UNIVERSITY OF EDUCATION, WINNEBA

TOPIC

INVESTIGATING THE USE OF PROBLEM-SOLVING APPROACH (PSA) IN THE TEACHING OF MATHEMATICS AT THE BASIC SCHOOL LEVEL

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A THESIS SUBMITTED TO THE DEPARTMENT OF MATHEMATICS EDUCATION, FACULTY OF SCIENCE EDUCATION AND SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY IN MATHEMATICS EDUCATION.

MARCH, 2018

DECLARATION

CANDIDATE'S DECLARATION

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

Name: Badoo Asabea Victoria

Signature…….

Date…….

SUPERVISOR'S DECLARATION

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

Name of Supervisor: Mr. M. E. Amppiah

Signature……

Date……

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DEDICATION

This work is dedicated to GOD and my family

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ABSTRACT

This study sought to find out whether Problem Solving Approach (PSA) is being used to teach Mathematics at the Basic School level in Kwahu West Municipality and Ghana as a whole. Simple random sampling was used to select the prospective respondents for good representation. A total of 62 respondents participated in the study made up of mathematics teachers and Circuit Supervisors. Questionnaires, unstructured interviews and observations were used to collect the data and analyzed using simple tables, charts and percentages. The study revealed that most mathematics teachers do not understand what is meant by "teaching through PSA" and referred to "teaching for PSA" instead. Respondents gave reasons for teacher inability to teach through PSA as: difficulty in using PSA to teach, time constraint and lack of knowledge about the use of PSA to teach mathematics. The study recommends amongst other things that the need for re-training, INSET and orientation of the teachers' minds to enable mathematics teachers include Problem Solving Approach (PSA) in their teaching methods.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter provides the Background to the Study, Statement of the Problem, Purpose of the Study, Objectives, Research Questions which served as a guide for the study, Significance, Limitations and Delimitations of the Study, Organisation of the Study and Definition of Terms.

1.1 Background of the Study

Historically, teaching Mathematics to all students has been motivated by the belief that a study of Mathematics helps students to learn to reason and apply such reasoning to everyday problems. This deeper understanding leads to students' cognitive development which enables them to understand new situations, delve into the repertoire of Mathematical Knowledge that they have in terms of concepts, processes, ideas and adopt those ideas so as to apply them towards resolving new problem situations.

In spite of this, students' performance in Mathematics in Ghana especially at the Basic School level has not been impressive over the years despite the huge resources and much attention paid to the study and teaching of Mathematics. The poor performance of students can be observed clearly from the summary of students' performance as expressed by Anamuah-Mensah, Mereku and Asabere-Ameyaw (2004). They reported on results from the Junior Secondary School two (JSS2) students participation in Trends in International Mathematics and Science Study (TIMSS) in 2003. In that study Ghana's overall performance out of 5,294 participants in Mathematics was very poor.

A further analysis on the results by Anamuah-Mensah and Mereku (2004) indicated that out of the 5,294 students Ghana presented;

- The mean percentage of students making correct responses in Algebra, Measurement and Geometry were 720 (13.6%), 916 (17.3%) and 709 (13.4%) respectively.
- For Number and Data, the mean percentage making correct responses were 1196 (22.6%) and 1429 (27%) respectively. The Ghanaian students found the constructed response items more difficult than the multiple-choice items.
- The mean percentage of students who were able to provide the correct responses to the multiple-choice items was 1144 (21.6%) while that observed for the constructed response items was 641 (12.1%).
- The scores for knowing and applying were quite similar, between 290 and 320 but scores for reasoning were relatively lower.

These performances not withstanding; Ghana's performances in TIMSS 2007 were better than that of 2003. According to Anamuah-Mensah, Mereku and Ghartey (2008), Ghana's Junior High School two (JHS2) students' performance in Mathematics have improved significantly since TIMSS 2003. This was however, among the lowest in Africa and the other countries that took part in the study.

Ghana presented five thousand, two hundred and ninety-four (5,294) JHS2 students from 163 Junior High Schools sampled across the country to participate in the study. The mean age of the Ghanaian students at the time of the test was 15.8 years and was the oldest in the study.

- They reported that in Mathematics, Ghana's score of 309 was among the lowest and was statistically significantly lower than the TIMSS scale score average of 500. This poor performance placed Ghana second from the bottom on the overall Mathematics results table doing slightly better than only Qatar, but was significantly higher than the 2003 score of 276, a 33 point increase.
- Ghana's scores in Mathematics were lower than those obtained by all the participating African countries but the country's performance level at TIMSS improved over that of 2003.

None of the Ghanaian year 8 students reached the Advanced Benchmark whereas, five per cent of Australian year 4 students and 38 per cent of Singapore year 4 students reached the Advanced International Benchmark. Seven (7) per cent of Australian Year 8 students and 44 per cent of Singapore year 8 students reached Advance Benchmark (Thompson & Fleming,2004). The Year 8 advanced benchmark states that "students can organize information, make generalization, solve non-routine problem, and draw and justify conclusions from data" (Thompson & Fleming, 2004). The Ghanaian students' inability to reach advanced benchmark and their low percentages in even the lower levels is unacceptable and unpardonable to the nation.

It is not surprising that a country like Japan has been doing so well in the TIMSS since its inception because they have adopted Problem-Solving Approach (PSA) to teaching all subjects at all levels. Stigler and Hiebert (1999) opines that the Japanese Junior High School textbooks were based on PSA teaching guidelines.

Japanese PSA, known as the Process through "posing a problem", 'independent solving', 'comparison and discussions' and 'summary and application' was known in the United States of America through comparative study on Problem-Solving in the 80s by Tatsuro Miwa and Jerry Becker. It influenced the world through the TIMSS video in the 90s (Stigler & Hiebert, 1999).

Considering Ghanaian Junior High School 2 (JHS 2) students' performance in the TIMSS 2003, if Ghana has adopted the Japanese "Lesson Study" as their main INSET activities, it might have been a step in the right direction. A lesson is like a 'swiftly flowing river' and to enjoy the full benefit, there is the need to make basic changes in the approach to teaching from 'teaching as telling' to 'teaching for understanding'.

The low performance at the Basic School level is a worry to all stakeholders of education in Ghana. This compelled the then Minister of Education in 2009, Hon. Betty Mould Idrisu to institute the '2-2-6 extra classes plan' for all Basic Schools in the country. That is, all basic schools in the country will have two (2) hours teaching before and after normal classes from Monday to Friday and six (6) hours of teaching on Saturday.

Even though the practice of extra classes for students preparing for examination intensified throughout the country from 1986, the performance of the students in the BECE did not reflect any gain by this extra effort on the part of the students to improve themselves (Eshun, 1999).

In Ghana, Mathematics plays a critical role in selection of students for higher Education and in accessing a wide range of occupations and therefore must be treated with all seriousness. Lamb (1997) opined that the social differences in mathematics participation

were associated with different attitudes towards mathematics. He added that girls from upper middle class viewed mathematics as an interesting subject.

Mathematics has always held a key position in the school curriculum because it is considered as knowledge indispensable to the educated man. The increasing dependence of scientific thoughts and of almost every career-professional skilled and semi-skilled on mathematical methods has made the subject indispensable to man. Mathematics is an intellectual tool, which is indispensable in most branches of knowledge such as Physics, Chemistry, Geography, Engineering, Biology, Agriculture, Medicine, Statistics, Economics and other Social Sciences. This perception of the usefulness of mathematics arises from the fact that mathematics provides a means of communication which is powerful.

The purpose of the Mathematics classroom is for the teacher to help the students acquire mathematical proficiency by allowing the students to acquire as much experience of independent work as possible. This could be done through Problem-Solving Approach (PSA) to the teaching and learning of Mathematics. This provokes learners critical thinking to solve problems.

My experiences as a teacher also revealed that, mathematically proficient students:

- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Model situations using Mathematical tools
- Use appropriate tools strategically

- Look for and make use of structures
- Look for and express regularity in repeated reasoning.

Problem solving is stated as part of the objectives in the Basic Education curriculum. According to Ministry of Education syllabus MOE (2010), mathematical knowledge is to foster mathematical thinking and creativity in students and develop their abilities in applying Mathematics to solve real life problems. It further states that Problem solving and application has not been made a topic by itself in the syllabus since nearly all topics include solving word problems as activities. It is hoped that teachers and textbook developers will incorporate appropriate problems that will require Mathematical thinking rather than mere recall and use of standard algorithms (MOE, 2010). This was again emphasized in 2012 syllabus as follows;

> *"The learning of mathematics at all levels involves more than just the basic acquisition of concepts and skills. It involves, more importantly, an understanding of the underlying mathematical thinking, general strategies of problem solving. The strong mathematical competencies developed at the J.H.S. level are necessary requirements for effective study in mathematics, science, commerce, industry and a variety of other professions and vocations for pupils terminating their education at the J.H.S level as well as for those continuing into tertiary education and beyond (*(MOE, 2012 pg iii)*"*

In Ghana, JHS students sit for the Basic Education Certificate Examination (BECE) which is organised by West Africa Examination Council (WAEC). This examination assesses students' mathematical knowledge including problem-solving skills. The assessment used is usually in two forms; multiple choice and essay type. Gronlund and Linn (1990) stated

that the multiple choice format does have limitations. It is limited to learning outcomes at the higher order thinking level. The multiple-choice item measures whether the student knows or understands what to do when faced with a problem, but it cannot determine how the student actually performs in that situation. The multiple choice-items require the student to select the correct answer from some distracters, but do not reflect the problem-solving skills and procedures applied by the student. The rubrics for the essay type in Mathematics do not also reflect the problem-solving skills of students. This shows that both formats are not well structured to measure the problem-solving skills of Ghanaian JHS students. Therefore there is the need for an alternative assessment that will inform teachers about students' problem-solving skills.

There are many research works which focus on enhancing problem-solving skills of students in Ghana. Okpoti (2004) investigated the approach some class five pupils used to solve problems in subtraction, and Mereku and Cofie (2008) focused on the language used for teaching and learning as a barrier to problem-solving. However, the problem of assessing problem-solving skills of Ghanaian students remains unattended to. The question that remains unanswered is that, what methods do teachers use or do teachers use Problem-Solving Approach (PSA) in teaching Ghanaian students, especially mathematics?

1.2 Statement of the Problem

In Ghana, although several Mathematics researchers have focused on investigating how to enhance students' problem-solving skills, the situation remains unchanged. The National Criteria Reference Test (CRT-2009) results show poor performance of Ghanaian primary school pupils in Mathematics (GES, 2009). Trends in International Mathematics and Science Study (TIMSS) 2003 and 2007 also revealed poor performance of JHS students in

Science and Mathematics. In Mathematics, only 9% and 2% of the student reached the low and intermediate benchmarks respectively and students of Kwahu West Municipal are no exception. The results of Basic Education Certificate Examination (BECE) organized by West Africa Examination Council (WAEC) also show poor performance in the core subjects especially, Mathematics. The issue at stake is; what are the factors responsible for the poor performance in Mathematics of Basic School students in the Kwahu West Municipality and Ghana as a whole?

There is the need for Ghanaian teachers to develop a mechanism to teach and assess the students since the results obtained by students in Basic Education Certificate Examination (BECE) is not enough to inform teachers about the problem-solving skills of Basic school students.

Studies have shown that students are not able to solve non-routine mathematical problems (TIMSS, 2003 and 2007) and that problem-solving is unpopular among Ghanaian students (Mereku, 1998). The most frequently used strategy in Mathematics classrooms is the teacher-centred approach (Ottevanger, Van den Akker & de Feiter, 2007). Such teacher-centred instructional method was criticized for failing to prepare students to attain high levels of achievement in Mathematics (Hartsel, Herron, Fang, & Rathod, 2009).

Therefore, the need for the use of constructivism approach to surmount these challenges, hence this study.

1.3 Significance of the Study

The findings would encourage Basic school teachers to have self-motivation to work harder and prepare their students to deal with the special problems they would face in their careers.

It would also motivate teachers in Basic Schools to vary their teaching methods by adopting Problem-Solving Approach (PSA) in their teaching to make students mathematically proficient and problem solvers.

The results of the study would serve as a guide to policy makers and contribute immensely to additional knowledge of in-service teachers.

1.4 Purpose of the Study

The Purpose of this study is to find out the effective use of Problem-Solving Approach (PSA) in the teaching and learning of Mathematics at the basic school level.

1.5 Objectives of the Study

The study intends to:

- Investigate how teachers understand and use Problem-Solving Approach(PSA) in the teaching of Mathematics
- Determine factors responsible for Basic School teachers' failure to use Problem-Solving Approach (PSA) in the teaching of Mathematics.
- Find out the support teachers need to implement Problem-Solving Approach (PSA) to the teaching of Mathematics in Ghanaian classrooms.

1.6 Research Questions

The study was designed to answer the following questions:

1. How do teachers understand and use Problem-Solving Approach (PSA) in the teaching of Mathematics?

2. What factors are responsible for teachers' failure to use Problem-Solving Approach (PSA) in the teaching of Mathematics?

3. What support do teachers need to implement Problem-Solving Approach (PSA) in the teaching of Mathematics in Ghanaian Basic Schools?

1.7 Limitation of the Study

Financial and time constraints restricted the researcher from involving more districts or circuits as more Circuit Supervisors and teachers in the study would have given a better description of the methods used in teaching Mathematics in Ghanaian Basic Schools.

If more Circuit Supervisors and teachers were involved in the study, their contributions based on their experiences would have given better solutions or suggestions to the solving of the problem.

1.8 Delimitation of the Study

The scope of this study is limited to the use of Problem-Solving Approach (PSA) to the teaching of Mathematics in the Kwahu West Municipality. Ideally the study should have covered all the Districts/Municipalities in Ghana and even extended to other subjects but it has been limited to only one Municipality in the Eastern Region. The findings, conclusions and recommendations could however be applicable to contemporary situations with similar educational and social backgrounds. However the result cannot be used to take decisions for the whole of Ghana.

1.9 Organization of the Study

The study is organized into five chapters. Chapter One discusses the introduction, background to the study, statement of the problem, objectives of the study, research

questions, purpose of the study, significance of the study among other aspects. Chapter Two reviews some relevant literature related to this study and discusses the theoretical framework. Chapter Three describes the research methodology, which includes research design, population, sampling and sampling techniques, instrumentation, procedures for gathering data and data analysis. Chapter Four comprises presentation of results and discussion of major findings and chapter five looks at the summary, conclusions and recommendations, implication for practice and areas for further research.

1.10 Definition of Terms

For the purpose of this study;

- PSA stands for Problem-Solving Approach
- Problem-Solving Approach to teaching is defined as engaging learners in an activity for which the solution method is not known to them (learners).
- Lesson Study is where groups of teachers meet regularly over a long period of time to work on the design, implementation, testing, and improvement of one or several "Research lessons"
- Teacher collectives are "groups of teachers, either in the same school or in nearby areas, that regularly come together to solve problems, share ideas, discuss pedagogy, plan lessons, and reflect collaboratively about teaching and learning"
- MoE stands for Ministry of Education
- INSET stands for In-Service Training
- CBI – Cluster Based INSET
- SBI – School Based INSET

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter is a review of literature on problem-solving approach which is the focus of this study. Problem-solving approach will be defined with emphasis on its distinctive elements and proposed as an alternative approach for teaching and learning of Mathematics.

The related literature is reviewed under the following headings;

- Theoretical framework for the study
- Problem-solving approach
- Problem-solving approach to the teaching and learning of Mathematics
- Challenges of Teaching Through Problem-solving

- Benefits of problem-solving approach
- Ways of promoting problem-solving in Mathematics instructions
- Implementation of Problem-solving Approach in Ghanaian Classrooms
- The Mathematics Teacher
- Summary

2.1 Theoretical Framework for the Study

The theoretical support comes from both constructivist and sociocultural perspectives of learning (Hiebert, Fusson, Murray, Wearne, Fennema and Carpenter 1997). Constructivism is an epistemology, or a theory used to explain how people know what they know. The basic idea is that problem-solving is at the heart of learning, thinking, and development. As people solve problems and discover the consequences of their actions through reflecting on past and immediate experiences, they construct their own understanding. Learning is thus an active process that requires a change in the learner. This is achieved through the activities the learner engages in, including the consequences of those activities, and through reflection. People only deeply understand what they have constructed.

Constructivism has been used as a referent to build a classroom that maximizes student learning, whereby a teacher takes account of what learners know and maximizes social interaction between learners such that they can negotiate meaning and provides a variety of sensory experiences from which learning is built. Accordingly knowledge is personally constructed but socially mediated and from the outset, an individual constructs knowledge with the influence of others. This study draws its theoretical underpinning from constructivism as proposed by Tobin (1993).

Constructivists believe that prior knowledge impacts the learning process. In trying to solve novel problems, perceptual or conceptual similarities between existing knowledge and a new problem can remind people of what they already know. This is often one's first approach towards solving novel problems. Information not connected with a learner's prior experiences will be quickly forgotten. In short, the learner must actively construct new information into his or her existing mental framework for meaningful learning to occur.

A constructively oriented curriculum presents an emerging agenda based on what children know, what they are puzzled by, and the teachers' learning goals. Thus, an important part of a constructivist-oriented curriculum should be the negotiation of meaning. According to Lampert (1986), a Mathematics teacher, guides students to make sense of Mathematics by comparing and resolving discrepancies between what they know and what seems to be implied by new experience.

In constructivist classrooms, curriculum is generally a process of digging deeper and deeper into big ideas, rather than presenting a breadth of coverage. As students pursue questions, they derive new and more complex questions to be investigated. Building useful knowledge structures requires effortful and purposeful activity over an extended period. Constructivists tend to celebrate complexity and multiple perspectives, though they do share at least a few educational prescriptions.

The teacher's role in a constructivist classroom is not so much to lecture at students but to act as an expert learner who can guide students into adopting cognitive strategies such as self-testing, articulating understanding, asking probing questions, and reflection. The role of the teacher in constructivist classrooms is to organize information around big ideas that

engage the students' interest, to assist students in developing new insights, and to connect them with their previous learning. The activities are student-centred, and students are encouraged to ask their own questions, carry out their own experiments, make their own analogies, and come to their own conclusions. Becoming a constructivist teacher may prove a difficult transformation. However, since most instructors have been prepared for teaching in the traditional, objectivist manner (Brooks and Brooks, 1993) observed that it requires a paradigm shift, as well as the willing abandonment of familiar perspectives and practices and the adoption of new ones.

A constructivist approach to education is widely accepted by most researchers, though not by all. Carl Bereiter argues that constructivism in schools is usually reduced to project based learning (Bereiter, 2002), and John Anderson, Lynn Reder, and Herbert Simon claim that constructivism advocates very inefficient learning and assessment procedures. In any event, the reality is that constructivism is rarely practiced in school (Anderson, Reder and Herbert, 1996).

2.2 Problem-Solving Approach

Problem

A problem occurs when a situation is in a given state and the problem solver wants the situation to be in a goal state but is not aware of an obvious way to transform the situation from the given state to goal state. When the individual is confronted with a situation that is for him/her contradictory, containing obstructions that have to be overcome in order to achieve the aim, or the human being experience various difficulties, it is desirable to apply

the thought processes enabling generating of knowledge necessary for a successful removal of the obstructions.

According to a leading Gestalt psychologist Duncker (1945), a problem arises when a living creature has a goal but does not know how this goal is to be reached. Whenever one cannot move from the given situation to the desired situation simply by action, then there has to be recourse to thinking. Such thinking has the task of devising some action which may mediate between the existing and the desired situation.

These problematic situations are possible to be assessed in terms of statics and dynamics. The changeability of the complex of the conditions that determined the creation and specifics of the problem in time is determinable. Problem-solving is more advantageous when the conditions are stable which is called static problematic situation. Dynamic problematic condition occurs when there is change in conditions that determines the creation and specifics of the problem in time.

The conditions can change because of various influences. The consideration of the influences acting in time and their control is an assumption for successful problem-solving process in those situations. The dynamics does not have to be in the context of problem-solving understood as negative, it can also operate positively (Klieme, 2004), (Wirth & Klieme, 2004) and (Blech & Funke, 2010).

Problem-Solving

The thinking of an individual begins with the awareness of the problematic situation which has the potential to grow into a problem that deserves a solution. When an individual perceives a problem, the willingness to deal with the problem is essential but it does not

mean he/she is going to be willing to solve it. Mayer and Wittrock (2006) averred that problem-solving is a personal and aimed process which means that activities done by individual during the problem-solving process are led to his/her personal aim. The individual has to identify the problem first and then seek for possible solutions. Funke (2010) also opined that in problem-solving, the person's initial knowledge of the problem are the conditions (the given state) and the operations are permissible activities that can be performed in order to achieve the required final state (result).

Polya's Problem-Solving Model

Four steps were identified in Polya's problem solving model (1945):

- Understanding the Problem
- Devising a plan
- Carrying out the plan and
- Looking back.

Problem-solving is "cognitive processing directed at achieving a goal when no solution method is obvious to the problem-solver" (Mayer & Wittrock, 2006, p. 287). This definition consists of four (4) parts:

1. Problem-solving is cognitive which occurs within the problem-solver's cognitive system and can only be inferred from the problem-solver's behavior.

2. Problem-solving is a process which involves applying cognitive processes to cognitive representations in the problem-solver's cognitive system.
3. Problem-solving is directed which is guided by the problem-solver's goal.
4. Problem-solving is personal which depends on the knowledge and skills of the problem-solver.

Problem-solving can also be seen as cognitive process directed at transforming a problem from a given state to the goal state when the problem solver is not immediately aware of the solution method. Problem-solving is fundamental to education because educators are interested in improving students' ability to solve problems especially helping students learn in ways that enable them to use what they have learned to solve problems in new situations.

Problem-Solving as a Kind of Thinking

Terms such as reasoning, decision making and thinking (critical thinking and creative thinking) are subsets of problem-solving. Thinking refers to the problem-solver's cognitive processes which includes directed thinking (problem-solving) and undirected (daydreaming). Reasoning, decision making, critical thinking and creative thinking are all forms of problem-solving.

Reasoning refers to problem-solving with specific task in which the goal is to draw a conclusion from premises using logical rules based on deduction or induction. For instance if even numbers are counting numbers divisible by 2 and 8, 10 and 12 are all divisible by 2 then, using deduction one can conclude that 8, 10 and 12 are all even numbers. Also given the sequence 1, 4, 9, 16, by induction one can conclude that the next number is 25.

Decision making also refers to problem-solving with a specific task in which the goal is to select one from two or more alternatives based on a given criteria. A decision making task is to decide whether someone would rather have GH¢100.00 for sure or a 1% chance of getting GH¢100,000.00.

Creative thinking and Critical thinking refers to specific aspects of problem-solving. Creative thinking involves generating alternatives that meet some criteria whereas critical thinking involves evaluating how well various alternatives meet some criteria. Creative thinking is involved in generating hypotheses and critical thinking is involved in testing them. Both creative thinking and critical thinking can be involved in reasoning and decision making.

Theories of Problem-solving

Gestalt Theory:

According to Duncker (1945), Gestalt's theory of Problem-solving occurs with a flash of insight and insight occurs when a problem-solver moves from a state of not knowing how to solve a problem to knowing how to solve a problem. Problem-solvers devise ways of representing the problem that enables solution and conceptualize what happens during insight. It also involves building a schema in which all the parts fit together, reorganizing the visual information to fit together suddenly to solve the problem, restarting a problem's givens or problem goal in a new way that makes the problem easier to solve, removing mental blocks and finding a problem analog (a similar problem that the problem-solver already knows how to solve). Gestalt theory informs educational programs aimed at teaching students how to represent problems.

Information Processing Theory:

Nelwell and Herbert (1972) opined that the information processing theory of problem-solving is based on a human-computer metaphor in which problem-solving involves carrying a series of mental computations on mental representations. The key components in the theory are:

- The idea that the problem can be represented as a problem space
- A presentation of the initial state, goal state, and all possible intervening states
- Search heuristic
- A strategy for moving through the problem space from one state of the problem to the next.

The problem begins in a given state, the problem-solver applies an operator that generates a new state until the goal state is reached.

There are instructional methods that are intended to promote problem-solving transfer. However, a more direct approach is to teach people the knowledge and skills they need to be better problem-solvers. In designing problem-solving course, Mayer (2008) identified four issues;

What to teach

Although conventional wisdom is that problem-solving is a single skill, research in cognitive science suggests that problem ability is a collection of small component skills

How to teach

It makes sense that students need to practice in getting the right answer but research in cognitive science suggests that students benefit from training in describing and evaluating

the method used to solve the problems. For instance, one technique that emphasises the process of problem-solving is modeling in which teachers and students demonstrate their problem-solving methods.

Where to teach

Although conditional wisdom is that students should be taught general skills in stand-alone courses, there is sufficient cognitive science research to propose that it would be effective to teach problem-solving within the context of specific subject domains.

When to teach

Although it seems to make sense that higher-order thinking skills should be taught only after lower-level skills have been mastered, there is sufficient cognitive science research to propose that it would be effective to teach higher-order skills before lower-level skills are mastered.

2.3 Problem-Solving Approach to the Teaching and Learning of Mathematics

Problem-solving means engaging in a task for which the solution method is not known in advance. It encompasses a multitude of routine and commonplace as well as non-routine functions considered to be essential to the day-to-day living of every citizen but must also prepare individuals to deal with the routine problems they will face in their individual careers. When researchers use the term problem-solving in Mathematics, they are referring to mathematical tasks that have the potential to provide intellectual challenges for enhancing students' mathematical understanding and development, promote students' conceptual understanding, foster their ability to reason and communicate mathematically,

and capture their interest and curiosity (National Council of Teachers of Mathematics (NCTM), 2010).

Polya's Problem-Solving Model

Four steps were identified in Polya's problem-solving model (1985):

- Understanding the Problem
- Devising a plan
- Carrying out the plan
- Looking back.

Based on the above model, learners at all levels of education can be taught through Problem-Solving Approach (PSA) in Mathematics. The steps in PSA to teaching especially Mathematics could be reviewed to suit our environment as follows;

1. Reviewing the Relevant Previous Knowledge (RPK)
2. Presenting the problem for the day.
3. Students working individually or in groups.
4. Discussing solution methods.
5. Highlighting and summarizing the major points

2.3.1 Teachers' Conceptions of Problem-Solving

Teachers have varied conceptions of problem-solving and have their classroom practices influenced by these conceptions. Saleh (2009) in a study of problem-solving schemes of secondary school Mathematics teachers reported that teachers' conceived mathematics problem-solving as difficult word questions, which are challenging and normally related

to everyday life problems. It also involves manipulations of numbers and symbols and requires the use of multiple skills and strategies.

Van de Walle (2004) described problem-solving as a principal instructional strategy used to fully engage students in important Mathematics learning situation. It also goes beyond the domain of Mathematics to include everyday life activities in general. Anderson, Sullivan and White (2004) described problem-solving as the process by which students explore non-routine questions. The explorations involve using a wide range of strategies to solve unfamiliar tasks, as well as developing the processes of analyzing, reasoning, generalizing and abstracting. In the exploration process students make mistakes and backtrack. Making mistakes and backtracking is a natural part of problem-solving. Henderson (2002) supported this assertion by saying that some teachers have the conception that making mistakes and having to backtrack them is a natural part of problem-solving. He added that teaching Mathematics through problem-solving is not logical but involves trial and error.

Traiton and Midgett (2001) asserted that problem-solving is a vehicle by which students make sense of Mathematics and learn content, skills and strategies and that when students learn Mathematics through problem-solving they understand better in both content and pedagogy and make meaning of the reasons behind the solution process. According to Goldberg (2003), mathematical problem-solving involves the ability to read, process and solve mathematical situations.

Problem-solving, according to the Principles and Standards for School Mathematics (NCTM, 2000), is getting involved in a task for which there is no immediate answer. The

same conception has appeared in many studies at different times (Hiebert, 2003).The researcher is therefore of the view that teachers' conception of problem-solving is based on 'one answer, many ways'.

2.3.2 Problem solving Approaches

Three problem-solving approaches to the teaching of Mathematics have been identified in problem-solving literature. They are: teaching for problem-solving, teaching about problem-solving and teaching through problem-solving (Anderson, 2000). Each of these approaches has implications for the types of activities and strategies that might be presented to students in Mathematics lessons.

All the three approaches involve the use of problem-solving strategies and heuristics. However, teaching through problem-solving treats problem-solving as a process of inquiry while both teaching for and about problem-solving treat problem-solving as an object of inquiry. It has been argued that there is a place for all the three approaches in teaching Mathematics, although teaching through problem-solving is considered the most appropriate. Schroeder and Lester (1989) also emphasised that all the three approaches have value but that teachers should be aware of the shortcomings of teaching for and about problem-solving approaches if used in isolation. They argued that when teaching for problem-solving, problems can be reduced to applications of recently learned concepts and may not require deep mathematical thinking by students. Also, they indicated that teaching about problem-solving can lead to problem-solving being treated as another topic in the curriculum. They recommended that teaching through problem-solving is most likely to promote understanding.

Teaching for Problem-Solving

Teaching for problem-solving involves students learning mathematical content so that they can apply it to solve problems related to that content area (Foong, 2002).

In this approach, teachers provide students with the necessary skills, and knowledge needed to solve mathematical problems. Problems are usually related to the mathematical content just studied and students are provided with a variety of applications in which that Mathematics may be used (Anderson, 2000). In teaching for problem-solving, emphasis is placed on learning Mathematics for the main purpose of applying it to solve problems in a wide range of situations after learning a particular topic (Foong, 2002). This approach is often associated with closed ended problems in terms of clearly formulated tasks where the one correct answer can always be determined in fixed ways from the necessary data given in the problem situation. These closed ended problems would include content, specific routine, multiple-step problems as well as non-routine heuristic-based problems (Foong, 2002).

Teaching about Problem-Solving

Teaching about problem-solving includes guidance about the problem-solving process and instruction about a variety of problem-solving strategies. It often includes the recommendations of Polya (1985) problem-solving strategy. When teaching about problem-solving students learn to use variety of problem-solving strategies or heuristics, such as make a list, draw a diagram, act it out, solve a similar problem and guess and check (Anderson, 2000). In teaching about problem-solving the emphasis is on using heuristic strategies to approach and solve unfamiliar problems that are usually not domain-specific

to any topics in the syllabus. It involves using non-routine problems to teach thinking skills and problem-solving heuristics (Foong, 2002).

Teaching through Problem-Solving

In this approach problems are used as vehicle for learning Mathematics. Teaching through Problem-Solving Approach (PSA) focuses more on students' understanding of concepts.

In this approach, an attempt is made to make sense of mathematical procedures needed to solve a problem as such; students are engaged in doing Mathematics (Foong, 2002). This approach makes problem-solving a means rather than an end. Teaching through problem-solving starts with a problem, teachers pose problems to challenge students' knowledge thus providing a need for the students to organise their understanding in order to resolve the problem (Anderson, 2000). Students learn and understand important aspects of the concept or idea by exploring the problem situation (Cai, 2003). This often involves more open-ended problems that allow multiple correct answers and multiple solution approaches. In teaching through problem-solving, problems not only form the organizational focus and stimulus for students' learning, but they also serve as a vehicle for mathematical exploration (Cai, 2003). Students play a very active role in their learning by exploring problem situations with teacher guidance and "inventing" their own solution strategies. In fact, the students' own exploration of the problem is an essential component in teaching through problem-solving.

In teaching through problem-solving, learning takes place during the process of problem-solving. As students solve problems, they use any approach they think of, draw on any piece of knowledge they have learned, and justify their ideas in ways they feel are

convincing (Cai, 2003). The learning environment of teaching through problem-solving provides a natural setting for students to present various solutions to their group or class and learn Mathematics through social interactions, meaningful negotiation, and reaching shared understanding (Cai, 2003). Such activities help students to clarify their ideas and to acquire different perspectives of the concept or idea they are learning. Teaching through problem-solving as noted by Corte (2000) is more process and strategy-oriented than product-oriented. According to Baki (2004), teaching through problem-solving involves creating an environment where students can discuss their views on a problem and explain their methods of inquiry and generalizations to their classmates. Van de walle (2004) on his part explained that teaching through problem-solving requires students to read a problem carefully, analyze it for whatever information it has, and then examine their own mathematical knowledge to see if they can come up with a strategy that will help them find a solution. This process forces the reorganization of existing ideas and the emergence of new ones as students work on problems with the help of a teacher who acts as a facilitator by asking questions that will help students to review their knowledge and construct new connections.

Instead of the teacher being the sole source of knowledge and solutions, he/she creates a classroom climate and culture that encourages and facilitates pupils own initiatives and stimulates interactive and collaborative problem-solving (Corte, 2000).

Norton, McRobbie and Cooper (2002) see the teaching of Mathematics through problem-solving as an approach in which teachers see themselves as guides, listeners, and observers rather than authorities and dispensers of knowledge and information. However, teaching Mathematics through problem-solving is a relatively new idea in the history of problem-

solving in the Mathematics curriculum (Cai, 2003). In fact, because teaching through problem-solving is a new concept, it has not been the subject of much research in Ghana.

2.3.3 Problem-Solving Approach to teaching and Lesson Study

Japan has been doing so well in the TIMSS since its inception because they have adopted Problem-Solving Approach (PSA) to teaching all subjects at all levels. They have institutionalized INSET activities called Lesson Study which ensures teacher continuous professional development and all stakeholders of education are committed to its success. Lesson Study is where groups of teachers meet regularly over a long period of time to work on the design, implementation, testing, and improvement of one or several "Research lessons". It is an authentic empowering approach to teacher-centred continuous professional development.

Japanese PSA, Known as the Process through "posing a problem", 'independent solving', 'comparison and discussions', and 'summary and application' was known in the United States of America through comparative study on Problem-Solving in the 80s by Tatsuro Miwa and Jerry Becker. It influenced the world through the TIMSS video in the 90s (Stigler & Hiebert, 1999).

Considering Ghanaian JHS 2 students' performance in the TIMSS 2003 and 2007, there is the need to make basic changes in the approach to teaching from "teaching as telling" to "teaching for understanding".

2.4 Challenges of Teaching Mathematics through Problem-solving

Although Polya (1985) presented the inquiry-based framework for teaching through problem-solving more than 60 years ago, there is yet to be widespread implementation of

his ideas in Ghanaian classrooms. This suggests that there are a number of challenges to making this shift in Mathematics teaching. Challenges of teaching Mathematics through problem-solving discussed in the research literature can be grouped into three broad categories. These are problems relating to: the teachers, the students and the school curriculum.

Challenges related to teachers

Basic School Mathematics teachers are trained as generalists and often do not have strong Mathematics background required to use problem-solving strategies in teaching. As generalist teachers, they may not possess enough knowledge to anticipate anything other than limited curricular objectives or teaching styles and hence may be handicapped in realising a problem-solving orientation (Xenofontos, 2007). This phenomenon may lead to teachers not being equipped in both content knowledge and pedagogical knowledge to teach mathematics using problem-solving strategies.

Xenofontos (2007) further added that the use of problem-solving approaches demands both extensive preparation and development of ways that will maintain at least a modicum of classroom control and, perhaps most importantly, the ability to anticipate the goals of Mathematics teaching in the light of such an orientation.

In a research study into the language problem in problem-solving in Basic School Mathematics, Mereku (1998), observed that problem-solving is unpopular in Basic Schools in Ghana because many teachers do not know how to introduce it in the classroom; they cannot solve problems themselves; and they cannot explain why students find problem-

solving so difficult to learn. He further emphasized that teachers find it difficult to teach problem-solving.

McIntosh, Jarrett and Peixotto (2000) stated that teaching Mathematics through problem-solving is difficult among teachers because they have inadequate subject matter knowledge, pedagogical knowledge, and personal problems. In addition, they lack the mathematical expertise to understand different approaches that students might use to solve a problem and to identify promising problem-solving approaches. However, they often provide strong rationale for not including problem-solving activities in their Mathematics instructions to include:

- it takes too much time to teach
- it is too demanding
- it is also not measured and tested in public examinations.

The authors also observed that teachers are generally expected to cover large areas of Mathematics content and yet problem-solving takes too much time to teach. Consequently, many teachers tend to feel unprepared to use problem-solving approach to teach Mathematics. Moreover, teachers often find it difficult watching their students struggle with frustration in problem-solving situations as regards to when to give hints and to intervene.

Mathematical knowledge for teaching is an essential ingredient for effective teaching (Ball & Bass 2000). Meanwhile, some teachers lack the requisite knowledge, skills and expertise for teaching Mathematics through problem-solving (Anderson, 2000). Lack of Mathematical knowledge for teaching reduces teachers' confidence in teaching

Mathematics through problem-solving. Such teachers rely on the traditional methods where students memorize rules to the detriment of teaching students to construct meaningful knowledge through problem-solving. Also little ownership of Mathematics content of the curriculum among teachers does not encourage teachers to practice problem-solving (Anderson, Sullivan & White, 2004).

Mathematics teachers seem to be more confident in teaching methods which they themselves had experienced in their school life (Saleh, 2009) and for that matter teachers who do not experience problem-solving method in their professional training tend not to emphasize problem-solving approaches in teaching. Taplin (1998) stated that even though problem-solving is emphasized in the Mathematics curriculum all over the world, teachers still do not know how best to teach problem-solving skills. In fact, there are still many difficulties associated with teaching students how to succeed in problem-solving. Teachers shun teaching problem-solving because they are uncomfortable with their own problem-solving skills (Ellison, 2009). For instance, teachers felt inadequate about their own teaching approaches to problem-solving, especially with non-routine problems. They were also concerned about their ability to communicate new concepts to their students to understand using the varied methods suggested in the curriculum reforms. Ellison further indicated that several teachers have expressed concerns about their ability to think of the right question at the right time in order to engage students in discussions when using problem-solving approach to teach the prescribed content of the Mathematics curriculum.

Teachers' beliefs inform their classroom practices and decisions. For instance, the general belief that Mathematics is a formal body of knowledge and should be presented to students in a formal way is a major constraint to teachers who wish to teach Mathematics using

problem-solving approaches (Anderson, Sullivan & White, 2004). Other teachers believe more in classroom management as compare to pedagogical or instructional considerations (Zanzali, 2003). These categories of teachers believed that the best way to learn Mathematics is doing routine problems repeatedly, while students sit down quietly and listen to what they say (Zanzali, 2003).

Anderson (2000) asserted that parents' expectations in terms of examinations results put pressure on teachers to teach for examination instead of adopting problem-solving strategies to teach for conceptual understanding. In Ghana, it is common to see teachers teaching according to examination syllabus to the detriment of teaching for conceptual understanding which is the benchmark of problem-solving.

The non-linearity and unpredictability nature of problem-solving may cause some teachers to resist the introduction of problem-solving in the Mathematics classroom. Burton (2002) propounded that uncertainty implicit in problem-solving is an obstacle to its use in teaching Mathematics. Further contrasts are found in the variety of approaches that students can employ to solve a Mathematical problem (Burton, 2002) and the multiplicity of methods of solutions that are often available for a given problem. If teachers are not pedagogically sound to face the challenge of discriminating among multiple strategies that students will use to solve Mathematical problems, they prefer to avoid it.

Teaching non-routine problem-solving is difficult. True problem-solving is as demanding on the teacher as it is on the students. The art of teaching mathematical problem-solving is best mastered over a long period of time (Thompson, 1989). Teaching problem-solving is difficult, writes (Schoenfeld, 1992). Teachers:

- Must perceive the implications of students' different approaches, whether they may be fruitful and, if not, what might make them so.
- Must decide when to intervene, and what suggestions will help the students while leaving the solution essentially in their hands, and carry this through for each student.
- Will at times be in the position of not knowing; to work well without knowing all the answers requires experience, confidence, and self-awareness.

Schoenfeld (1992) states even more succinctly that teaching problem-solving is difficult for teachers mathematically, pedagogically, and personally.

Teachers must have the mathematical expertise to understand the different approaches that students might take to a problem and how promising those approaches will be. Pedagogically, teachers must make complex decisions about the level of difficulty of the problems assigned, when to give help, and how to give assistance that supports students' success while ensuring that they retain ownership of their solution strategies. Personally, teachers will sometimes find themselves in the uncomfortable position of not knowing the solution. Letting go of the "expert" role teachers have traditionally played requires experience, confidence, and self-awareness. Often, teachers are asked to teach Mathematics they never encountered in school and in a way that differs from how they were taught. For these reasons, teachers may need additional training in mathematical content and theory, as well as in methods for teaching problem-solving.

Challenges related to students

Non-routine, open-ended problems are often, by their nature, difficult for many students. Shannon and Zawojewski (1995) conducted a mini-study that demonstrated the difficulty

presenting problem-solving tasks without providing hints and procedural steps poses to students. Watching students struggle in frustration is often very difficult for teachers. Knowing when to give hints and how much help to give requires striking a delicate balance that comes with experience and knowing students' capabilities.

Dollah (2006), asserted that student's willingness to accept a challenging problem is seen as important part of problem-solving. In problem-solving, whether a task at hand is difficult or not does not necessarily matter, as long as the student accepts it as a challenge. Student accepting a challenge here implies that the student is willing to find appropriate methods to solve the problem.

Henderson (2002) in the study of Faculty conceptions about the teaching and learning of problem-solving in introductory calculus-based physics described students' knowledge and skills related to problem-solving as being poor. Meanwhile a study conducted by Adesoji, (2008) shows that students with high ability level understand problem-solving better. It is therefore, relatively easy to teach such students Mathematics using problem-solving. However, those with low ability could also perfect their problem-solving skills if they are exposed to problem-solving instructional strategy. Saleh (2009) in a research study confirmed students' knowledge base as a determinant in teaching Mathematics through problem-solving and concluded that problem-solving is not good for students with low ability. Students' inability to read and comprehend poses yet another problem to teachers when teaching Mathematics using problem-solving strategies. (Flecher & Santoli 2003) mentioned that the vocabulary of Mathematics is not usually taught in schools and if students are not reading good textbooks, then they have no place to understand Mathematics terms. It is therefore crucial to emphasize vocabulary instruction as part of

Mathematics programmes if students have to learn Mathematics through problem-solving entirely.

Anderson (2000) also found that students are sometimes so tuned to some laid down procedures in solving mathematical problems. Such students resist teacher's initiatives or plans to adopt problem-solving approaches of teaching Mathematics. They prefer to be told Mathematics rather than to be guided by the teacher to explore and construct their own understanding. He also found that diversity in classrooms, students' comprehension of language and their attitudes and beliefs towards Mathematics are potential factors militating against the implementation of problem-solving Mathematics curriculum.

Challenges related to the school curricular

Teachers are generally expected to cover large areas of content each year. Yet solving challenging, non-routine problems takes time, often a single problem can occupy a class for a whole period or more. It is essential that content and skills be integrated within the context of problem-solving by selecting rich, engaging, and worthwhile tasks, teachers can ensure that time is well spent.

Anderson, Sullivan and White (2004) in their study of the influence of perceived constraints on teachers' problem-solving beliefs and practices, identified textbooks and assessments used in the school and the time schedule for Mathematics lessons as impediments to the teaching of Mathematics through problem-solving. Moreover, conservative teaching methods by other teachers in the school as well as parents' demands for preparation of their wards for competitive examinations were other factors identified as barriers to the implementation of problem-solving instructions in the Mathematics

classroom. McIntosh, Jarret and Peixotto (2000) in a review of literature on teaching Mathematics through problem-solving found that many textbooks do not provide adequate number of non-routine problems from which teachers can choose. This affects teachers' use of problem-solving methods of teaching Mathematics since they mostly rely on textbooks as their source of information. Ali, Hukamdad, Akhter and Khan (2010) in a study purported to investigate the effects of using problem-solving method on students' achievement in teaching Mathematics at elementary level, observed that traditional textbooks do not meet the criteria of problem-solving approach. This phenomenon of textbooks not presenting sufficient problem-solving questions has the possibility of preventing teachers from teaching Mathematics using problem-solving approaches.

Zanzali (2003) in a study to document constraints that teachers face in implementing the aspirations of the curriculum identified the influence of examination on what and how Mathematics should be taught to students as an impediment to teachers towards the use of problem-solving approach in teaching. Since the hallmark of a good teacher is to help students pass their examination and the trend of examination parallels teaching through problem-solving, its implementation in the classroom has become an issue of concern to teachers.

Saleh (2009) observed that, limited time for Mathematics lessons and problem-solving method not needed in answering examination questions were some of the reasons hindering the teaching of Mathematics through problem-solving. The teachers in the study believed that teaching of Mathematics through problem was time consuming.

As noted by Anderson (2000) the culture of a school can sometimes serve as a barrier to implementing new educational innovations. School programmes, Mathematics textbooks, streaming, assessment practices, staff attitudes and time are some of the constraints that the school can put against the implementation of Mathematics problem-solving. The culture of the school can hinder teacher's planning and approaches as a result of the prescribed curriculum practices as well as the traditional beliefs of other staff members. In the school, so many things compete for time. Among these are the mandatory school curriculum, the external assessment procedures and the workload in the school curriculum. However teachers believed that the teaching of problem-solving requires a lot of time and if time is not sufficient, it is better they resort to teaching Mathematics by telling.

Teachers expressed lack of resource materials available for teaching through problem-solving (Foong, Yap. & Koay, 1996)). Research literature has emphasized the importance of teaching through problem-solving and teaching of problem-solving skills to students, but pressure on teachers to increase examination scores of their students, makes them to stick to textbooks routine of teaching Mathematics instead of using problem-solving approaches (Traiton & Midgett, 2001).

Textbooks present few non-routine problems. Although these textbook writers are improving, many textbooks do not provide adequate number of problems from which teachers can choose. Many teachers are not comfortable straying from the scope and sequence the textbook provides, but must develop the confidence to search out and develop other materials to supplement their texts.

Language is also a problem to students because TIMSS 2003, 2007 and 2011 results showed clearly that countries that performed very well were those who used their local languages and PSA in the teaching and learning of Mathematics.

2.5 Benefits of Problem-Solving Approach

Empirically, teaching Mathematics through problem-solving helps students go beyond acquiring isolated ideas towards developing increasingly connected and complex systems of knowledge (Lambdin, 2003). Problem-solving approach to the teaching of Mathematics refers to mathematical tasks that have the potential to provide intellectual challenges that can enhance students' mathematical development. Such tasks or problems can promote students' conceptual understanding, foster their ability to reason and communicate mathematically, and capture their interests and curiosity (National Council of Teachers of Mathematics (NCTM), 2010). There are many reasons why problem-solving approach can contribute significantly to the outcomes of Mathematics education. These reasons include the following:

- It is a vehicle for developing logical thinking,
- It provides students with a context for learning mathematical knowledge
- It enhances transfer of skills to unfamiliar situations
- It is an aesthetic form in itself.
- A problem-solving approach can provide a vehicle for students to construct their own ideas about Mathematics and
- It helps students to take responsibility for their own learning.

Just to mention a few (Lambdin, 2003).

2.6 Ways of Promoting Problem-Solving in Mathematics Instructions

Reflection is critical to the professional growth of a teacher. This implies that practicing teachers should be provided the chance to reflect on their own teaching, if possible with others, concerning teaching Mathematics through problem-solving. Teachers particularly, need training and experience in problem development and mathematical content knowledge.

One effective way to help practicing teachers develop these skills is to create teacher collectives. Teacher collectives are "groups of teachers, either in the same school or in nearby areas, that regularly come together to solve problems, share ideas, discuss pedagogy, plan lessons, and reflect collaboratively about teaching and learning" (Institute for Advanced Study/Park City Mathematics Institute International Seminar (IAS/PCMIIS),(2006, p. 11).

Peer observation and team teaching are also effective ways of developing teachers' knowledge and skills in problem-solving (IAS/PCMIIS, 2006). Ali, Hukamdad, Akhter and Khan (2010) recommended organising extensive training programmes; seminars and workshops for Mathematics teachers in elementary schools to enable them employ problem-solving method in the classroom. They further suggested organising training sessions for untrained teachers to be trained in problem-solving.

They also proposed the transformation of textbooks of Mathematics into problem based learning forms. Since many teachers depend on textbooks as the major source of information for teaching, availability of problem-solving questions in Mathematics

textbooks will encourage them to teach Mathematics using problem-solving approaches (Ali et al, 2010).

Mural and Memnum (2010) asserted that the provision of a social constructivist learning environment and the content of instruction wiped out negative attitudes and beliefs students have about problem-solving. Beliefs such as mathematical problems have only one way of solving it, one correct answer therefore ordinary students can never solve an unusual problem correctly are removed from the minds of students.

Providing valuable resources and more time are important steps, in promoting the teaching of problem-solving. It is possible that problem-solving in the Mathematics curriculum will only become valued when it is included in high-stakes assessment. In addition, teachers need readily available examples of useful non-routine problems, particularly in textbooks (Anderson, 2010).

2.7 Implementation of Problem-Solving Approach in Ghanaian Basic Schools: Support from stakeholders of education

Accountability should be thought of as a collective responsibility for supporting learning by governments, Headteachers, Headmasters, parents, principals, school board members, and teachers, to say nothing of the students themselves. Holding teachers accountable for students' achievement without recognition of the roles played by these other partners in the educational process is patently unfair and can amount to scapegoating.

Ultimately, learning is a phenomenon that occurs as a result of the interactions between a teacher and student. Teachers cannot be solely responsible for student learning because it

is an internally controlled activity. However, teachers are expected to optimize the conditions for learning. It is what they were hired to do and it is their professional obligation. As Schalock (1998) noted, educator accountability for students' progress in learning goes hand-in-hand with the social contract that assigns responsibility for education to schools.

In Singapore where teachers place emphasis on Problem-Solving, they are entitled to 100 hours of in-service training each year" and professional development can take forms like conferences, workshops, regular collaborative meeting, networking and university partnership. This is very good and need to be replicated in other countries like Ghana. The "support of academic mentor" to assist teachers implement problem-solving or investigative approaches is a good thing because Stigler and Hiebert (1999) also averred that as a result of teachers challenges, several local theories of teaching were shared including 'Problem-Solving Approach' which has been known as the Japanese teaching Approach.

The researcher agrees with Anderson (2010) that a lot of teachers are scared to teach through Problem-Solving Approach because they are not sure themselves of what they should be telling the children to do and teachers themselves need to develop their competences in Problem-Solving processes and devise appropriate problem-solving strategies for their students.

According to Nicole, (2007), in mathematical problem-solving instruction, the five focuses that help teachers identified their main goals are to help students develop:

- Flexible understanding of mathematical concepts

- Confidence and eagerness to approach unknown situations
- Metacognitive skills
- Oral and written communication skills and
- Acceptance and exploration of multiple strategies

Creating opportunities for teacher to plan and learn to gain knowledge and confidence in teaching Mathematics through problem-solving is necessary. Teachers' efforts need to be supported by providing professional development that challenges commonly held beliefs but at the same time provide the resources for teachers to spend time investigating ways to implement new approaches. Increasing the level of support for teachers through appropriate learning experiences by National Teaching Council (NTC) is necessary.

2.8 The Mathematics Teacher

The purpose of the Mathematics classroom is for the teacher to help the students acquire Mathematical proficiency by allowing the students to acquire as much experience of independent work as possible. This could be done through Problem-Solving Approach (PSA) to the teaching of Mathematics which provokes learners critical thinking to solve problems. From my experience as a teacher, mathematically proficient students:

- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Model with Mathematics
- Use appropriate tools strategically

- Attend to precision
- Look for and make use of structures
- Look for and express regularity in repeated reasoning.

There is little doubt that the Mathematics programme can be enhanced by the establishment of an environment in which students are exposed to teaching through problem-solving, as opposed to more traditional models of teaching about problem-solving.

Researchers including (Cai, 2003), (Anderson, 2000), (Weber (2008), (Schoenfeld, 1992), (Zanzali, 2003), (Ellison, 2009), (Saleh, 2009), and (Anderson, 2010) agree that teachers' content knowledge influences student performance. Many studies support the notion that teachers who teach subjects that they have previously studied in depth (by earning a major or minor in the field while in college or earning first degree in the discipline) are particularly effective. However, first degrees in general-degrees that are not in the subject matter being taught have not been found to be associated with higher student achievement.

The challenge for teachers, at all levels, is to develop the process of mathematical thinking alongside the knowledge and to seek opportunities to present even routine Mathematics tasks in problem-solving contexts. Teachers need to attend workshops and INSET to share experiences and read materials to update their knowledge on the teaching and learning of Mathematics through problem-solving.

Research on problem-solving emphasizes the role of the teacher in developing students' reasoning skills (Weber 2008), "to lead students to develop accurate criteria for what constitutes good argument, the teacher must have a solid understanding of this criteria" (p. 431-459).

Teachers themselves need to develop competences in problem-solving processes and then through staff INSET and instructions, devise appropriate problem-solving strategies for their students. Anderson,(2010) stated that teachers do not use problem-solving in teaching Mathematics because of accountability with external examinations. The researcher do not support this view because Nicole (2007, p. 312) opined that "when teachers carefully choose task that require students to engage in Mathematical thinking and problem-solving and provoke students' thinking through questioning and encourage reflection and sense making, their students understand Mathematics better and attain higher levels of achievements" (pass examinations).

Research recommends that students should be exposed to truly problematic task so that mathematical sense making is practiced. NCTM (2010) indicated that teachers would have to choose, modify, revise and design non-routine problems for their Mathematics lessons so the following worthwhile-problem criteria have been recommended:

1. The problem has important and useful Mathematics embedded in it.
2. The problem requires high-level thinking and problem-solving.
3. The problem contributes to conceptual development of students.
4. The problem creates an opportunity for the teacher to assess what his or her students are learning and where they are experiencing difficulty (NCTM, 2010).

2.9 Summary

A growing body of research shows that student achievement is more heavily influenced by teacher quality than by students' class, prior academic record, or school a student attends. This effect is particularly strong among students from low-income families and rural areas.

The benefits associated with being taught by "good teachers" are cumulative. Research indicates that the achievement gap widens each year between students with most effective teachers and those with least effective teachers. This suggests that the most significant gains in students' achievement will likely be realized when students receive instruction from "good teachers" over consecutive years. Research on problem-solving emphasizes the role of the teacher in developing students' reasoning skills (Weber (2008), "to lead students to develop accurate criteria for what constitutes good argument, the teacher must have a solid understanding of this criterion" (p. 431-459).

Teachers themselves need to develop competences in problem-solving processes and devise appropriate problem-solving strategies for their students (Anderson, 2010).

Poor and minority students are the least likely group to be taught by teachers with experience, knowledge, and credentials. The elements of teacher quality that research demonstrates are strongly associated with high student achievement. Research also shows that these students produce the most gains when assigned to effective teachers. Indeed, these findings have led many researchers and analysts to assert that the lack of good teachers is a major contributor to the achievement gap.

In Ghana, studies have shown that schools hit a "tipping point" when approximately 20 percent of the school faculty comprised of untrained or unqualified teachers. After this point, schools begin to lose their ability to improve student achievement. The best strategy for closing achievement gaps is to make sure that schools serving poor and minority students have their fair share of qualified teachers and experienced teachers.

School accountability is a theme now commonly heard in the regular discourse among state government officials and local community members. Parents, policymakers, and educators alike have examined their public schools and are calling for, even demanding for improvement in educational delivery. School reform efforts are taking a variety of forms, with two of the most prominent being a focus on higher teacher standards and improved student performance.

Clearly, if students are to achieve high standards, we can expect no less from their teachers and other educators. Teachers do, in fact, make a difference in student learning, and if we are to have competent and caring teachers, we have to relate teacher work to student output. Student achievement should be a fundamental measure of teacher effectiveness.

In Mathematics education, PSA has been closely linked to cognitive development which stemmed from re-conceptualization of Mathematical thinking. This alternative epistemology of Mathematical knowledge has less focused on domain knowledge. To translate this theoretical perspective into the classroom, we need to bring about a fairly revolutionary change in our attitude and belief structures about Mathematics. It is critical that we begin this change with educating our Basic School teachers who are the agents of change in Basic School classrooms where they influence the attitudes of very young learners. Mathematics educators must bring Mathematical reasoning to the forefront of our discussions in our content and pedagogy cases by turning the lens on ourselves so as to examine our own pedagogies in the classroom. It is the belief of the writer that this research offers some insight into Problem-Solving Approach to the teaching of Mathematics. The entire process is difficult and time-consuming, but given what is at stake, it is well worth

the effort so teachers must develop a problem-solving culture in classrooms to make problem-solving a regular and consistent part of one's classroom practice.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the area of study, population and sample of study as well as the sampling technique used. The research instruments used together with the methods of data collection and analysis of data collected were also described.

3.1 Geographical Area of study

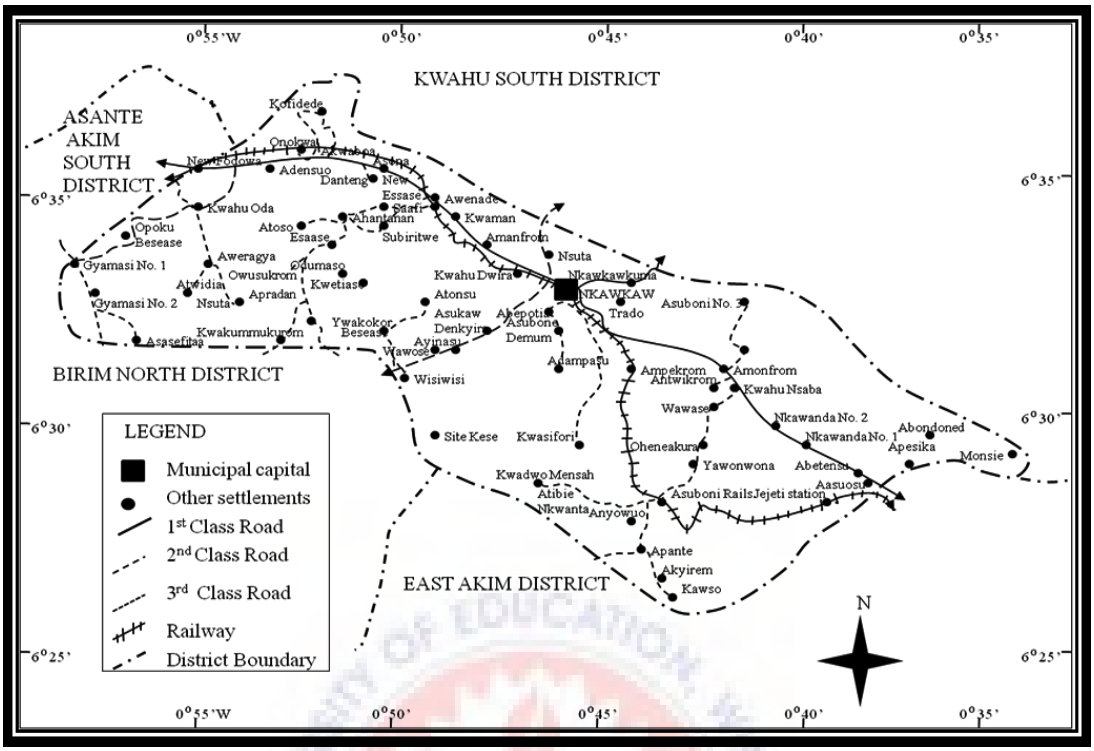
The Kwahu West Municipal Assembly (KWMA) was created in 2004 as a district and it became a Municipality in 2007 in the Eastern Region of Ghana. It lies between latitudes 6º30' North, and 7º North and longitudes 0º30' West and 1º West of the equator, covering an area of about 414 square kilometers. The Municipality capital, Nkawkaw, is located about 241 kilometers North–West of Accra.

The Municipality is bounded to the north by the Kwahu South District, to the West by Asante-Akim South District. To the East, it is bounded by the Fanteakwa Municipality and to the south by Birim North and Atiwa Districts.

Basically, the economy of Kwahu West Municipality is an agrarian one with agriculture constituting 55.5 percent of the labour force employed. This can be attributed to the fact that the climatic condition and soil organization in the Municipality favours the cultivation of crops such as maize, cassava, plantain, cocoyam, yam, cocoa, cola nut and oil palm. The livestock and animal rearing sub sector serves as a supplement of income to the people with animals such as sheep, goats, poultry and pigs. The service and commerce sector is the second highest sector employing 37 percent of the labour force. The main activities under this sector is buying and selling of agriculture and manufactured goods and provision of services such as teaching, nursing and others. The industrial sector is the least sector in terms of employment, thus, employing only 7.5 percent of the labour force. Most industries in Kwahu West Municipality can be classified under small and medium scale industries since they have a total workforce ranging from 5 to 30 persons each. The industrial activities in this Municipality are diversified, ranging from household industries, handicrafts / traditional crafts, modern crafts and small / medium scale manufacturing (KWMA, 2010).

(*See fig 3.1 for Context Map of Kwahu West Municipality*)

Figure 1: Context Map of Kwahu West Municipality



Source: Adapted from the Town and Country Planning Department, KWMA, 2010

3.2 Population

The targeted population was all Mathematics teachers in public Basic Schools and all Circuit Supervisors in Ghana but the accessible population was the Mathematics teachers of all public Basic Schools and Circuit Supervisors in the Kwahu West Municipality. There were sixty-five (65) Mathematics teachers at the Basic School level and eight (8) Circuit Supervisors.

3.3 Sample and sampling technique

Simple random sampling was used to select the prospective respondents for good representation. A total of 62 respondents were selected which was made up of 54 Mathematics teacher from 54 Basic Schools and 8 circuit Supervisors.

3.4 Research design

Research design according to Nodding (1992) is a plan or blue print which specifies how data relating to a given problem should be collected and analyzed. It provides the procedural outline for the conduct of any investigation.

This study is a descriptive survey design. A descriptive survey is inductively from attributes of a particular event in the real world and attempts to describe the situation that exists. It also depicts the participants in an accurate way (Gall, Gall & Borg 1999). This study probes into Methods used to teach Mathematics in the Kwahu West Municipality and tries to describe the existing situation. Teachers from the selected schools answered a questionnaire. The researcher conducted unstructured interviews and observed some Mathematics lessons where necessary.

3.5 Research Instruments and data collection Procedure

The instruments used to collect data were the questionnaire, observation and interview schedule. Questionnaire was administered, observations made and unstructured interviews conducted using an interview guide to collect information from the respondents. The questions were divided into four parts. The first part consisted of questions that solicited information on the biographical characteristics of the respondents. The second part found out the general attitude of the respondents towards the teaching of mathematics while the third part sought for respondents' knowledge on the use of Problem-Solving Approach(PSA) in the teaching of Mathematics followed by the last part, support needed by teachers to implement PSA in Ghanaian classrooms. Questions were both open-ended and closed-ended.

The unstructured interview followed the usual manner in which interviews are conducted where answers to the questions were written down along the discussion.

Questionnaire was used, since it takes less time to administer and ensures the anonymity of respondents (Fraenkel &Wallen, 2000).

The research questions and the instruments used to collect data to answer them are as follows:

Research question 1: How do teachers understand and use PSA in the teaching of Mathematics?

For the above research question, questionnaire, unstructured interview and observation were used to collect the data.

Research question 2: What factors are responsible for teachers' failure to use PSA in the teaching of Mathematics?

Questionnaire and unstructured interviews were used to collect data to answer this research question.

Research question 3: What support do teachers need to implement PSA in the teaching of Mathematics in Ghanaian Basic Schools?

Questionnaire and unstructured interviews were used to collect data to answer this research question.

3.6 Validity/Reliability

The validity of a research instrument is determined by how well it measures the concept(s) it is intended to measure (Awanta, & Asiedu-Addo 2008). Three senior Mathematics lecturers who are experts in curriculum research assessed the validity of the instrument and their suggestions were used to improve the validity of the instrument.

Reliability concerns the degree to which an experiment, test, or any measuring procedure yields the same results on repeated trails (Ruland, Bakken, & Roislien, 2007). The reliability coefficient of the questionnaire was not calculated because the questionnaire items which were open-ended, demanding free responses from the respondents. The piloting conducted on a sample of ten (10) Mathematics teachers from Kwahu South District in the Eastern region was used to address ambiguity of the items.

3.7 Piloting the Research Questionnaire

The questionnaire instrument was piloted on a small sample of ten (10) Mathematics teachers from Kwahu South District in the Eastern region to assess its suitability. The reason for selecting ten (10) Mathematics teachers was based on convenience in terms of time and resources. The instrument was piloted to enable the researcher modify some items that were difficult for the Mathematics teachers to understand, reduce ambiguities and incorporate new categories of responses that were identified as relevant to the study (Awanta, & Asiedu-Addo, 2008). This was done based on the advice from my supervisor.

3.8 Data analysis

All the copies of the questionnaire were examined to see if all the items were answered properly. The responses were then coded and analyzed using simple tables, frequency tables, percentages and pie chart.

Notes taken during unstructured interviews were also analyzed using simple frequency tables and percentages.

Lessons observed were also presented using simple table and percentages.

The research questions and the analysis used to answer them were:

Research question 1: How do teachers understand and use Problem Solving Approach in the teaching of Mathematics?

Frequency tables and percentages were used for the analysis.

Research question 2: What factors are responsible for teachers' failure to use PSA in the teaching of Mathematics?

Frequency tables and compilation of views were used in the analysis

Research question 3: What support do teachers need to implement Problem Solving Approach in the teaching of Mathematics in Ghanaian Basic Schools?

This research question was analysed by compiling the respondents' views.

CHAPTER FOUR

PRESENTATION OF FINDINGS

4.0 Overview

The aim of this study is to find out about the use of Problem-Solving Approach(PSA) to the teaching of Mathematics in Ghanaian Basic schools. Questionnaire, unstructured interview and observations were used to collect the data. In all 62 questionnaires were administered to the respondents (54 Mathematics teachers and 8 circuit supervisors) but 60 were retrieved representing 96.8%. The data gathered was analyzed using frequency tables, charts and percentages. The biographic data was reported followed by data related to the research questions.

4.1 Demographic Data

Table 4. 1: Biographic data of respondents

Gender	No. of Respondents	Percentages (%)
Male	56	93.3
Female	4	6.7
Total	60	100.0

From the table obtained, male respondents were 56 representing 93.3 %, while female respondents were 4 representing 6.7 %. The researcher has no control over that because the respondents were selected based on their schedule and the subject they teach.

Table 4.2: Age Distribution of Respondents

Age in years	No. of Respondents	Percentages (%)
Under 30	27	45.0
30 – 39	20	33.3
40 – 49	4	6.7
50 and above	9	15.0
Total	60	100.0

Table 4.2 shows that majority of the respondents (27) representing 45% were under 30 years of age followed by those between 30 and 39 with (20) representing 33.3%. Those between 40 and 49 years were 4 (6.7%) and finally 50 years and above (9) representing

15%.This shows that the youth were actively involved and the older ones supported with their experiences.

Table 4.3 Teaching Experience of Respondents

Teaching Experience in Years	No. of respondents	Percentages (%)
0 – 4	23	38.3
5 - 10	25	41.7
11 – 14	4	6.7
15 and above	8	13.3
Total	60	100.0

From table 4.3 above, majority (25) of the respondents' teaching experience were between 5-10 years representing 41.7% followed by those who have taught for at most 4 years with (23) representing 38.3%. The most experienced ones in the teaching of Mathematics within the respondents were 8 representing 13.3% who have taught for at least 15 years and the least within the group were 4 (6.7%) who had taught for 11-14 years. It is very clear that the respondents have some level of experience because 37 of them had taught for at least five years.

Table 4.4: Current Post Level of Respondents

Post level	No. of respondents	Percentages (%)
Teacher	41	68.3
Senior teacher(above PS)	12	20.0
Head of Department	7	11.7
Total	60	100.0

Table 4.4 shows that, 41 of the respondents representing 68.3% indicated their current post level as teachers, senior teachers were 12 representing 20% and Heads of department were 7 representing 11.7%. This indicated that though the junior staff/ranks were teaching Mathematics, the senior staff and Heads of department were supporting them.

Table 4.5: Highest Academic Qualification of Respondents

Academic Qualification	No. of Respondents	Percentages (%)
GCE 'O' Level	0	0.0
GCE 'A' Level	2	3.3
SSCE/WASSCE	10	16.7
Dip /HND	30	50.0
Bachelor's Degree	18	30
Master's Degree	0	0.0
Total	60	100.0

The highest academic qualification of respondents and their respective percentages were as shown in table 4.5 above. One-half of the respondents (30) had Diploma/HND representing 50% followed by those with Bachelor's Degree with 18 representing 30%. Respondents who had SSCE/WASSCE were (10) followed by GCE 'A' level (2), GCE 'O' Level (0) and Master's Degree (0) representing 16.7%, 3.3%, 0.0% and 0.0% respectively.

The various levels of the educational ladder were represented from GCE 'A' Level to Bachelor's Degree level which enhanced the quality of the information through expression of divergent views. Though GCE 'O' level and second Degree were not represented, it had

not affected the results in any way because a teacher needs diploma in education as a minimum qualification to teach at the Basic School level.

Table 4. 6: Professional Qualification of Respondents

Professional qualification	No. of respondents	Percentages (%)
Teachers' Cert 'A'	0	0.0
Certificate in Education	0	0.0
Diploma in Education	38	63.3
Graduate Cert in Education	3	5.0
Postgraduate Diploma in Education	7	11.7
Bachelor of Education	12	20.0
Master of Education	0	0.0
Total	60	100.0

When it came to professional qualification, most of the respondents (38) had Diploma in Education representing 63.3%, Bachelor of education (12) followed with 20.0%. Respondents with Postgraduate Diploma in Education were 7 and those with Graduate Certificate in Education were 3 representing 11.7% and 5.0% respectively. There were no respondents with Teachers' Certificate 'A', Certificate in Education or Master of Education. This means all the respondents were professional teachers. Therefore the highest professional qualification of respondents was Bachelor of education.

4.2 Presentation of Findings

This section presents finding on how teachers understand and use Problem-Solving Approach in the teaching of Mathematics, what key educational stakeholders see as factors responsible for Basic School teachers' failure to use Problem-Solving Approach (PSA) in the teaching of Mathematics and support teachers need to implement Problem-Solving Approach to the teaching of Mathematics in Ghanaian classrooms.

Research question 1

How do teachers understand and use Problem-Solving Approach in the teaching of Mathematics?

Teachers Understanding of Teaching Mathematics through Problem-Solving Approach was assessed. Respondents were asked to give their understanding of teaching Mathematics through PSA and their responses were as follows.

Table 4.7: Teaching Mathematics through PSA

	Response	No. of respondents			
		TRUE	%	FALSE	%
1.	Giving problems to learners to solve after a Mathematics lesson	30	50.0	30	50.0

2.	Using problems as vehicles to convey meaning of mathematical concepts to learners	12	20.0	48	80.0
3.	Teaching learners about mathematical problem solving	10	16.7	50	83.3
4.	Allowing learners to solve their own mathematical problems	8	13.3	52	86.7

Thirty (30) representing 50% of the respondents said teaching Mathematics through Problem-Solving Approach meant "giving problems to learners to solve after a Mathematics lesson". While the same number said the statement was false.

Twelve (12) representing 20% of the respondents also indicated that teaching through PSA meant "using problems as vehicles to convey meaning of mathematical concepts to learners" 48 (80%) disagreed with them with the view that the statement was False.

Ten of the respondents representing 16.7% also chose true for "teaching learners about mathematical problem-solving" while 50 respondents representing 83.3% said the statement was false.

Eight respondents representing 13.3% indicated that the statement "allowing learners to solve their own mathematical problems" was what it meant to teach Mathematics through PSA but 52 respondents (86.7%) said the statement was false.

Table 4.8: Importance of Teaching Mathematics through Problem Solving

Response	No. of respondents	Percentages (%)

Yes	48	80.0
No	12	20.0
Total	60	100.0

When asked whether engaging learners in a task for which the solution method is not known is important in teaching through problem solving approach, 48 of the respondents (80%) responded in the affirmative while 12 of the respondents (20%) disagreed with them (Table 4.8 above).

Table 4.9: Understanding of PSA as Learners Solving Word Problems

Response	No. of respondents	Percentages (%)
True	32	53.3
False	28	46.7
Total	60	100.0

Respondents who said it is true that "PSA to the teaching of Mathematics is giving learner word problem to solve" were 32 representing 53.3% while 28 of the respondents (46.7%) disagreed with them saying the statement was false (Table 4.9 above).

Table 4.10: Understanding of PSA as Learners Solving Difficult Mathematics Questions

Response	No. of respondents	Percentages (%)
True	26	43.3
False	34	56.7
Total	60	100.0

Twenty-six (26) of the respondents (43.3%) said it was true that "when learners are able to solve difficult mathematics question it means the teacher is using PSA to teach Mathematics" but the rest (34) representing 56.7% said the statement was false (Table 4.10 above).

Respondents had these to say when asked to express themselves about teaching through PSA. They said teaching through PSA meant:

- helping students construct deep understanding in Mathematics
- using generic skills in finding solution to a problem
- using pupils own ability to solve problems
- a method of teaching which also relates to other activities in everyday life
- giving task to pupils to solve with the guidance of the teacher
- giving leaner mathematical task to solve which has no known method
- giving problems to pupils to solve after a lesson
- methodology teachers use to capture learners interest and motivates them to learn Mathematics
- giving learners a word problem and helping them to solve

Putting all the responses together gave a good picture of respondent's views on teaching through PSA though some of the expressions may not be exact.

The opinions of respondents concerning the teaching of Mathematics through Problem-Solving Approach were also considered. Majority of the respondents said the teaching of Mathematics through PSA meant:

- teaching mathematical topics through problem-solving contexts and enquiry-oriented environment
- learning to solve mathematical problems using non-routine method
- pupils solving everyday problems with their mathematical knowledge
- giving mathematical problem to pupil to solve on their own with the guidance of the teacher
- a mathematical task that has the potential to provide intellectual challenge that enhances students' mathematical understanding and development
- giving learners mathematical task to solve without following an already known method
- the method that allows learners to solve their own mathematical problems
- identifying practical problems and pupils applying mathematical concepts to find solutions
- serving as a vehicle for learning new concepts and skills in Mathematics
- using problems to help pupils bring into play the concept, skills, generalization and anything mathematical

- giving learners word problem in Mathematics and guiding them to solve

Considering the total responses, the respondents have divergent views on teaching of Mathematics through PSA.

The respondents gave the importance or benefits of teaching Mathematics through Problem-Solving Approach as:

- producing positive attitudes towards the learning of Mathematics
- fostering pupils ability to reason and communicate mathematically
- capturing and sustaining learners interest for a longer period
- enhancing transfer of knowledge
- making learners more analytic in decision making
- helping pupils to learn Mathematics on their own thereby solve their own everyday problems
- building students' confidence and helping students to relate concepts to real life issues
- providing students' with conceptual understanding
- reducing workload of teachers
- producing positive attitude towards Mathematics
- enhancing logical reasoning, critical thinking, flexibility and creativity
- making the learning of Mathematics interesting and enjoyable

- enabling learners to attempt and solve any challenging question they find
- offering ample chance for students to practice Mathematics
- enriching students experiences to apply what they learn to real life situation
- enabling students apply mathematical concept and develop interest in solving practical problems

Table 4.11: Benefits of Teaching Mathematics through PSA

A: Teaching Mathematics through PSA can provide a vehicle for students to construct their own ideas about Mathematics

B: It is a vehicle for developing logical thinking

C: It helps learners to take responsibility for their own learning

D: It is an aesthetic form in itself and can provide students with a context for learning mathematical knowledge

E: It enhance transfer of skills to unfamiliar situations

Benefit / Views	A		B		C		D		E	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
Strongly Agree	46	76.7	41	68.3	18	30.0	29	48.3	30	50.0

Agree	10	16.7	15	25.0	32	53.3	27	45.0	24	40.0
Uncertain	2	3.3	3	5.0	5	8.3	4	6.7	6	10.0
Disagree	0	0.0	0	0.0	4	6.7	0	0.0	0	0.0
Strongly Disagree	2	3.3	1	1.7	1	1.7	0	0.0	0	0.0
TOTAL	60	100	60	100	60	100	60	100	60	100

On the view of "teaching Mathematics through problem Solving approach can provide a vehicle for students to construct their own ideas about Mathematics" majority of the respondents (56) representing 93.4% agreed while 2 of the respondents (3.3%) disagreed with them. Two respondents (3.3%) were uncertain.

Fifty-six of the respondents (93.3%) supported the view that "it is a vehicle for developing logical thinking" but 1 respondent (1.7%) disagreed with them while 3 respondents representing 5.0% were uncertain.

Majority (50) of the respondents (83.3%) supported the view that "problem solving approach helps learners to take responsibility for their own learning". Precisely 30.0% strongly agreed while 53.3% agreed with the view. Five (5) respondents representing 8.4% disagreed with the view (4 respondents-6.7% disagreed and 1 respondent-1.7% strongly disagreed) while the same number of respondents (5) representing 8.3% were uncertain.

"It is an aesthetic form in itself and can provide students with a context for learning mathematical knowledge" was the next view for consideration. Fifty-six (93.3%) of the

respondents agreed with the view. Those who were uncertain were 4 representing 6.7% while no respondent disagreed with this view.

Most of the respondents (90.0%) agreed with the view that "PSA enhances transfer of skills to unfamiliar situations" while the rest (6) representing 10.0% were uncertain. No respondent disagreed with this view.

Any good teacher would be satisfied if his/her students were able to do what has been stated above. It was clear that majority of the respondents(above 80%) know some of these benefits of teaching mathematics through PSA. The question is why were they not using it to teach Mathematics in spite of all these benefits?

Table 4.12: Teachers interested in using PSA to teach Mathematics

Response	No. of respondents	Percentages (%)
Yes	56	93.3
No	4	6.7
Total	60	100.0

Most of the respondents(56) representing 93.3% responded in the affirmative that they were interested in using PSA in teaching Mathematics while the few (6.7%) disagreed with them; they were not interested in using problem PSA in teaching Mathematics.

Table 13: Teacher's Use of PSA in the Teaching of Mathematics

Response	No. of respondents	Percentages (%)
Yes	42	70.0

No	18	30.0
Total	60	100.0

Forty-two respondents, representing (70%) said they use PSA in teaching Mathematics while 18 of the respondents representing 30% said they do not use it.

Table 14: Teacher's use of PSA in teaching Mathematics per week

Response	No. of respondents	Percentages (%)
None	26	43.3
Once	4	6.7
Twice	12	20.0
3 times	16	26.7
4 times	2	3.3
Total	60	100.0

Twenty-six (26) of the respondents (43.3%) said they do not use PSA in teaching Mathematics, those who use it once per week were 4, twice per week (12), thrice per week (16) and 4 times per week (2) representing 6.7%, 20.0%, 26.7% and 3.3% respectively.

Respondents gave reasons for their choices of frequency in the use of Problem-Solving Approach. Teaching through PSA is:

- an interesting and enjoyable way of learning Mathematics
- time consuming, due to the topics to cover (workload) as compare to contact hours
- enabling pupils to reason and solve mathematical problems on their own

- enhancing pupils constant practice of new procedures of problem solving which even leads to transfer of knowledge
- helping the students to explore on their own and find solutions to problems which are posed to them
- a method which arouses the interest of the pupils and help them to think critically in solving Mathematical problems
- pupils thinking ability being low which does not aid in exploration of new ideas

Meanwhile, four (4) of the respondents gave no reason for their choice of frequency in the use of Problem-Solving Approach.

Although Mathematics teachers know the importance of problem-solving approach in the teaching of Mathematics the reasons given above and other constraints prevent them from using it as expected.

Table 15: Learners Active Participation in Mathematics Lessons

Response	No. of respondents	Percentages (%)
Yes	60	100.0
No	0	0.0
Total	60	100.0

All the respondent (100%) said learners participate actively in their Mathematics lesson and the teaching methods they used were PSA, Demonstration method, Child-centred

approach, Discovery method, Discussion method, Activity Based method, Question and answer method and Instrumental learning approach

Table 16: Use of TLMs in Mathematics lesson delivery

Response	No. of respondents	Percentages (%)
Yes	60	100.0
No	0	0.0
Total	60	100.0

All the respondents (100%) indicated that they use variety of Teaching and Learning Materials (TLMs) in their lesson delivery. The TLMs mentioned include Geoboard, measuring instruments (rulers), counters, solid figures, Real objects, charts on manila cards, role play ,Solid shapes (cubes, cuboids, etc) and mathematical instrument, Multi-based block, abacus, Picture cards, flash cards and number cards, Model shapes, Cuisenaire rods, mathematical charts and tables, Paper- cut-outs, Coins and place value charts.

Concerning teachers understanding and use of Problem-Solving Approach in the teaching of Mathematics, only few(20%) of the respondents understood what teaching through Problem-Solving Approach (PSA) meant, that is, using problems as vehicles to convey meaning of mathematical concepts to learners.

Considering respondents views on usage of Problem-Solving Approach to the teaching of Mathematics in Ghanaian classrooms, Majority of the respondents(70%) said they use it in teaching Mathematics, quite a reasonable number of respondents said they do not know what was happening in their schools, therefore could not tell whether PSA was being used

or not. Majority of the respondents had not attended any workshop on teaching Mathematics through PSA which has contributed to teachers not being comfortable teaching Mathematics through PSA. Respondents gave reasons for teachers' inability to teach Mathematics through PSA which included difficulty in using PSA to teach, time constraints and lack of knowledge about the use of PSA in teaching Mathematics.

Research question 2

What factors are responsible for teachers' failure to use Problem-Solving Approach in the teaching of Mathematics?

Key educational stakeholders views on factors responsible for teachers' failure to use problem-solving approach in the teaching of mathematics were sought and respondents came out with the following.

Table 17: Teachers' use of PSA to teach Mathematics

Response	No. of respondents	Percentages (%)
Yes	33	55.0
No	27	45.0
Total	60	100.0

When asked generally whether teachers were using PSA in teaching Mathematics in the classrooms, 33 respondents representing 55% said yes, 27 respondents (45.0%) also said no.

The respondents who said yes, PSA was been used to teach Mathematics in their classrooms explained how it was being done as:

- giving pupils questions to solve during lesson delivery
- posing problems (challenging ones) to pupils and guiding pupils to use non-routine methods in solving
- introducing a lessons by teachers while learners are brainstorm to come out with meanings and answers to the problem
- giving the questions to learners to answer on the chalkboard
- motivating pupils to accept challenging questions and guide them through it

They also said teachers are using it because pupils are mostly giving project works to do within some limited period (weeks and days) for them to submit later to the class for discussion.

Respondents who said no, PSA was not used to teach Mathematics in their classrooms also gave reasons for the non-usage as:

- being difficult for some teachers to use the approach
- the needs for research and understanding but the resources are not there or not available
- teachers having no in-service training on the use of the approach
- teachers lacking adequate TLMs to aid them use problem Solving approach

- time consuming and difficult to use
- based on the method of teaching the teacher wanted to use because of varying methods of teaching Mathematics
- Pupils always want to rely on rules to follow in solving problems

Table 18: Mathematics teachers' attendance of workshop on the use of PSA

Response	No. of respondents	Percentages (%)
Yes	19	31.7
No	41	68.3
Total	60	100.0

Nineteen (19) respondents (31.7%) said they had attended workshop on the use of PSA in the teaching of Mathematics while the rest, 41 respondents (68.3%) responded negatively that they had not attended such workshop.

Responding to why teachers were not comfortable teaching through PSA, the respondents said:

- teachers' knowledge on the use of PSA is inadequate
- Use of PSA is time consuming
- Teaching through PSA is a bit tedious for the pupils or students
- teachers' low knowledge on the content to be taught

- inadequate training (pre-service) on teaching Mathematics through Problem-Solving Approach
- the pupils need to be spoon-fed rather than thinking critically to solve the problem
- non-availability of TLMs
- lack of information on teaching of Mathematics through PSA
- lack of in-service training on teaching Mathematics through Problem-Solving Approach.

Majority (55%) of the respondents were interested in using PSA in teaching Mathematics and said they use PSA in teaching Mathematics whilst the rest (45%) said they did not.

Those who said they use PSA in teaching Mathematics explain how they use it as giving pupils questions to solve during lesson delivery, posing problems (challenging ones) to pupils and guiding pupils to use non-routine methods in solving and teacher introducing a lessons while learners are brainstorm to come out with answers to the problem.

However, those who said PSA was not used to teach Mathematics in their Basic Schools also gave reasons for the non-usage as, being difficult for some teachers to use, needs for research and understanding but the resources are not there or not available, teachers having no in-service training on the use of the approach, time consuming and difficult to use.

Only 31.7% of the respondents said they had ever attended workshop on the use of PSA in the teaching of Mathematics while the rest, 68.3% said they had never attended such workshop.

Respondents inability to use PSA in the teaching of Mathematics stemmed from the following factors; teachers' inadequate knowledge on the use of PSA, it is time consuming, tedious for the pupils or students, teachers' low knowledge on the content to be taught, inadequate training (pre-service) on teaching Mathematics through PSA, lack of in-service training on teaching Mathematics through PSA.

Research question 3

What support do teachers need to implement Problem-Solving Approach (PSA) in the teaching of Mathematics in Ghanaian Basic Schools?

Respondents' views on how teaching through PSA can be implemented in Ghanaian Basic Schools were given below.

Table 19: Interest of the Mathematics teacher for successful implementation of PSA

Response	No. of respondents	Percentages (%)
Yes	49	81.7
No	11	18.3
Total	60	100.0

Majority of the respondents(49) representing 81.7% said the interest of the Mathematics teacher is a factor in the successful implementation of PSA in Ghanaian Basic Schools while 11 respondents representing (18.3%) disagreed with them.

Table 20: Teachers need of INSET to enable them use PSA in teaching Mathematics

Response	No. of respondents	Percentages (%)
Yes	60	100.0
No	0	0.0
Total	60	100.0

All the respondents (100%) agreed that teachers need INSET to enable them use PSA to teach Mathematics in Ghanaian Basic Schools successfully.

Table 21: Teachers need of re-training to enable them use PSA

Response	No. of respondents	Percentages (%)
Yes	54	90
No	6	10
Total	60	100

Fifty-four (54) of the respondents (90%) said there was the need for re-training of teachers to enable them includes PSA in their teaching methods while 6 of the respondents (10%) said there was no need for re-training probably just workshop would be enough to revamp teachers' teaching skills for this good purpose.

Table 22: Orientation of the Teachers' Mind for Implementation of PSA

Response	No. of respondents	Percentages (%)
Yes	60	100.0
No	0	0.0
Total	60	100.0

All the respondents (100%) indicated that orientation of the teachers' mind will help in the implementation of Problem-Solving Approach in Ghanaian schools.

Respondents' views on what teachers need to enable them implement PSA were as follows:

- proper and well organized pre-service training for teacher trainees
- organization of regular INSET, demonstration lessons during SBI/CBI sessions
- provision of textbooks and teachers' guides with prepared TLMs to teach Mathematics through Problem-Solving Approach
- Practice of team teaching to help colleague teachers become familiar with teaching Mathematics through Problem-Solving Approach
- proper monitoring, supervision, guidance and motivation of teachers to include Problem-Solving Approach in their teaching methods

- funds should be made available for regular INSET for teachers and supervisors
- better supervision of Circuit supervisors and Heads of schools should be done
- there should be special assessments for both teachers and students on the use of PSA for rewards/awards especially Mathematics.

Teachers also need time and resources so that they can share teaching ideas, challenges, reflect on practices and develop new understanding about the approach.

Respondents indicated that, for PSA in the teaching of Mathematics to be implemented successfully in Ghanaian schools there was the need for Government to:

- re-structure the school curriculum in such way that every teacher will be familiar with teaching through Problem-Solving Approach
- provide funds for re-training of teachers to better their methods of teaching
- supply of books to schools and organize in-service training for teachers on teaching through PSA
- include practical teaching through Problem-Solving Approach in teachers' pre-service training curriculum
- provide textbooks for pupils/students containing challenging questions that will make them think analytically, critically and objectively
- empower Municipal Assemblies and District Assemblies to organize workshops frequently to update Mathematics teachers' knowledge on new methods of teaching,

- organize Nationwide INSET for all Mathematics teachers on teaching through PSA
- disabuse the students' minds on misconceptions about Mathematics through education

The respondents also emphasized that to ensure successful implementation of PSA in Ghanaian Basic Schools, they expect Schools, Headmasters and Circuit supervisors to:

- organizing INSET on Problem-Solving Approach regularly through SBI and CBI
- supervise teachers during the teaching process to ensure that teachers use the approach in their lesson delivery
- give more time to Mathematics teaching
- give orientation to teachers and those who teach mathematics to have interest in the subject to teach through Problem-Solving Approach
- motivate, supervise, guide, monitor and encourage teachers concerned to partake in workshops
- inspect teachers work on the use of Problem-Solving Approach
- encourage teachers to give exercises and report about pupils level/performance
- organize regular quizzes and institute award schemes

For successful implementation of Problem-Solving Approach in Ghanaian classrooms, respondents were of the view that:

- the Mathematics teachers should accept the challenge and avail themselves for INSET, re-training and other forms of orientations to develop their professional competencies to help their students
- other views were attending in-service training to develop interest in the use of the approach
- enough preparation prior to lesson delivery and also finding right problems to use to introduce a problem solving activity at a particular level is key
- regular use of problem-solving approach to teach
- encouraging pupils to solve problems on their own
- questions based on application of knowledge should be encouraged in examinations
- teachers showing dedication to work by researching to train their learners to be problem solvers
- more research on teaching through problem Solving approach should be done and implemented

Respondents emphasized that, teachers needed support to enable implement PSA in Ghanaian classroom. Majority (82%) of the respondents said the interest of the Mathematics teacher is a factor in the successful implementation of PSA in Ghanaian schools. Ninety percent (90%) of the respondents opined that there was the need for re-training to enable them includes PSA in their teaching methods. All the respondents again, indicated that orientation of the teachers' mind and that of the students would help in the successful implementation of PSA in Ghanaian Basic Schools.

Respondents' views on what teachers need to enable them implement PSA were proper and well organized pre-service training for teacher trainees, organization of regular INSET for teachers and supervisors , demonstration lessons during SBI/CBI sessions, provision of textbooks and teachers' guides with prepared TLMs to teach Mathematics through Problem-Solving Approach, Practice of team teaching to help colleague teachers become familiar with teaching Mathematics through PSA, proper monitoring, supervision, guidance and motivation of teachers to include Problem-Solving Approach in their teaching methods. Better supervision of Circuit supervisors and Heads of schools should be done.

Teachers also need time and resources so that they can share teaching ideas, challenges, reflect on practices and develop new understanding about the approach.

Interview

Concerning teachers understanding and use of Problem-Solving Approach in the teaching of Mathematics, only few(20%) of the respondents understood what teaching through Problem-Solving Approach (PSA) meant, that is, using problems as vehicles to convey meaning of mathematical concepts to learners. Majority of the respondents (70%) said they use PSA in teaching Mathematics and mentioned the average number of times they use it per week. A sample of eight respondents were selected randomly and interviewed. Their responses are shown below.

Research Question 1

How do teachers understand and use Problem-Solving Approach (PSA) in the teaching of Mathematics?

Respondents were asked to tell whether the given statements were TRUE or FALSE about the meaning of using problem-solving approach to teach mathematics at the Basic School level. The results were as follows:

Table 23: Giving problems to learners to solve after a Mathematics lesson

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	True	7	87.5	87.5	87.5
	False	1	12.5	12.5	100.0
Total		8	100.0	100.0	100.0

From the table, respondents gave their views on the question "giving problems to learners to solve after mathematics lesson". Seven out of the total of 8 representing 87.5% responded that, Problem-Solving Approach to the teaching of mathematics is to give learners problems to solve after a mathematics lesson whilst only 1 respondent out of the 8 representing 12.5% said it is false.

Table 24: Use of problems as vehicles to convey meaning of Mathematical concepts to learners

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	True	8	100.0	100.0	100.0
	False	0	0.0	0.0	100.0
Total		8	100.0	100.0	100.0

The interviewer asked respondents if Problem-Solving Approach in teaching mathematics is the use of problems as vehicles to convey mathematical concept, all the 8 respondents gave their views as true which is 100%. This shows that teachers understand the use of problems as vehicle to convey mathematical concept to learner as teaching Mathematics through problem-solving approach.

Table 25: Teaching learners about Mathematical problem-solving

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	True	0	0.0	0.0	0.0
	False	8	100.0	100.0	100.0
Total		8	100.0	100.0	100.0

The interviewer asked respondents if teaching learners about mathematical problem-solving is teaching Mathematics through PSA, all the 8 respondents which is 100% responded that, teaching learners about Mathematical problem-solving is not using Problem-Solving Approach (PSA).

Table 26: Allowing learners to solve their own mathematical problems

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	True	8	100.0	100.0	100.0
	False	0	0.0	0.0	100.0

Total	8	100.0	100.0	100.0

Respondents were asked if allowing learners to solve their own mathematical problems is the use of Problem-Solving Approach in teaching Mathematics, all the 8 respondents which is 100% said true to the question which implies that teachers understand that if learners are allowed to solve problems on their own means teaching is done using PSA.

Table 27: Learners' engagement in a task for which the solution method is not known

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	87.5	87.5	87.5
	No	1	12.5	12.5	100.0
Total		8	100.0	100.0	100.0

From the above table, 7 respondents which represents 87.5% responded yes to the question "Engaging learners in a task for which the solution method is not known is important in teaching through problem-solving" and only 1 respondent representing 12.5% responded that "engaging learners in a task for which the solution method is not known is not important in teaching through problem-solving".

Respondents had these to say when the researcher asked them to express themselves about teaching through Problem-Solving Approach (PSA). The respondents said teaching through PSA meant:

- helping students construct deep understanding in Mathematics

- using pupils own ability to solve problems
- a method of teaching which also relates to other activities in everyday life
- giving task to pupils to solve with the guidance of the teacher
- giving learners a word problem and helping them to solve

Putting all the responses together gave a good picture of respondents' views on teaching through PSA though some of the expressions may not be exact.

The opinions of respondents concerning the teaching of Mathematics through PSA were also considered. The respondents said the teaching of Mathematics through PSA meant:

- teaching mathematical topics through problem-solving contexts and enquiry-oriented environment
- learning to solve mathematical problems using non-routine method
- pupils solving everyday problems with their mathematical knowledge
- giving mathematical problem to pupils to solve on their own with the guidance of the teacher

- Problem-solving approach to the teaching of mathematics is giving learners word problems to solve

Table 28: learner solving word problems is teaching Mathematics through PSA

Respondents	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	True	8	100.0	100.0	100.0
	False	0	0.0	0.0	100.0
Total		8	100.0	100.0	100.0

Interviewer asked respondents if giving word problems to learners to solve is the method of teaching mathematics through Problem-Solving approach. All the 8 respondents which represents 100% responded that it is true which means that, they agree to the fact that teaching mathematics through PSA is when teachers give learners word problems to solve after mathematical lessons. Considering the total responses, the respondents have the same views on teaching of Mathematics through PSA.

Table 29: solving difficult mathematics questions as teaching mathematics through PSA

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	True	0	0.0	0.0	0.0
	False	8	100.0	100.0	100.0
Total		8	100.0	100.0	100.0

From the above table, respondents made the interviewer understand that, when learners are able to solve difficult mathematics questions does not mean that they were taught by the use of PSA as all 8 respondents responded that it is false.

The interviewer wanted to find out the importance of using PSA in solving Mathematical issues. The respondents gave the importance or benefits of teaching Mathematics through PSA as:

- producing positive attitudes towards the learning of Mathematics
- fostering pupils ability to reason and communicate mathematically
- capturing and sustaining learners' interest for a longer period
- enhancing transfer of knowledge
- making learners more analytic in decision making
- helping pupils to learn Mathematics on their own thereby solve their own everyday problems
- building students' confidence and helping students to relate concepts to real life issues
- reducing workload of teachers
- producing positive attitude towards Mathematics
- making the learning of Mathematics interesting and enjoyable

Although Mathematics teachers know the importance of problem- solving approach in the teaching of Mathematics certain constraints prevent them from using it as expected of them.

Table 30: Interest in using PSA to teach mathematics

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	100.0	100.0	100.0
	No	0	0.0	0.0	100.0
Total		8	100.0	100.0	100.0

Respondents were asked if they have interest in teaching mathematics lessons using PSA. From the above table, all the 8 respondents (100%) answered that they are interested in using PSA in teaching mathematics.

Table 31: use of PSA in teaching Mathematics

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	True	4	50.0	50.0	50.0
	False	4	50.0	50.0	100.0
Total		8	100.0	100.0	100.0

Interviewer asked respondents if they practice the use of PSA in teaching mathematics. Fifty percent (50%) which is half of the respondents were practitioners of Problem-Solving

approach in the teaching of mathematics lessons and the other half were not practicing PSA in their classrooms.

Above 80% of the respondents were able to choose appropriately what is meant by teaching/ teaching Mathematics through Problem-Solving Approach. All the respondents (100%) said they are interested in teaching Mathematics through PSA but one-half (50%) said they teach Mathematics through PSA. They explained teaching Mathematics through PSA as teaching mathematical topics through problem-solving contexts and enquiry-oriented environment, learning to solve mathematical problems using non-routine method, pupils solving everyday problems with their mathematical knowledge, giving mathematical problems to pupils to solve on their own with the guidance of the teacher, and giving learners word problems to solve.

Importance of teaching Mathematics through PSA was given as producing positive attitudes towards the learning of Mathematics, fostering pupils' ability to reason and communicate mathematically, enhancing transfer of knowledge, helping pupils to learn Mathematics on their own thereby solve their own everyday problems, building students' confidence and helping students to relate concepts to real life issues, reducing workload of teachers, producing positive attitude towards Mathematics and making the learning of Mathematics interesting and enjoyable.

Research Question 2

What factors are responsible for teachers' failure to use Problem-Solving Approach (PSA) in the teaching of Mathematics?

Table 32: teachers' use of PSA to teach mathematics

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	50.0	50.0	50.0
	No	4	50.0	50.0	100.0
Total		8	100.0	100.0	100.0

Respondents were asked if they use PSA in teaching Mathematics. The above table gives the results of what respondents had to say. Four (4) of the respondent representing 50% said they use PSA in teaching Mathematics but the other half said they don't.

Table 33: Attendance of workshop on the use of PSA to teach mathematics

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	0	0.0	0.0	0.0
	No	8	100.0	100.0	100.0
Total		8	100.0	100.0	100.0

Respondents were asked if they have attended any workshop on the use of PSA in teaching Mathematics. The above table gives the results of what respondents had to say. All the 8 respondents representing 100% had not attended any workshop on the use of PSA in teaching mathematics.

The interviewer asked the respondents how they learnt about teaching Mathematics through Problem-Solving Approach and their responses were as follows:

- learnt about problem-solving models at the training college and decided to do further research
- It was mentioned during orientation for newly trained teachers
- during Cluster-Based INSET(CBI) sessions
- Explanation from a senior teacher
- Doing research about teaching methods
- Came across it in a book while reading
- A friend mentioned it during conversation

Responding to why teachers are not comfortable teaching through PSA, the respondents said:

- teachers' knowledge on the use of PSA is inadequate
- Use of PSA is time consuming
- Teaching through PSA is a bit tedious for the pupils or students

- teachers' low knowledge on the content to be taught
- Inadequate training (pre-service) on teaching Mathematics through Problem-Solving Approach.

Four (4) of the respondent (50%) said they use PSA in teaching Mathematics but the other half said they don't. All the 8 respondents (100%) had not attended any workshop on the use of PSA in teaching mathematics which means that what they know about teaching Mathematics through Problem-Solving Approach was through their own effort.

Respondents said teachers are not comfortable teaching through PSA because of teachers' inadequate knowledge on the use of PSA, it is time consuming and tedious for both teachers and students, teachers' low knowledge on the content to be taught and inadequate training (pre-service) on teaching Mathematics through Problem-Solving Approach.

Research Question 3

What support do teachers need to implement Problem-Solving Approach (PSA) in the teaching of Mathematics in Ghanaian Basic Schools?

The researcher wanted to know what teachers need to be able to implement teaching through Problem-Solving Approach (PSA) in Ghanaian schools.

Table 34: Teachers' interest is a factor in implementation of PSA.

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	100.0	100.0	100.0
	No	0	0.0	0.0	100.0
Total		8	100.0	100.0	100.0

Interviewer asked respondents if the interest of mathematics teachers is a factor in the successful implementation of PSA in Ghanaian classrooms. All the 8 respondents believe that, the interest of mathematics teachers is important in successful implementation of PSA in Ghanaian classrooms.

Table 35: Need of INSET to enable teachers use PSA in teaching mathematics

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	100.0	100.0	100.0
	No	0	0.0	0.0	100.0
Total		8	100.0	100.0	100.0

Interviewer asked respondents if mathematics teachers need INSET to use PSA in teaching Mathematics in Ghanaian classrooms. All the 8 respondents said Yes, they need INSET to enable them to use PSA in teaching Mathematics.

Table 36: Need of re-training to enable teachers include PSA in their teaching methods

Respondents	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Yes	8	100.0	100.0	100.0
	No	0	0.0	0.0	100.0
Total		8	100.0	100.0	100.0

Respondents had this to say when interviewer asked the question "Do teachers need re-training to enable them include PSA in their teaching methods?" All the respondents answered "Yes" which imply that, teachers need to be re-trained to enable them include PSA in their teaching methods.

Table 37: Orientation of the teachers' mind about implementation of PSA

Respondents		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	100.0	100.0	100.0
	No	0	0.0	0.0	100.0
Total		8	100.0	100.0	100.0

Respondents were asked by interviewer the question "Would orientation of the teachers' mind help in the implementation of problem-solving approach in Ghanaian classrooms?" All the respondents answered "Yes" which implies that, teachers need orientation of mind to help implement PSA successfully in Ghanaian classrooms.

Respondents' views on what teachers need to enable them implement PSA were highlighted as:

- proper and well-organized pre-service training for teacher trainees

- organization of regular INSET and demonstration lessons
- provision of textbooks and teachers' guides to teach Mathematics through PSA
- proper monitoring, supervision, guidance and motivation of teachers to include PSA in their teaching methods
- funds should be made available for regular INSET for teachers and supervisors
- proper supervision of Circuit supervisors and Heads of schools should be done.

The respondents also emphasized that to ensure successful implementation of PSA in Ghanaian Schools, there would be:

- inspection of teachers work on the use of Problem-Solving Approach
- organization of INSET on Problem-Solving Approach regularly.
- Supervision of teachers during the teaching process to ensure that teachers use the approach in their lesson delivery
- more time is given to Mathematics teaching
- orientation for teachers and those who teach mathematics to be interested and to teach through PSA
- Encouragement of teachers concerned to partake in workshops
- Organization of regular quizzes and institute award schemes

Respondents indicated that, for PSA in the teaching of Mathematics to be implemented successfully in Ghanaian schools there was the need for Government to:

- re-structure the school curriculum in such way that every teacher will be familiar with teaching through PSA
- provide funds for re-training of teachers to better their methods of teaching
- organize in-service training for teachers on teaching through PSA
- include practical teaching through PSA in teachers' pre-service training curriculum
- provide textbooks for pupils/students containing challenging questions that will make them think analytically, critically and objectively
- disabuse the students' minds on misconceptions about Mathematics through education

The respondents also emphasized that to ensure successful implementation of PSA in Ghanaian schools, Headmasters and Circuit supervisors are expected to:

- inspect teachers work on the use of Problem-Solving Approach
- organizing INSET on PSA regularly through SBI and CBI
- supervise teachers during the teaching process to ensure that teachers use the approach in the lesson delivery process
- give more time to Mathematics teaching
- give orientation to teachers and those who teach mathematics to develop interest in teaching through Problem Solving Approach
- motivate, supervise, guide, monitor and encourage teachers concerned to partake in workshops

- encourage teachers to give exercises and report about pupils level/performance
- organize regular quizzes and institute award schemes

For successful implementation of Problem-Solving Approach in Ghanaian classrooms, respondents were of the view that the Mathematics teachers should accept the challenge and avail themselves for INSET, re-training and other forms of orientations to develop their professional competencies to help their students.

- other views were attending in-service training to develop interest in the use of the approach
- enough preparation prior to lesson delivery and also finding right problems to use to introduce a problem-solving activity at a particular level is key
- regular use of problem solving approach to teach
- encouraging pupils to solve problems on their own
- questions based on application of knowledge should be encouraged in examinations
- teachers showing dedication to work by researching to train their learners to be problem solvers
- more research on teaching through Problem-Solving Approach should be done and implemented

In response to support needed by teachers to implement PSA in Ghanaian Basic School, all the 8 respondents believe that, the interest of mathematics teachers is important in successful implementation of PSA in Ghanaian classrooms. All the 8 respondents were of

the opinion that, there was the need for INSET, re-training, orientation of the teachers' mind to enable them to use PSA in teaching Mathematics.

Respondents views concerning teachers understanding and use of PSA in the teaching of Mathematics. The unstructured interview was conducted on eight respondents and 4 of the respondents (50%) said they teach Mathematics through PSA. Above 80% of the respondents were able to choose appropriately what is meant by teaching/ teaching Mathematics through Problem-Solving Approach. All the respondents (100%) said they are interested in teaching Mathematics through PSA but one-half (50%) said they teach Mathematics through PSA. They explained teaching Mathematics through PSA as teaching mathematical topics through problem-solving contexts and enquiry-oriented environment, learning to solve mathematical problems using non-routine method, pupils solving everyday problems with their mathematical knowledge, giving mathematical problems to pupils to solve on their own with the guidance of the teacher and giving learners word problems to solve.

With respect to key educational stakeholders (teachers and Circuit Supervisors) views on factors responsible for teachers' failure to use Problem-Solving Approach in the teaching of Mathematics, all the respondents (100%) had not attended any workshop on the use of PSA in teaching mathematics which means that what they know about teaching Mathematics through Problem-Solving Approach was through their own effort.

Respondents said teachers are not comfortable teaching through PSA because of teachers' inadequate knowledge on the use of PSA, it is time consuming and tedious for both teachers

and students, teachers' low knowledge on the content to be taught and inadequate training (pre-service) on teaching Mathematics through Problem-Solving Approach.

Support needed by teachers to implement Problem-Solving Approach in Ghanaian classrooms was given by respondents. All the 8 respondents believe that, the interest of mathematics teachers is important in successful implementation of PSA in Ghanaian classrooms. All the respondents (100%) were of the opinion that, there was the need for INSET, re-training, orientation of the teachers' mind to enable them to use PSA in teaching Mathematics. They also suggested that those in charge of Education re-structure the school curriculum in such way that every teacher will be familiar with teaching through PSA, provide funds for re-training of teachers to better their methods of teaching, organize regular in-service training for teachers on teaching through PSA, include practical teaching through PSA in teachers' pre-service training curriculum and provide textbooks for pupils/students containing challenging questions that will make them think analytically, critically and objectively.

Lesson Observation

The unstructured interview was conducted on 8 respondents and 4 of the respondents representing 50% said they teach Mathematics through PSA. Lessons of the 4 respondents who said they teach Mathematics through PSA were observed and results were as follows:

Table 38: lesson observation

Lessons Details	Iesson1	Lesson 2	Lesson3	Lesson 4

Circuit	Asuboni Rails	Nkawkaw 'A'	Apradang	Awenade
School	M/A JHS	Presby JHS	M/A JHS	Anglican JHS
Form	Two(2)	Three(3A)	One(1)	Two(2)
Topic	Proportion	Speed	Area of a circle	Equations in two variables
Method used	Demonstration (Teaching for Problem Solving)	Demonstration (Teaching for Problem Solving)	Demonstration (Teaching for Problem Solving)	Demonstration (Teaching for Problem Solving)

All the teachers used demonstration method and gave exercises at the end of the lessons. Problem-Solving Approach (PSA) was not used to teach any of the lessons observed. The traditional way of teaching by demonstrating how to solve questions on a particular topic, giving students formulae, guiding them to solve examples and giving them similar questions to solve was demonstrated.

Polya's four-step problem-solving model (1985):

- understanding the Problem
- devising a plan
- carrying out the plan
- Looking back.

Based on the above model the steps in PSA to teaching especially Mathematics could be reviewed to suit our environment as follows;

1 Reviewing the Relevant Previous Knowledge (RPK)

2 Presenting the problem for the day.

3 Students working individually or in groups.

4 Discussing solution methods.

5 Highlighting and summarizing the major points

Learners at all levels of education can be taught through Problem-Solving Approach (PSA) in Mathematics if serious attention is given to it by stakeholders of education.

From the above, eight (8) of the respondent (20%) indicated on the questionnaire that they use PSA in teaching Mathematics and mentioned the average number of times they use it per week. The unstructured interview was conducted on 8 respondents and 4 of the respondents representing 50% said they teach Mathematics through PSA. Lessons of the 4 respondents who said they teach Mathematics through PSA were observed. The lessons observation revealed that the respondents were referring to "teaching for problem-solving" instead of "teaching through problem-solving".

Majority (80%) of the respondents were able to choose appropriately but explaining teaching through PSA and using it to teach was difficult. For instance after taking learners through an activity, questions were solved following steps or methods after which learners were given similar questions to solve following the same steps or methods.

4.3 Discussion

Most of the respondents were males because those involved were Mathematics teachers and circuit supervisors. Majority of the respondents were under thirty years and most of them indicated that their teaching experience were from 5 to 10 years with their current post level being "teacher". One-half of the respondents had Dip/HND as their highest

academic qualification whilst more than One-half of the respondents had Diploma in Education as their highest Professional qualification.

Research question 1

Concerning teachers understanding and use of PSA in the teaching of Mathematics, few (20%) of the respondents understood what teaching through PSA meant, that is, using problems as vehicles to convey meaning of mathematical concepts to learners. The views of these respondents were in line with that of Traiton and Midgett (2001) who said among other things that problem-solving is a vehicle by which students make sense of Mathematics. Other respondents understood teaching Mathematics through PSA as teaching for problem-solving. Majority of the respondents were of the view that engaging learners in task for which the solution method is not known is important in problem solving. Some of the respondents were also of the view that teaching Mathematics through PSA means giving learner word problem to solve. These are consistent with the findings of Saleh (2009) who reported that teachers conceived Mathematics problem-solving as solving difficult word questions that are challenging.

Most of the respondents said, when learners were able to solve difficult Mathematics questions, it did not mean the teacher was teaching Mathematics through PSA and gave their opinions and importance of teaching Mathematics through PSA. Responding to the benefits of teaching Mathematics through PSA, majority of them agreed that it is beneficial to teach Mathematics through PSA and gave the importance or benefits of teaching Mathematics through Problem-Solving Approach as, producing positive attitudes towards the learning of Mathematics, fostering pupils ability to reason and communicate mathematically, sustaining learners interest, enhancing transfer of knowledge, making

learners more analytic in decision making, helping pupils to learn Mathematics on their own thereby solve their own everyday problems, building students' confidence, helping students to relate concepts to real life issues, providing students' with conceptual understanding, reducing workload of teachers, producing positive attitude towards Mathematics, enhancing logical reasoning, critical thinking, flexibility and creativity.

Other views on the importance/benefits of PSA were making the learning of Mathematics interesting and enjoyable, helping pupils to understand the method of teaching, enabling learners to attempt and solve any challenging question they find, offering ample chance for students to practice Mathematics, enriching students experiences to apply what they learn to real life situation, enabling students apply mathematical concept and develop interest in solving practical problems

Research question 2

With respect to key educational stakeholders (teachers and Circuit Supervisors) views on factors responsible for teachers' failure to use Problem-Solving Approach in the teaching of Mathematics. Majority (93.3%) of the respondents were interested in using PSA in teaching Mathematics and said they use PSA in teaching Mathematics and mentioned the average number of times they use PSA in teaching Mathematics per week whilst few of them said they did not use PSA in teaching Mathematics. The unstructured interview conducted and observation revealed that most of the respondents were referring to "teaching for problem-solving" instead of "teaching through problem-solving". The entire respondent said learners participate actively in their lessons and mentioned some teaching methods and materials they use in teaching Mathematics.

Most of the respondents gave their reasons for non-usage of PSA in the teaching of Mathematics as time consuming, due to the number of topics to cover (workload} as compare to contact hours, lack of knowledge about teaching through PSA, inadequate curriculum materials and TLMs, and pupils low thinking ability which does not aid in exploration of new ideas or use of PSA.

The respondents gave a number of factors for teachers' failure to use PSA in teaching Mathematics. Some of the respondents said that they find it difficult to use the approach. This is understandable since majority of basic school teachers are trained as general teachers rather than specialist teachers. (Xenofontos, 2007), Mereku (2008) and McIntosh, Jarrett and Peixotto (2000). Some of the respondents also said, they don't understand the PSA. McIntosh, Jarrett and Peixotto (2000) stated that teaching Mathematics through problem-solving is difficult among teachers because they have inadequate subject matter knowledge. This view is also echoed by Anderson (2000) who said that some teachers lack the requisite knowledge, skills and expertise for teaching Mathematics through problem-solving.

Some of the respondents also said there were varying methods of teaching Mathematics and pupils always want to rely on rules to follow in solving problems. This view is greatly influenced, according to Anderson (2000), parents' expectations in terms of examinations results put pressure on teachers to teach for examination instead of adopting problem-solving strategies to teach for conceptual understanding.

A number of respondents stated that using PSA is time consuming and difficult. This supports Schoenfeld's (1992) view that teaching problem-solving is difficult for teachers mathematically, pedagogically, and personally.

Other factors contributing to the lack of use of PSA in teaching Mathematics, according to the respondents, are non-availability of resources and lack of in-service training.

Research question 3

Support needed by teachers to implement Problem-Solving Approach in Ghanaian classrooms was given by respondents. Majority of the respondents said the interest of the Mathematics teacher is a factor in the successful implementation of PSA in Ghanaian schools. All the respondents opined that there was the need for re-training to enable them includes PSA in their teaching methods. All the respondents again, indicated that orientation of the teachers' mind and that of the students would help in the implementation of PSA in Ghanaian Schools. The respondents also mentioned that teachers would need INSET, new Teacher's Guides (TGs), and funds. The need for INSET is in line with what Ali, Hukamdad Akhter and Khan (2010) recommended. They said extensive training programmes, seminars and workshops for Mathematics teachers in Basic Schools need to be organized to enable the teachers employ problem-solving method in the classrooms.

There was also the need for guidance, supervision, monitoring, mentoring, informal networking of teachers and others to support the implementation of PSA to the teaching of Mathematics. These views of the respondents are supported by Cogill (2008), IAS/PCMIIS (2006) and Ali, Hukamdad, Akhter and Khan (2010).

The Government was also expected to re-structure the curriculum to suit the approach, provide new curriculum materials and provide funds for organization of workshops so that teaching through PSA could be practical at all levels of education. In addition, teachers need readily available examples of useful non-routine problems, particularly in textbooks (Anderson, 2010).

To ensure successful implementation of PSA in Ghanaian schools, Headmasters/mistresses and Circuit Supervisors were expected to encourage, motivate, supervise teachers and organize INSETs for teacher when the need arise.

Respondents were also of the view that for a successful implementation of PSA in Ghanaian schools, the Mathematics teachers' contribution would be needed in various capacities including attending INSETs, showing interest in the use of PSA, dedication to work and researching to train their learners to be problem solvers.

Majority of the respondents had not attended any workshop on teaching/ teaching Mathematics through PSA which has contributed to teachers not being comfortable teaching Mathematics through PSA. Respondents gave reasons for teachers' inability to teach Mathematics through PSA which included difficulty in using PSA to teach, time constraints and lack of knowledge about the use of PSA in teaching Mathematics.

To help teachers overcome these difficulties and be able to use PSA in teaching Mathematics, there is the need to form a community of practice where teachers could meet and discuss their problems, plan lessons and reflect on their practice Cogill (2008), IAS/PCMISS (2006). Respondent said proper and well organized pre-service training for teacher trainees, organization of regular INSET, demonstration lessons during SBI/CBI

sessions, provision of textbooks and teachers' guides with prepared TLMs to teach Mathematics through PSA, practice of team teaching to help colleague teachers become familiar with teaching Mathematics through PSA. There should be proper monitoring, supervision, guidance and motivation of teachers to include PSA in their teaching methods.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

The study was necessary because there was the need to promote implementation of problem solving approach in the Mathematics classroom. It was emphasized in Ghana's MOE (2010) Mathematics syllabus but little is practically known or documented about the implementation, benefits and how to promote it in the Ghanaian classroom. This study focused on the understanding and usage of PSA by Mathematics teachers. It was also to interpret from the respondents' point of view, the challenges hindering the implementation of PSA and support needed by Mathematics teachers to implement PSA in Ghanaian Basic Schools.

5.1 Summary of Findings and Conclusion

The responses from the respondents showed that they knew something about teaching through PSA but how to do it was difficult because of lack of knowledge about the method and practice. Looking at the benefits/importance of teaching through PSA, current trends in Education and TIMSS report, this call to revamp the educational system should not be overlooked. There was the need to help our teachers to train the youth to be problem solvers

rather than mere certificate holders who always rely on rules/formulae to answer routine questions.

They also indicated that for Problem Solving Approach (PSA) to be implemented in Ghanaian classrooms/schools successfully, all stakeholders have roles to play especially; Government, Circuit Supervisors, Headmaster/Headteachers, Mathematics teachers and the students themselves.

5.2 Recommendations

Education is the backbone or bedrock of every developing country like Ghana. Education which is irrelevant to the society is just waste of time and resources. Based on the significance of Problem-solving Approach(PSA) to the teaching of Mathematics, it is recommended that;

I. Headteachers/Headmaster should collaborate with CSs to organise INSET for teacher on teaching through PSA during CBI/SBI sessions.
II. Institutions (Colleges of Education) responsible for training teachers should collaborate with Japanese JICA-Facilitators who are down to earth and ready to help and tape their expertise in addition to ours to revamp our educational system.
III. Modalities for promotion of teachers should be used to motivate teachers to develop interest in attending workshops even if they have to use their own resources.
IV. Ministry of Education / Ghana Education Service should consult the teaching universities in the country to train our teachers on how to teach through PSA and review the school curriculum to suit it because the time for Ghanaian education to

be geared towards training critical thinkers to solve environmental problems, rather than mere "certificate holders" is long overdue.

V. Ministry of Education / Ghana Education Service should make provision for nationwide training of teachers and regular refresher courses on Problem-Solving Approach (PSA) to the teaching of all subjects especially Mathematics to help reinforce the demands of our educational reforms because the 2007 educational reform emphasised practical teaching of Mathematics and relating it to real life but teachers are still "tellers"

VI. National Council for Curriculum and Assessment (NaCCA) reviews the curriculum and write new textbooks for teaching through Problem-Solving Approach

5.3 Suggestion for Further Research

The researcher suggests investigation into comparative performance of students taught through PSA and those taught through other methods. Also the study of the relationship between teachers' knowledge in a subject and the student performance could be considered for further study.

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APPENDICES

Appendix A: Questionnaire

QUESTIONNAIRE ON PROBLEM SOLVING APPROACH TO THE TEACHING OF MATHEMATICS

This questionnaire which you are being requested to complete intends to generate data on "The use of Problem Solving Approach (PSA) in the teaching of Mathematics at the Basic School level". The data that are obtained in this way will form part of a bigger research project, the results of which may influence decision makers in formulation of policies about methods of teaching at the basic school level.

- Please answer all questions as honestly as possible. There are no right or wrong answers. Read all options before answering.
- All respondents will remain anonymous. The answers to the questions will be treated as strictly confidential.
- Thank you for your cooperation. It is truly appreciated.

Part I: Demographic information

Please tick in the box that applies to you.

1. Gender: Male ☐ Female ☐

2. Age: Under 30 years ☐ 30 to 39 years ☐ 40 to 49 years ☐ 50 years and above ☐

3. Teaching experience: 0 to 4 years ☐ 5 to 10 years ☐ 11 to15 years ☐

More than 15 ☐

4. Your current post level: Teacher ☐ Senior teacher ☐ Head of Department ☐

Others (specify) ..... ……..

5. Highest academic qualification:

GCE 'O' level ☐ SSSCE / WASSCE ☐

GCE 'A' level ☐ Diploma / HND ☐

Bachelor's Degree ☐ Master's Degree ☐

6. Highest professional qualification:

Teachers' Cert'A' ☐

Certificate in Education ☐

Diploma in Education ☐

Graduate's Certificate in Education ☐

Postgraduate's Diploma in Education ☐

Bachelor of Education ☐

Master of Education ☐

Others (specify) ……

PART II

Teachers understanding of teaching Mathematics through Problem Solving Approach.

1. State whether the following statements are TRUE or FALSE about the meaning of using problem solving approach to teach mathematics at the Basic School level.

i. Giving problems to learners to solve after a mathematics lesson …….

ii. Using problems as vehicles to convey meaning of mathematical concepts to learners ……..

iii. Teaching learners about mathematical problem solving ……..

iv. Allowing learners to solve their own mathematical problems ……..

2. Engaging learners in a task for which the solution method is not known is important in teaching through problem solving. Yes ☐ No ☐
3. Problem solving approach to the teaching mathematics is giving learner word problem to solve True ☐ False ☐
4. When learners are able to solve difficult mathematics question it means the teacher is using PSA to teach mathematics

True ☐ False ☐

5. What do you know about problem solving approach to teaching?

……

6. What do you know about problem solving approach to the teaching of mathematics? …….

7. Give any importance/benefits of problem solving approach to the teaching of mathematics……

……

Please, tick [✓] *the option that best reflects how you associate with each of the following statements*

Rating Scale: Strongly Agree (SA = 5), Agree (A = 4), Uncertain (U = 3), Disagree (D = 2), Strongly Disagree (SD = 1)

	To what extent do you agree with the following benefits of problem-solving approach to the teaching	SA	A	U	D	SD
8	A problem-solving approach can provide a vehicle for students to construct their own ideas about mathematics					
9	It is a vehicle for developing logical thinking,					
10	To take responsibility for their own learning.					
11	It is an aesthetic form in itself and It can provide students with a context for learning mathematical knowledge					
12	It enhance transfer of skills to unfamiliar situations					

Frequency of teachers' use of problem solving approach in mathematics lesson

13. Are you interested in using problem solving approach in teaching mathematics?

Yes ☐ No ☐

14. Do you use problem solving approach in teaching Mathematics?

Yes ☐ No ☐

15. If yes to Q14, how many times do you use PSA in teaching mathematics per week?

Once ☐ twice ☐ 3 times ☐ 4 times ☐

Give reasons for your choice of frequency

……
……..

16. Do learners participate actively in your mathematics lessons? Yes ☐ No ☐

17. Which teaching methods do you use very often in the teaching of mathematics?

. …….

18. Do you use TLMs in your lesson delivery? Yes ☐ No ☐

19. If yes to Q17, mention some of the TLMs you use

…….

Key educational stakeholders views on factors responsible for teachers' failure to use problem solving approach in the teaching of mathematics

20. Are teachers using problem solving approach to teach mathematics in your classroom/ school?

21. If yes to Q19, how do they use it? …….....

……

22. If No to Q19, why are they not using it?

…….

23. Have you attended any workshop on the use of problem solving approach to the teaching of mathematics? Yes ☐ No ☐

24. Why are most teachers not comfortable with the use of problem solving approach to the teaching of mathematics? . …….

……

Support needed by classroom teachers to implement problem solving approach in Ghanaian classroom

25. Is the interest of the mathematics teacher a factor in the successful implementation of problem solving approach in Ghanaian classroom? Yes ☐ No ☐

26. Do teachers need INSET to enable them use problem solving approach in teaching mathematics? Yes ☐ No ☐

27. Do teachers need re- training to enable them include problem solving approach in their teaching methods?

Yes ☐ No ☐

28. Would orientation of the teachers' mind help in the implementation of problem solving approach in Ghanaian classrooms? Yes ☐ No ☐

29. Which other support do teachers need if there is the need to implement problem solving approach in Ghanaian classrooms? …….

. ……..……..

30. What is the government supposed to do to ensure successful implementation of problem solving approach in Ghanaian Basic Schools? ……

……

31. What is the School/Headmaster/Circuit supervisor supposed to do to ensure successful implementation of PSA in Ghanaian Basic Schools?..... ….……

……

32. How would the Mathematics teacher contribute to successful implementation of problem solving approach in his/her schools/ classroom? ……..……

……..……

Appendix B: Interview Schedule

INTERVIEW SCHEDULE ON PROBLEM-SOLVING APPROACH TO THE TEACHING OF MATHEMATICS

How do teachers understand and use Problem-Solving Approach (PSA) in the teaching of Mathematics?

Interviewer: Listen to the following statements and tell whether they are TRUE or FALSE about the meaning of using problem-solving approach to teach mathematics at the Basic School level.

i. Interviewer: Giving problems to learners to solve after a mathematics lesson

   Respondent:

ii. Interviewer: Using problems as vehicles to convey meaning of mathematical concepts to learners

   Respondent:

iii. Interviewer: Teaching learners about mathematical problem solving

   Respondent:

iv. Interviewer: Allowing learners to solve their own mathematical problems

   Respondent:

2. Interviewer: Engaging learners in a task for which the solution method is not known is important in teaching through problem solving.

   Respondent :

3. Problem solving approach to the teaching of mathematics is giving learner word problem to solve

   Respondent :

4. Interviewer: When learners are able to solve difficult mathematics question it means the teacher is using PSA to teach mathematics

Respondent :

5. Interviewer: What do you know about problem-solving approach to teaching?

Respondent :

6. Interviewer: What do you know about problem-solving approach to the teaching of mathematics?

Respondent :

7. Interviewer: Give any importance/benefits of problem-solving approach to the teaching of mathematics

Respondent :

8. Are you interested in using problem-solving approach in teaching mathematics?

Respondent :

9. Do you use problem-solving approach in teaching Mathematics?

Respondent :

10. If yes to Q9, how do you use it?

Respondent :

Research Q2

What factors are responsible for teachers' failure to use Problem-Solving Approach (PSA) in the teaching of Mathematics?

11. Interviewer: Are teachers using problem-solving approach to teach mathematics in your classroom/ school?

Respondent :

12. Interviewer: Have you attended any workshop on the use of problem-solving approach to the teaching of mathematics?

Respondent :

13. How did you learn about teaching Mathematics through Problem-Solving Approach?

Respondent :

Failure to use

Support needed by classroom teachers to implement problem solving approach in Ghanaian classroom

14. Interviewer: Is the interest of the mathematics teacher a factor in the successful implementation of problem solving approach in Ghanaian classroom?

Respondent :

15. Interviewer: Do teachers need INSET to enable them use problem solving approach in teaching mathematics?

Respondent :

16. Interviewer: Do teachers need re- training to enable them include problem solving approach in their teaching methods?

Respondent:

17. Interviewer: Would orientation of the teachers' mind help in the implementation of problem-solving approach in Ghanaian classrooms?

Respondent:

18. Interviewer: Which other support do teachers need if there is the need to implement PSA in Ghanaian classrooms?

Respondent:

19. Interviewer: What is the government supposed to do to ensure successful implementation of PSA in Ghanaian Basic Schools?

Respondent :

20. Interviewer: What is the Headmaster/Circuit supervisor supposed to do to ensure successful implementation of PSA in Ghanaian Basic Schools?

Respondent :

Appendix C: Lesson Observation

LESSON 1

CIRCUIT: Asuboni Rails

SCHOOL: Asuboni M/A JHS

SUBJECT: Mathematics

FORM: Two (2)

TOPIC: Proportion

REFERENCE: Mathematics syllabus for JHS Page 15, Maths for teacher training colleges in Ghana; student's activity and teacher's notes. Akiola for junior High school

OBJECTIVE: By the end of the lesson the student will be able to:

i. Explain the concept of proportion
ii. Solve problems on proportion

R.P.K.: Students have been taught the concept of ratio and can solve exercise on it.

LESSON PRESENTATION: The lesson was introduced by asking students to solve ratio questions on the board. The teacher solved two (2) proportion questions on the board with students and used it to explain the concept. Students were guided by the teacher to solve more examples. The lesson was summarised by the teacher that proportion is comparism of two ratios.

Discussions were held after the lesson delivery. Though the objectives were achieved, the delivery was not through Problem-Solving Approach (PSA).

LESSON 2

CIRCUIT: Nkawkaw 'A'

SCHOOL: Presby JHS

SUBJECT: Mathematics

FORM: 3A

TOPIC: Speed

REFERENCE: Mathematics syllabus for JHS and Student's textbook, page 26

OBJECTIVE: By the end of the lesson the student will be able to:

i. Calculate for speed when given distance and time
ii. Find time or distance when speed is given

R.P.K.: Students have been watching athletics

LESSON PRESENTATION:

i. Lesson was introduced by asking students to give or write some distances and time on the board.
ii. The teacher used some of the distances and time to find speed.
iii. Students were given some distances and time to find the speed.
iv. Word problems were given to students to find distance/time or speed.
v. The teacher explained to the student that the unit of speed is always distance/time (m/s or Km/hr)

Post-delivery discussions were held

LESSON 3

CIRCUIT: Apradang

SCHOOL: Apradang Methodist JHS

SUBJECT: Mathematics

FORM: One (1)

TOPIC: Area of a Circle

REFERENCE: Mathematics syllabus for JHS, Maths for teacher training colleges in Ghana; student's activity and teacher's notes.

OBJECTIVE: By the end of the lesson the student will be able to:

i. Identify the parts of a circle
ii. Find the area of a circle when given pi/diameter/radius.

R.P.K.:

LESSON PRESENTATION

Lesson was introduced by asking students to mention some parts of a circle.

Students were guided to identify some parts of a circle.

Teacher explained to the student that the area of a circle is $A = \pi r^2$

Students were given Pi/ diameter or radii and guided to find areas of different circles.

Closure of the lesson was done through summary

There was a post-delivery discussion.

LESSON 4

CIRCUIT: Awenade

SCHOOL: Awenade Anglican

SUBJECT: Mathematics

FORM: Two (2)

TOPIC: Equation in two variables

REFERENCE: Mathematics syllabus for JHS, Akiola for junior High School

OBJECTIVE: By the end of the lesson the student will be able to find truth set of simultaneous equations using substitution method.

R.P.K.: Students have been taught "change of subject"

LESSON PRESENTATION

Lesson was introduced by asking students to make some variables the subjects of given equations

- students were given two equations in two variables and guided to make one variable the subject of one equation.
- The new equation was substituted into the other equation, solved and the value of the variable, substituted into the first equation to obtain the value of the other variable.
- Students were given some examples to solve as teacher goes round to assist those having difficulties.
- Lesson was summarised and evaluation exercise was given to the class

Post-delivery discussions were held.