (SD = 0.5), indicating a slightly lower positive motivation level.

4.4 Strategies teachers employ in teaching non-routine mathematics problems

This section presents data on the strategies JHS teachers mostly use in teaching non-routine mathematics problems in the municipality. The questions in this section explore various approaches teachers take, such as trial and error, breaking problems into smaller parts, collaborating with peers, looking for patterns, and trying different methods. It also investigates teachers comfort levels in discussing and sharing their problem-solving strategies with colleagues, as well as the frequency with which they reflect on the effectiveness of these strategies after teaching. The questions aim to gather comprehensive insights into the practical methods teachers use to tackle non-routine problems, their collaborative practices, and their reflective processes. The results of the strategies Junior High School teachers mostly use in teaching non-routine mathematics problems are presented in Table 4.6.

Table 4.6: JHS teachers strategies in teaching non-routine mathematics**problems**

Item	N	M	SD
I use Trial and error technique when faced with a non-routine mathematical problem	34	4.3	0.4
I collaborate with peers when faced with a non-routine mathematical problem	34	3.9	0.3
I break the problem into smaller parts when faced with a non-routine mathematical problem	34	4.0	0.6
I look for patterns when faced with a non-routine mathematical problem	34	4.1	0.6
I try different approaches when faced with a non-routine mathematical problem	34	3.1	0.3
I reflect on the effectiveness of my chosen strategy after teaching a non-routine problem	34	3.1	0.4

N = Number of respondents; M = Mean; SD = Standard Deviation

Source: Field Data, 2023

Table 4.6 indicate that trial and error is the most commonly employed strategy by Junior High School teachers when dealing with non-routine mathematical problems. The item “I use trial and error technique when faced with a non-routine mathematical problem” recorded the highest mean score of 4.3 (SD = 0.4), showing a strong preference for this method. This suggests that many teachers attempt various possible solutions until they arrive at the correct one, a strategy that aligns with exploratory learning in problem-solving contexts.

Collaboration with peers also featured prominently among the strategies adopted by teachers. The statement “I collaborate with peers when faced with a non-routine mathematical problem” had a mean of 3.9 and a low standard deviation of 0.3, indicating not only frequent use but also consistency among respondents. This

suggests a strong culture of professional interaction and support among teachers when tackling unfamiliar or complex problems.

Teachers also rely on problem decomposition to navigate non-routine challenges. The item “I break the problem into smaller parts when faced with a non-routine mathematical problem” received a mean score of 4.0 (SD = 0.6). This implies that many teachers find it useful to simplify and tackle components of a larger problem sequentially, a cognitive strategy known to aid understanding and reduce complexity in problem-solving tasks.

Another strategic approach is pattern recognition, which also scored high among respondents. The item “I look for patterns when faced with a non-routine mathematical problem” recorded a mean of 4.1 (SD = 0.6). This indicates that many teachers look for repeated or recognisable structures within problems, a method often associated with mathematical reasoning and problem generalisation. However, the use of multiple approaches and self-reflection appears to be less common among the teachers. The item “I try different approaches when faced with a non-routine mathematical problem” had a relatively low mean of 3.1 (SD = 0.3), suggesting that many teachers may not actively experiment with varied solution paths. Similarly, the statement “I reflect on the effectiveness of my chosen strategy after teaching a non-routine problem” also recorded a mean of 3.1 (SD = 0.4), pointing to limited post-lesson reflection. This could imply a gap in metacognitive practices that are crucial for improving teaching strategies over time.

4.5 Challenges Faced by Junior High School Teachers in Teaching Non-Routine Mathematics Problems in the Wa Municipality

This section focuses on the most prevalent challenges Junior High School teachers face in teaching non-routine problems in the Wa Municipality. It delves into the complex landscape of Junior High School education in the area, examining the specific obstacles teachers encounter when teaching non-routine mathematical problems. This part of the study probes the nuanced experiences of Junior High School teachers as they navigate the intricacies of non-routine problem-solving instruction, highlighting the challenges they face and their implications for pedagogical practice. The results on the challenges Junior High School teachers experience in teaching non-routine problems are presented in Table 4.7.

Table 4.7: Most prevalent challenges Junior High School teachers experience in teaching non-routine problems

Item	N	M	SD
I find all types of non-routine problems equally challenging.	34	4.3	0.6
I find problems involving geometry or spatial reasoning are more challenging.	34	3.6	0.7
I find problems that involve multiple steps or complex calculations more challenging.	34	4.3	0.6
Problems that require creative or out-of-the-box thinking are more difficult for me.	34	3.5	0.5
Difficulty in choosing the right strategy to approach the problem	34	3.4	0.5
Lack of clarity in understanding the problem statement	34	4.4	0.4
Insufficient time to solve complex non-routine problems	34	3.3	0.6
Trouble connecting concepts or applying learned principles	34	3.4	0.3
Difficulty in choosing the right strategy	34	3.5	0.6

N = Number of respondents; M = Mean; SD = Standard Deviation

Source: Field Data, 2023

Results in Table 4.7 indicate that many teachers perceive all types of non-routine problems as equally challenging. The item “I find all types of non-routine problems equally challenging” recorded a high mean of 4.3 (SD = 0.6), suggesting a widespread difficulty in differentiating between types of problems and their relative difficulty. This implies that the complexity of non-routine problems cuts across content areas, potentially overwhelming teachers irrespective of the specific mathematical domain.

In addition, problems involving multiple steps or complex calculations were identified as equally challenging. This item also received a mean of 4.3 (SD = 0.6), indicating that multi-step problem-solving tasks present significant cognitive demands on teachers. Such tasks often require planning, sequencing, and sustained reasoning, which can be difficult to manage, especially in a classroom context with limited time and resources.

The lack of clarity in understanding the problem statement emerged as the most challenging aspect overall, with the highest mean score of 4.4 (SD = 0.4). This reflects a fundamental obstacle in problem comprehension, which is critical in initiating any successful solution process. If teachers themselves struggle to interpret problem statements, it becomes even more difficult to guide students through such tasks.

Meanwhile, problems involving geometry or spatial reasoning were seen as moderately difficult, with a mean of 3.6 (SD = 0.7). This points to potential gaps in spatial visualisation skills or in-depth content knowledge in geometry among some teachers. These areas may need targeted professional development, particularly since spatial reasoning is crucial for understanding diagrams, figures, and transformations.

Tasks that require creative or out-of-the-box thinking were also perceived as difficult, reflected in a mean of 3.5 (SD = 0.5). Non-routine problems typically demand divergent thinking, which differs from the conventional procedural focus of many mathematics lessons. This result suggests that such problems challenge teachers' comfort zones and traditional instructional habits.

Further, some teachers acknowledged having difficulty in choosing the right strategy to approach non-routine problems. This challenge appeared in two slightly overlapping items “Difficulty in choosing the right strategy to approach the problem” (M = 3.4, SD = 0.5) and “Difficulty in choosing the right strategy” (M = 3.5, SD = 0.6). The near-identical responses confirm that uncertainty in strategic decision-making is a recurring issue when navigating complex problem types.

Insufficient time to solve complex non-routine problems was another highlighted concern, with a mean score of 3.3 (SD = 0.6). This suggests that the demands of the school curriculum and large class sizes may limit the time available for deeper engagement with challenging mathematical problems. Finally, some teachers expressed trouble connecting concepts or applying learned principles, which recorded a mean of 3.4 (SD = 0.3). This may indicate a fragmented understanding of mathematical content or difficulties with helping students see the relevance and application of concepts across various problem contexts.

4.6 Minimizing Challenges Faced by Junior High School Teachers in Teaching Non-Routine Mathematics Problems in the Wa Municipality.

This section presents data on how the challenges Junior High School teachers experience in teaching non-routine mathematics problems can be minimized in the Wa Municipality. Teaching non-routine mathematical problems presents a unique set

of challenges for teachers, requiring innovative approaches and effective resources to facilitate student understanding and engagement. Non-routine problems often demand higher-order thinking skills, creativity, and the ability to apply mathematical concepts in unfamiliar contexts. These problems can be particularly daunting for both teachers and pupils, as they require not only a strong foundational knowledge of mathematics but also the capacity to think flexibly and adaptively. When teachers were asked about minimizing these challenges, five themes emerged as follows:

Theme 1: Availability and integration of technological tools

Teacher 4: “The implementation of collaborative learning platforms that facilitate student interaction and idea-sharing represents a valuable educational asset. Platforms like Google Classroom or Microsoft Teams play a pivotal role in promoting group collaboration and peer-to-peer learning, which are deemed indispensable elements in the process of addressing non-routine problems.”

Teacher 6: “The availability of regularly updated online repositories and databases housing a comprehensive collection of non-routine problems segmented according to difficulty levels and thematic categorisations stands as an invaluable educational resource. Such repositories afford educators effortless access to a wide array of problem sets for integration into their instructional practices.”

Teacher 8: “The integration of technological tools such as interactive whiteboards and tablets into the classroom setting represents a transformative approach to enhancing the instruction of non-routine problems. These tools enable dynamic and engaging presentations, thereby fostering enhanced student engagement and comprehension.”

Theme 2: Utilisation of Technology and Resources

Teacher 1: “I firmly believe that the integration of interactive software applications designed to promote hands-on problem-solving skills among pupils can yield significant benefits in the realm of education.”

The utilisation of sophisticated tools like GeoGebra or Desmos enables the visualisation of intricate mathematical problems, thereby aiding in the transformation of abstract concepts into tangible entities for pupils, ultimately enhancing their comprehension and learning experience.”

Theme 3: Access to Learning Materials

Teacher 2: “The availability of a well-stocked library featuring a diverse array of mathematical problem-solving literature and resources has the potential to exert a profound impact on the academic growth of pupils. By offering a plethora of examples and exercises spanning various levels of complexity, pupils are afforded the opportunity to progressively enhance their problem-solving skills, thereby fostering a comprehensive understanding of mathematical concepts.”

Teacher 5: “The provision of access to manipulatives and visual aids, such as algebra tiles and geometry tools, serves as a fundamental pedagogical tool for enhancing pupils' comprehension of the structural intricacies inherent in non-routine problems. These aids play a pivotal role in simplifying the deconstruction and exploration of various facets of a given problem.”

Teacher 9: “The provision of supplementary classroom resources including detailed lesson plans, activity sheets, and comprehensive guides outlining various problem-solving strategies serves as a valuable educational asset. These resources offer educators a structured framework for imparting instruction on non-routine problems, thereby enhancing the effectiveness of the teaching process.”

Theme 4: Professional Development and Support

Teacher 3: “The significance of professional development workshops that are specifically tailored to concentrate on non-routine problem-solving strategies cannot be overstated. These workshops serve as

indispensable platforms for equipping educators with the most up-to-date methodologies and techniques essential for effectively instructing pupils in the art of tackling complex and unconventional problems.”

Teacher 7: “The establishment of a supportive community of practice wherein educators can engage in the exchange of experiences and strategies pertinent to the teaching of non-routine problems holds immeasurable value. This communal support system can be effectively facilitated through online forums or local teacher networks, fostering a conducive environment for professional growth and knowledge sharing.”

Theme 5: Curriculum and Time Allocation

Teacher 10: “Ensuring the allocation of adequate time within the curriculum to focus on problem-solving activities assumes paramount importance in the realm of education. Oftentimes, the primary challenge lies in the scarcity of time available to thoroughly delve into non-routine problems, underscoring the necessity of dedicated problem-solving sessions to optimize student learning outcomes.”

4.7 Discussion of Results

This section of the study presents discussion of the findings. It presents discussions on the following areas including, experiences in teaching non-routine mathematical problem solving, prevalent strategies, challenges junior high school teachers face in non-routine mathematical problems and junior high school teacher’s minimisation of non-routine problems

4.7.1 Experiences in Teaching Non-Routine Mathematical Problem Solving

The study revealed that teachers in the Wa Municipality frequently encounter non-routine mathematical problems, making them a core part of the Junior High School mathematics curriculum. While teachers were confident with traditional problems,

they struggle with non-routine ones that involve real-world contexts and require innovative thinking. Some teachers are unsure what defines a non-routine problem, suggesting the need for clearer curriculum guidelines and professional development. Additionally, moderate anxiety and mixed motivation levels among teachers highlight the importance of creating supportive and collaborative teaching environments to enhance their confidence and engagement with challenging tasks.

The finding that teachers in the Wa Municipality frequently encounter non-routine mathematical problems aligns with existing literature emphasizing the importance of incorporating problem-solving tasks into mathematics education (Kant, 2017; NCTM, 2000). Non-routine problems are crucial for developing pupils' critical thinking, problem-solving, and mathematical reasoning skills (Kant, 2017; Mousoulides, 2014). However, the struggle reported by teachers when dealing with these problems echoes previous research highlighting the challenges educators face in teaching non-routine tasks (Tzur, 2008).

The disparity between teachers confidence in traditional problems and their struggle with non-routine ones resonates with studies indicating that traditional mathematics education often emphasizes rote memorisation and procedural understanding over conceptual understanding and problem-solving abilities (Boaler, 2016; National Research Council, 2001). This suggests a need for pedagogical shifts towards more inquiry-based and problem-centered approaches that promote deeper understanding and application of mathematical concepts (Hiebert & Grouws, 2019).

The finding that some teachers are uncertain about what defines a non-routine problem underscores the importance of clear curriculum guidelines and effective professional development programs. Research suggests that teacher knowledge and

beliefs play a crucial role in shaping instructional practices (Ball, Thames, & Phelps, 2008), highlighting the need for targeted training to enhance teachers understanding and confidence in teaching non-routine tasks.

The observed moderate anxiety and mixed motivation levels among teachers further emphasize the significance of creating supportive and collaborative teaching environments. Studies have shown that teacher anxiety can negatively impact student learning outcomes and classroom dynamics (Pekrun, 2017), underscoring the importance of addressing teachers emotional well-being and fostering positive teaching environments conducive to tackling challenging tasks (Fredrickson, 2001; Skaalvik & Skaalvik, 2010). These findings highlight the need for comprehensive reforms in mathematics education, including clearer curriculum guidelines, effective professional development, and the creation of supportive teaching environments. By addressing these aspects, educational stakeholders can better support teachers in effectively integrating non-routine mathematical problems into the curriculum, ultimately enhancing student learning outcomes and promoting mathematical proficiency.

4.7.2 Prevalent Strategies

The finding indicates that teachers in the Wa Municipality commonly resort to collaborative efforts with their peers and external resources to navigate the challenges posed by non-routine mathematical problems. This aligns with contemporary educational approaches that emphasize the importance of collaborative learning environments and the utilisation of diverse resources to enhance problem-solving skills (Erbil, 2020). However, the need for teachers to supplement the provided curriculum independently suggests potential gaps in the existing educational resources

or professional development programs. This underscores the importance of curriculum reviews and ongoing support for teachers to ensure alignment with instructional needs and objectives (Desimone et al., 2002; Darling-Hammond et al., 2017).

Additionally, teachers often employ specific problem-solving strategies, such as trial and error and breaking down problems into smaller parts, to manage non-routine tasks. While these strategies can be effective in supporting student learning, there appears to be less emphasis on reflective practices, such as evaluating the effectiveness of chosen strategies after teaching non-routine problems. Incorporating reflective practices into instructional routines can promote deeper understanding and continuous improvement in teaching practices (Hattie, 2009; Hatton & Smith, 1995). Therefore, fostering a culture of reflection among teachers could enhance their professional growth and contribute to more effective teaching of non-routine mathematical problems.

4.7.3 Challenges Junior High School teachers face in non-routine mathematical problems

The primary finding reveals the formidable challenges faced by Junior High School (JHS) teachers in the Wa Municipality when addressing non-routine mathematical problems, reflecting broader trends in mathematics education. These challenges encompass various dimensions, presenting significant barriers to effective teaching and learning. Teachers grapple with the intricate nature of these problems, which demand pupils to integrate multiple mathematical concepts and strategies innovatively (Hiebert, 2007). When confronted with non-routine tasks, educators often struggle to guide pupils through the problem-solving process, select appropriate problem-solving

approaches, and scaffold pupils' understanding of complex mathematical concepts (Schoenfeld, 2016).

Moreover, interpreting and comprehending the problem statements themselves presents formidable obstacles, as non-routine problems frequently introduce unfamiliar contexts or require the application of mathematical concepts in real-world scenarios, leading to ambiguity and challenges in discerning the intended mathematical task (Kilpatrick et al., 2001). This ambiguity can hinder teachers ability to effectively facilitate student learning and may result in misconceptions or misunderstandings about the mathematical concepts being explored (Leung et al., 2004; Schoenfeld, 2016).

Additionally, the creative demands inherent in non-routine problems call for educators to foster environments that not only encourage but also nurture pupils' creative thinking abilities (Amabile, 2003; Oliver, 2024). However, the integration of creativity within traditional pedagogical approaches poses challenges, necessitating the adoption of flexible and student-centered instructional practices that promote exploration, experimentation, and risk-taking (Polyak, 2021; Verschaffel et al., 2020). These findings underscore the urgency for targeted professional development initiatives and curriculum reforms to equip teachers with the requisite knowledge, skills, and instructional strategies needed to effectively address the complexities of non-routine mathematical problems and foster creativity in mathematics education.

4.7.4 Junior High School teacher's minimisation of non-routine problems

The findings from the five themes show that teaching non-routine mathematical problems presents a unique set of challenges for teachers. These non-routine problems often require higher-order thinking skills, creativity, and the ability to apply

mathematical concepts in unfamiliar contexts as alluded by Teacher 5. This confirms the findings of (Lesh & Zawojewski, 2007, p. 764) that demand not only a strong foundational knowledge of mathematics but also the ability to think flexibly and adaptively.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the findings; conclusions drawn as well as recommendations based on the findings of this study.

5.1 Summary of the Findings

The purpose of the study was to explore JHS teachers experiences in teaching non-routine mathematics problem-solving in the Wa municipality in the Upper West Region of Ghana. The target population for the study was 53 public Junior High School Mathematics teachers in Wa Municipal. The accessible population consisted of all the thirty-four (34) Junior High School Mathematics teachers in the Wa Municipal. The study adopted two research instruments, namely: questionnaire and semi-structured interview. The data collected (quantitative) were analysed using tables and figures and the qualitative data from the interview were transcribed and analysed. The study was guided by the following research questions:

1. How do Junior High School teachers experience teaching non-routine problem solving in the Wa Municipality?
2. What strategies do Junior High School teachers mostly use in teaching non-routine mathematics problems in the Wa Municipality?
3. What are Junior High School teachers most prevalent challenges in teaching non-routine problems in the Wa Municipality?
4. How can the challenges Junior High School teachers experience in teaching non-routine mathematics problems be minimized in the Wa Municipality?

5.2 Findings of the Study

1. The study found that many Junior High School mathematics teachers in the Wa Municipality reported being exposed to non-routine mathematical problems in their classrooms. However, their understanding of what constitutes a non-routine problem varied significantly. While a few teachers correctly identified non-routine problems as tasks that do not follow standard procedures and often require creative or critical thinking, others seemed to confuse them with routine textbook-based exercises. Some teachers even expressed uncertainty or admitted they lacked a clear understanding of the concept entirely. This inconsistency in understanding suggests that while teachers are somewhat familiar with the term, many are not deeply grounded in its meaning or application. This has implications for how non-routine problems are selected and taught in classrooms, potentially limiting students' exposure to genuine problem-solving experiences.
2. The study found that many Junior High School mathematics teachers in the Wa Municipality employed in teaching non-routine mathematics problems, the findings revealed that most teachers resort to practical, familiar techniques. The most common strategy was trial and error, where teachers and students attempt multiple solutions until they arrive at the correct one. Additionally, teachers frequently collaborated with their colleagues to discuss and solve challenging problems together. Other approaches included breaking complex problems into smaller, manageable parts and searching for recognisable patterns. However, strategies that demand deeper reflection, such as evaluating the effectiveness of one's approach after solving a problem, were less frequently used. This suggests that while teachers are resourceful in dealing with problem-solving tasks, there is

a limited use of metacognitive and strategic thinking, which are essential for cultivating higher-order mathematical reasoning among learners.

3. The study uncovered several challenges faced by teachers in teaching non-routine mathematics problems. Chief among these was the difficulty in understanding vague or poorly worded problem statements, which made it hard for both teachers and students to determine what was being asked. Teachers also found multi-step problems and tasks requiring complex calculations to be particularly challenging. Some participants indicated that problems demanding creative or unconventional thinking were especially difficult to handle. Additionally, time constraints within the curriculum often meant that teachers had insufficient time to explore non-routine tasks in depth. These findings underscore the cognitive and instructional difficulties involved in non-routine problem-solving, indicating that both content and systemic barriers hinder effective teaching in this area.
4. The study also revealed that teachers often rely on self-driven and peer-supported strategies to cope. Many of them seek guidance from more experienced colleagues or turn to online platforms and teaching materials to better understand non-routine problems. Peer collaboration emerged as a strong informal support mechanism, with teachers frequently discussing difficult problems and sharing strategies. However, the study also revealed a gap in formal institutional support, such as professional development workshops, ongoing training, or access to problem-solving resources tailored for non-routine mathematics. This indicates a pressing need for capacity-building initiatives at the district or national level to empower teachers with the requisite knowledge, strategies, and confidence to effectively teach non-routine problems in the classroom.

5.3 Conclusions

The purpose of this study was to explore public Junior High School Mathematics teachers experiences in teaching non-routine mathematics problem-solving in the Wa Municipality. This includes exploring how Junior High School teachers experience in teaching non-routine mathematics problems, Unstitching the realities of Junior High School teachers challenges in teaching non-routine problems, Ascertaining Junior High School teachers' strategies experienced in teaching non-routine mathematics problems and finally identifying ways to minimize the challenges faced by Junior High School teachers in teaching non-routine mathematics problems in the Wa Municipality. The study brought to light some of the experiences Junior High School Mathematics teachers in the Wa Municipality have regarding non-routine problem-solving, highlighting their awareness and understanding of this critical skill.

The findings revealed that Junior High School Mathematics teachers possess a good knowledge and experience of non-routine problem-solving. However, despite this level of knowledge, they only moderately use instructional strategies tailored to non-routine problem-solving in their teaching. Qualitative data from the interview indicated that Junior High School Mathematics teachers lack expertise in effectively applying non-routine problem-solving strategies in their classrooms. Furthermore, the study revealed that these teachers occasionally engage pupils in non-routine problem-solving activities, with a preference for using manipulative materials over other engagement methods.

Some recommendations have been made to address these challenges. It is important to note that integrating non-routine problem-solving approaches into teaching is a gradual process that cannot be achieved overnight. Convincing teachers to transition

from traditional methods to more effective non-routine problem-solving strategies will require sustained effort and support. Opportunities should be provided for teachers to enhance their perceived knowledge, improve their instructional strategies, and increase their engagement of pupils in non-routine problem-solving. Teachers also need to frequently challenge and critically reflect on their teaching methods. It is believed that if attention is given to non-routine problem-solving and the use of related instructional strategies, it will positively influence the teaching and learning of Mathematics in the Wa Municipality.

5.4 Recommendations

Drawing from the findings of this study on exploring Junior High School teachers experiences in teaching non-routine mathematics problem-solving in the Wa Municipality, the following recommendations are proposed:

1. Given that many Junior High School mathematics teachers in the Wa Municipality struggle with understanding and confidently teaching non-routine problems, the Municipal Directorate of Education in the Wa Municipal should organize structured professional development programs. These training sessions which are delivered through workshops, in-service programs, and seminars should focus on building teachers' conceptual clarity, pedagogical skills, and confidence in teaching non-routine tasks. This responds directly to the identified gap in teacher knowledge and preparedness.
2. The study revealed that teachers often rely on peer support and collaboration when handling non-routine mathematical problems. To institutionalize this support, the Directorate should establish learning collectives or communities of practice within the municipality. These platforms will enable teachers to share practical strategies, reflect on their instructional practices, and co-develop solutions to common

challenges, enhancing their ongoing professional growth in a context-specific and sustainable manner.

3. Teachers indicated a need for continuous support in applying problem-solving strategies effectively. In response, mentorship programs involving experienced mathematics teachers, along with regular circuit supervisor visits, should be rolled out in partnership with school heads. These efforts will provide personalized guidance, reinforce instructional quality, and ensure accountability for the implementation of problem-solving methodologies in the classroom within the Wa Municipality.
4. Recognizing the effort and creativity required to teach non-routine mathematics effectively, the Directorate should consider strategies to motivate teachers. This includes improving conditions of service, acknowledging innovative teaching practices, and introducing performance-based incentives. Enhancing morale in this way not only acknowledges the workload but also fosters greater dedication to problem-solving instruction among teachers in the municipality.

5.5 Suggestions for Further Research

Based on the findings of this study, the following suggestions for further research are made:

1. Investigate the effectiveness of the suggested strategies, such as technology integration, professional development workshops, and access to learning materials, in enhancing teachers ability to teach non-routine problems and improving student learning outcomes.
2. Explore the specific training needs of Junior High School teachers regarding non-routine problem-solving strategies and assess the effectiveness of different professional development approaches in addressing these needs. This

could involve longitudinal studies tracking teacher growth and efficacy over time.

3. Evaluate the impact of curriculum reforms aimed at incorporating more non-routine problem-solving activities into mathematics education. Assess how changes in curriculum design and time allocation influence teachers' instructional practices and pupils' problem-solving skills and mathematical understanding.



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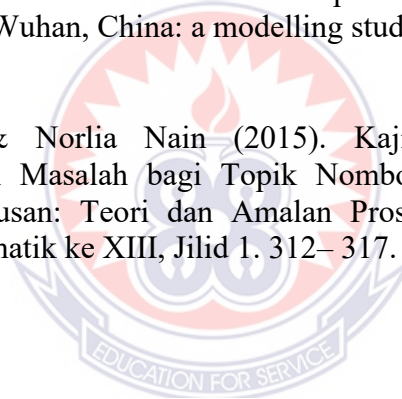
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APPENDIX A

QUESTIONNAIRES

EXPLORING JHS TEACHERS EXPERIENCES IN NON-ROUTINE MATHEMATICS PROBLEM-SOLVING IN THE WA MUNICIPALITY

Thank you for participating in this research study. The purpose of this questionnaire is to understand your experiences with teaching non-routine mathematical problems. Your responses will contribute to gaining insights into how Junior High School teachers in the Wa Municipality engage with and perceive non-routine mathematical challenges.

Section A: Demographic Information

1. Form taught (a) JHS 1 [] (b) JHS 2 [] (c) JHS 3 []
2. Age: (a) 18-24 [] (b) 25-29 [] (c) 30-34 [] (d) 35-39 [] (e) 40-44 [] (f) 45-49 []
(g) 50 and above []
3. Gender: (a) Male [] (b) Female []
4. Highest qualification obtained (a) Diploma [] (b) Bachelor's Degree [] (c) Master's Degree [] (d) PhD []

Section B: JHS teacher's experience in teaching non-routine mathematical problems

Please indicate the extent to which you agree or disagree to each of the statements on your experience in teaching non-routine mathematical problems by ticking $\{\surd\}$ the appropriate responses. The scale is presented as Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD).

s/n	Item	SA	A	N	D	SD
1	I am often exposed to non-routine mathematical problems in my classes.					
2	Non-routine mathematical problems are mathematical tasks that involve standard procedures and are commonly encountered in textbooks.					
3	Non-routine mathematical problems are tasks that do not follow established algorithms and often involve real-world scenarios or unfamiliar contexts.					
4	I am not sure or do not have a clear understanding of what is meant by "non-routine mathematical problems.					
5	I feel anxious when faced with a non-routine mathematical problem					
6	I seek guidance when faced with a non-routine problem.					
7	I collaborate with my peers to discuss and solve the problem together.					
8	I use online resources or additional materials to help me understand and solve the problem.					
9	I lack motivation or interest in tackling challenging mathematical tasks.					
10	I feel motivated to engage with non-routine mathematical problems?					

SECTION C: JHS teachers challenges in teaching non-routine problems

Please indicate the extent to which you agree or disagree to each of the statements on challenges you face in teaching non-routine problems by ticking $\{\surd\}$ the appropriate responses. The scale is presented as Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD).

s/n	Item	SA	A	N	D	SD
1	I find all types of non-routine problems equally challenging.					
2	I find problems involving geometry or spatial reasoning are more challenging.					
3	I find problems that involve multiple steps or complex calculations more challenging.					
4	Problems that require creative or out-of-the-box thinking are more difficult for me.					
5	Difficulty in choosing the right strategy to approach the problem					
6	Lack of clarity in understanding the problem statement					
7	Insufficient time to solve complex non-routine problems					
8	Trouble connecting concepts or applying learned principles					
9	Difficulty in choosing the right strategy					
10	I do not face any specific challenges when working on non-routine problems.					

Section D: JHS teachers strategies in teaching non-routine mathematics problems

Please indicate the extent to which you agree or disagree to each of the statements on the strategies you employ in teaching non-routine mathematics problems by ticking {√} the appropriate responses. The scale is presented as Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD).

s/n	Item	SA	A	N	D	SD
1	I use Trial and error technique when faced with a non-routine mathematical problem					
2	I collaborate with peers when faced with a non-routine mathematical problem					
3	I break the problem into smaller parts when faced with a non-routine mathematical problem					
4	I look for patterns when faced with a non-routine mathematical problem					
5	I try different approaches when faced with a non-routine mathematical problem					
6	I reflect on the effectiveness of my chosen strategy after teaching a non-routine problem					

APPENDIX B

INTERVIEW GUIDE

Section E: Ways to minimize the difficulties faced by JHS teachers in teaching non-routine mathematics problems

1. Provide an example of a non-routine mathematical problem that you found particularly challenging? What specific difficulties did you encounter?
2. What resources or tools do you think would be helpful in minimizing difficulties in teaching non-routine mathematical problems?
3. How often do you currently have access to these resources in your learning environment?
4. What strategies do you think would be effective in minimizing the difficulties faced by JHS teachers in solving non-routine mathematics problems? (Open-ended)
5. How do you believe collaboration with peers could help in overcoming difficulties in non-routine problem-solving?

APPENDIX C**DISTRIBUTION OF MATHEMATICS TEACHERS ACROSS JUNIOR HIGH SCHOOLS IN THE WA MUNICIPALITY**

Circuit	Junior High Schools	Number of Mathematics Teachers
Boli	Boli M/A Junior High School	1
	Danku E/A Junior High School	1
	Dapuoha M/A Junior High School	1
	Seiyiri M/A Junior High School	1
Busa	Busa M/A Junior High School	1
	Busa-Tendamba M/A Junior High School	1
	Doodiyiri Islamic Junior High School	1
Charia	Charia R/C Junior High School 'A'	1
	Charia R/C Junior High School 'B'	1
	Charia R/C Junior High School 'C'	1
Dobile	Dobile Presby Junior High School	1
	Fongo E/A Junior High School	2
	Wa Catholic Junior High School	1
	Wa Municipal Girls' Model Junior High School	1
Jonga	Charingu Islamic Junior High School	1
	Jonga Islamic Junior High School	1
	Kadoli Islamic Junior High School	1
Kabanye	Kabanye Islamic Junior High School	2
	Kabanye Islamic Model Junior High School	1
	St. Andrew's R/C Junior High School	1
Kambali/Nakore	Wa Municipal Model Junior High School	1
	Kambali Islamic Junior High School	1
	Nakore/Chansa M/A Junior High School	1

	Star of God Junior High School	1
	Wa SDA Junior High School	1
Bamahu/Konta	Bamahu M/A Junior High School	2
	Kparesaga M/S Junior High School	1
	Piisi R/C Junior High School	1
	T. I. Ahmadiyya Junior High School	1
Kperisi	Chegli Islamic Junior High School	1
	Konjehi M/A Junior High School	1
	Kperisi M/A Junior High School	1
Kpongu	Al-Azhar Islamic Junior High School	1
	Dignafuro Islamic Junior High School	1
	Kpongu Islamic Junior High School	1
Mangu	Aswaj Islamic Junior High School	1
	Shakarfatu Islamic Junior High School	1
	St. Cecilia's Catholic Junior High School	1
Sawaba	Adabiyat Islamic Junior High School	1
	Fallahia Islamic Junior High School	1
	Limanyiri Model Junior High School	1
Tampaalipaani	Biihee M/A Junior High School	1
	Jujeidayiri T.I. Junior High School	1
	N.J.A Demonstration Junior High School	1
Tendamba	Huriyat Islamic Junior High School	1
	St. Paul's Methodist Junior High School	1
	Tendamba M/A Junior High School	1

Source: Wa Municipal Educational Directorate, (2022)

APPENDIX D

INTRODUCTORY LETTER

	UNIVERSITY OF EDUCATION, WINNEBA SCHOOL OF EDUCATION AND LIFE-LONG LEARNING DEPARTMENT OF BASIC EDUCATION P. O. Box 23, Winneba, Ghana +233 (0)31 9212015	basiceducation@uew.edu.gh
Our ref: SELLD/DBE/ S.9/VOL.1/74	August 5, 2025	
The Director, Ghana Education Service, Wa Municipality, Upper Wa Region.		
Dear Sir/Madam,		
LETTER OF INTRODUCTION		
I write to introduce Mr Abdul Rauf Mashood , a second year M.Phil. student of the Department of Basic Education, University of Education, Winneba, with registration number 202113953 .		
Mr Mashood is to carry out research on the Topic: <i>"Junior High School Teachers' Experiences in Teaching Non-Routine Mathematics Problem Solving in the Wa Municipality."</i>		
We would be grateful if he could be given the needed assistance to carry out his studies in your institution.		
Thank you.		
		
ALEXANDRA NORLEY DOWUONA CHIEF ADMINISTRATIVE ASSISTANT FOR: HEAD OF DEPARTMENT		
	www.uew.edu.gh	