UNIVERSITY OF EDUCATION, WINNEBA

JUNIOR HIGH SCHOOL STUDENTS' DIFFICULTIES IN SOLVING WORD PROBLEMS IN ALGEBRA IN TEMA EDUCATION METROPOLIS

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THIS THESIS HAS BEEN READ AND APPROVED AS MEETING THE REQUIREMENTS OF THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA.

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DEDICATION

This thesis is dedicated to my wife, Theresa Yawa Kpontsu, my children, Magdalene Awo Aforklenu, Caleb Kofi Aforklenu and my father, Samuel Atitsogbey Aforklenu.

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ABSTRACT

Case study research design was used to examine JHS mathematics teachers‟ conceptions and practice of word problem solving (WPS), and difficulties students encounter when solving algebraic word problems in the mathematics classroom in the Tema Education Metropolis of the Greater Accra region of Ghana. The study used qualitative approach to collect and analyze data. Data was obtained from 12 participants consisting of 6 JHS mathematics teachers and 6 students. Interview, observation and analysis of documents (students‟ workbooks) were used as instruments to collect data.

The findings identified three different teachers‟ conceptions of word problem solving which include: accepting a challenging mathematical problem and striving hard to solve it, solving difficult mathematics story problems which involve everyday life situations and finding solution to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation and do not have immediate method of solving. The findings also indicated that some teachers use Polya‟s (1985) four-stage problem solving model and problem solving heuristics in the teaching of algebraic WPS. In addition, the findings showed that negligible amount of work was being done on WPS in the classroom. Problems hindering the teaching of mathematics word problem solving in the mathematics classroom were identified in a broader perspective to include teachers‟ inadequate pedagogical content knowledge and subject matter knowledge, teaching of word problem solving being time consuming, teachers and students beliefs‟ about WPS and low linguistic ability of students. Inadequate curricular materials and inadequate time slots for mathematics on the school timetable were also

identified. The findings also showed that very little work is done on WPS practices in the schools. Organizing in-service training for teachers, improving the conditions of service of teachers and providing teaching and learning materials were suggested as ways of encouraging the teaching of mathematics WPS in the mathematics classroom. As a case study which employed qualitative approach, the study results were limited to the researcher‟s interpretation and building of meaning in the context of teachers‟ WPS practices in the mathematics classroom.

CHAPTER 1

INTRODUCTION

1.2 Overview

This chapter discusses the background to the study, statement of the problem, purpose of the study, research questions, significance of the study, the delimitations and limitations of the study and the organization of the study.

1.2 Background to the Study

Mathematics is the bedrock for economic, scientific and technological advancement of any progressive nation. It is for this reason that the education system of countries that are concerned about their development put a great deal of emphases on the study of mathematics. (Obodo, 2004; MOE, 2010).

The need to apply mathematics to solve everyday life problems calls for introduction of problem solving as a component of the mathematics curriculum. Problem solving mathematics curriculum encourages the use of mathematics in novel or complex situations. It also emphasizes the teaching of mathematics content through processes that students encounter in real world situations. Problem solving mathematics curriculum includes using and applying mathematics in practical tasks, in real life problems and within mathematics itself. It covers a wide range of situations from routine mathematical problems to problems in unfamiliar contexts and open-ended investigations that make use of the relevant mathematics and thinking processes (Singapore, Ministry of Education, 2006).

Ghanaians increasingly hear about pupils who have gone through the basic educational system and are quite unhappy and uncomfortable with mathematics and

regard it as a difficult subject in the curriculum (Awanta, 2003). As mathematics teacher at the Junior High School and Senior High School levels, my observation revealed that students have problems in solving word problems in mathematics during standardized tests and national examinations.

The Chief Examiners" Report (2008) stated among other weaknesses, that in solving worded problems, candidates are far from right.

Also the 2003 and 2007 Trends in International Mathematics and Science Study (TIMSS), saw Ghanaian eighth grade (JSS2) students" performance to be so poor that Ghana placed 45th position on the overall mathematics achievement results table from the 46 participating countries (Anamuah-Mensah, Mereku & Asabre-Ameyaw, 2004; Anamuah-Mensah, Mereku & Ghartey-Ampiah, 2008). One of the reasons for this level of performance was that our students could not answer most of the algebraic word problems.

Recent evidence provided in National Education Assessment (NEA), a component of the Basic Education Comprehensive Assessment System (BECAS), reports is that numeracy has greatly not improved. In 2005 the NEA, administered to about 3% of P3 and of P6 pupils nationwide, indicated that only 18.6% of the P3 and 9.8% of the P6 pupils reached proficiency level of 53% in mathematics (Adu, Acquaye, Buckle & Quansah, 2005). In 2007, 2009 and 2011" the NEA results indicated that the performance of pupils was still weak in mathematics.

Some reasons given for the abysmal performance of the Ghanaian students in the subject at both primary and junior high schools are weak problem solving abilities and the inability to comprehend language of text (Mereku & Anamuah-Mensah, 2007; Adu, Acquaye, Buckle & Quansah, 2007). It is also said that because in Ghana, most

teachers do not use problem solving as a teaching approach, they fail to teach students how to solve problems (JICA, 2006).

The term *word problem* in mathematics education is often used to refer to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation (Martinez, 2001). As word problems involve a narrative of some sort, they are occasionally also referred to as story problems and may vary in the amount of language used.

In the debate concerning what might be the reasons for the low achievements in mathematics by our students, Dotse (1999) and Sokpe (2004) argued that teachers should be blamed.

Also under the "Definition of Profile Dimension" of the Ghanaian Junior High School mathematics syllabus, it has been stated that "Knowledge", "Application", etc. are dimensions that should be the prime focus of teaching and learning in schools. It has been realized unfortunately that schools still teach the low ability thinking skills of knowledge and understanding and ignore the higher ability thinking skills.

Instruction in most cases has tended to stress knowledge acquisition to the detriment of the higher ability behaviours such as application, analysis etc. The persistence of this situation in the school system means that pupils will only do well on recall items and questions and perform poorly on questions that require higher ability thinking skills such as application of mathematical principles and problem solving.

This available evidence of poor mathematics performance is worrying and calls for an urgent scrutiny of the teaching and learning process in our mathematics classroom so that measures can be taken to deal with the undesired situation.

In Ghana, the Education Reform Review Committee (MOE, 2002) recommended a problem solving curriculum for pre-university education. This curriculum took effect in 2007. This current pre-university problem solving mathematics syllabus requires the use of mathematics in solving everyday life problems. Specifically, it recommended the application of appropriate mathematical problem- solving strategies in the teaching and learning of mathematics (MOE, 2010). Helping students to acquire the techniques of problem solving therefore becomes one of the main objectives of teaching mathematics in pre-university institutions in Ghana.

To promote equal opportunity efforts, an Act of Parliament was passed in 1994 in Ghana making basic education free and compulsory for all children of school going age. The policy, popularly known as fCUBE (Free and Compulsory Universal Basic Education), highlighted some very important issues in the teaching and learning of mathematics. One of these issues is: Having a lot to say about teaching styles, emphasizing discussion, practical work, investigative approaches and „problem solving" (Awanta, 2003).

Problem solving is not a distinct topic to be treated, rather it cuts across all the content domains described by the Ghanaian mathematics curriculum and provides the context in which concepts and skills can be learned. This makes problem solving a primary goal of every mathematics instruction and an integral part of all mathematical activity. Problem solving is not peculiar to mathematics education in Ghana alone. In America, the National Council of Teachers of Mathematics (NTCM 1989; 2000) had earlier endorsed the inclusion of problem solving in school mathematics. The NTCM (2000) specifically stressed that all "instructional programs should enable all students to build new mathematical knowledge through problem solving; solve problems that

arise in mathematics and in other contexts; apply and adapt a variety of appropriate strategies to solve problems; and monitor and reflect on the process of mathematical problem solving" (p.52).

Problem solving and for that matter word problem solving is very important in the study of mathematics. It offers opportunities for students to engage in meaningful mathematical discourse, including analysing various representations of and justifications for their solutions. Problem solving instructional practices force students to become active participants in the learning process and engage teachers to participate actively as learners in the classroom along with students. Problem solving activities can make mathematics more accessible to students as such activities allow students to partake in the construction of their own knowledge. In this context, problem solving develops students‟ ability to solve a wide variety of complex mathematics problems by making them become analytic in making decisions in life (Wilson, Fernandez & Hadaway, 1993).

Kahan and Wyberg (2003) also identified some benefits of teaching mathematics through problem solving to include: (i) helping students to understand that mathematics develops through sense-making process; (ii) deepening students‟ understanding of underlying mathematical ideas and methods and (iii) engaging students‟ interest (p.20). Problem solving helps students develop the mathematics, reading, writing, and thinking skills they need to solve math problems (word problems) typically found in textbooks, standardized tests and national examinations and to transfer these skills to real life math scenarios. Problem solving ability is enhanced when students have opportunities to solve problems themselves and to see problems being solved (Kilpatrick, Swafford, & Findel, 2001).

In addition, problem solving can provide the site for practising learned skills. “Problem solving ability does not develop over a few weeks or months. Nor is it a topic that is taught at a particular grade level. We need to address problem solving virtually every day, in every lesson, beginning from kindergarten and continuing through high school, because problem solving and learning mathematics are so intimately connected” (Van de Walle, 2004). In teaching problem solving teachers play an important role in developing students' problem solving dispositions. In doing so, they choose problems that engage students to this end (Haftu, 2008). They create an environment that encourages students to explore, take risk, share failure and successes, and question one another (Ibid). In such supportive environments students develop the confidence that helps them to explore problems and the ability to make adjustments in their problem solving strategies (NCTM, 2004).

According to Micintosh (2000), a good problem is one that is connected to students‟ interest, and applicable to students‟ real world problem solving. When the problem is engaging and interesting to the students, it promotes active involvement and intrinsically motivate students in the process of problem solving.

Problem solving is the process which starts when individuals encounter with problems and end when they obtain answer. Haftu (2008) explained that problem solving ability is enhanced when students have opportunities to solve problems by themselves and to see problems solved. The development of problem solving skill is not secured by providing only frequent opportunities to solve problems for students; but also by giving instructions in problem solving process using heuristics.

Direct teaching of problem solving math strategies such as make a list, draw a diagram and make a simple problem should be a day to day practice of teachers so as

to develop problem solving skill of students (NCTM, 2004). Problem solving approach of teaching tends to be more learner-focused, involving students in exploring mathematics concepts and creating solution, strategies and constructing meaning in a problem rich environment (Thompson, 1992).

Therefore, teachers at all levels of pre-university education should provide practical problem solving opportunities for students as well as adequate practical examples to enable students to consolidate the mathematical concepts being taught to be learned. By so doing, students can learn new concepts, practice skills and value problem solving as an important aspect of doing, learning and teaching mathematics (Korah, 2010).

The Ontario Ministry of Education (2007) adopted problem solving mathematics curriculum because it leads to better understanding of mathematical concepts, makes the learning of mathematics enjoyable, helps students to develop communication skills and develops collaborative learning and critical thinking skills. Learning mathematics through problem solving boosts students‟ confidence in mathematics and also facilitates their application of mathematics outside the classroom to solve real life problem situations.

The importance of problem solving cannot be overemphasized in the school curriculum. Through problem solving students acquire skills that are needed in everyday activities. It offers students the training that they need to prepare for career or job, helps students get more out of life, increases their knowledge and understanding of the universe, and helps them acquire skills that make their lives more interesting and enjoyable (Bryant, 2009). Students develop, extend and enrich

their understanding by solving problems (Hieber & Wearne, 2003). Teaching problem solving prepares students for a life full of able-mindedness. It also helps students to develop confidence as problem solvers and become mathematical risk-takers (Traiton & Midgett, 2001).

The successful implementation of a problem solving mathematics curriculum depends largely on teachers‟ actions and decisions and the acquisition of problem solving abilities and deepening of the students‟ problem solving skills depend on the teacher (Korah, 2010). Specifically, the teacher has to make good choices, which include; choosing appropriate problems that could engage students, selecting appropriate methods of teaching, providing an enabling environment for students to explore, taking appropriate decisions to avoid risks, and sharing failures and successes in real practice.

Teacher‟s role in problem solving mathematics classroom is drastically transformed from his or her traditional role as a source of knowledge and authority to a guide and facilitator. As reported by (Baki, 2004) in the study of problem solving experiences of pre-service mathematics teachers that, “students felt that the teacher was closer to them by giving up the role of authority or a distributor of pre-organized knowledge and assuming the role of a counselor, bridging their previous experience with an appropriate use of software” (p.179).

Although teachers play a major role in implementing educational curriculum, most research works on mathematics problem solving have focused more on students (Marcou & Philippou, 2005; Alfaro, 2006; Mereku, 1998; Lau & Kiong, 2006; Akinsola, 2008). Few or none have examined teachers problem solving and word

problem solving practices in teaching mathematics as it pertains in the Junior High School (JHS) mathematics classroom in the Ghanaian context.

Hence this study was designed to examine Junior School Students‟ difficulties in solving word problems in algebra in the mathematics classroom.

1.3 Statement of the Problem

The primary aim of mathematics teaching and learning is to develop learner‟s ability to solve a wide variety of complex mathematics problems and to apply mathematics to real world situations. In Ghana, the mathematics syllabus recommended the use of mathematics in daily life by recognising and applying appropriate mathematics problem solving strategies (MOE, 2010).

However, as mathematics teacher at the Junior High School and Senior High School levels, my observation revealed that students have problems in solving word problems in mathematics during standardized tests and national examinations. It is stated in the Chief Examiners‟ Report (2008), among other weaknesses, that in solving word problems, candidates are far from right. Also studies have shown that students are not able to solve unfamiliar mathematics problems (TIMSS, 2003; 2007) and that problem solving is unpopular among Ghanaian students (Mereku, 1998).

Students‟ inability to use appropriate problem solving - strategies to deal with new mathematical situations and the unpopularity of problem solving in schools is a reflection of how mathematics teachers conceive and practice problem solving in the classroom. Hence this study aimed at JHS students‟ difficulties in solving word problems in algebra and teachers WPS practices.

1.4 Purpose of the Study

The purpose of the study is to determine Ghanaian JHS students‟ difficulties in solving word problems in algebra and how they practice problem solving across the content domains described by the mathematics curriculum.

1.5 Objective of the Study

Skills in problem solving are applied in all spheres of human endeavour. They are applied in commerce, industry or science. In view of this, problem solving is recommended as a powerful instructional tool in mathematics education. Teachers can equip students with problems solving skills to enable them solve real life problems, if their practices are tailored to achieve the objective of the problem solving delineated by the curriculum.

The objective of the study is to gain an insight into difficulties experienced by Junior High School students when solving word problems from the perspective of teachers.

1.6 Research Questions

Problem solving is central to mathematics education in Ghana. Teachers are implementing the problem solving curriculum and yet many students seem to lack problem- solving skills to be functional in real life situations. The following research questions guided the study:

1. What are JHS teachers‟ conceptions of word problem solving in the mathematics curriculum?
2. How is the teaching of word problem solving practiced by JHS teachers in the mathematics classroom?

3. What problems militate against the teaching of word problem solving in the JHS mathematics classroom?
4. What difficulties do JHS students encounter when solving word problems in the mathematics classroom?
5. How can the teaching of mathematics word problem solving be encouraged among JHS teachers?

1.7 Significance of the Study

The findings of this study would enable teachers to realise the importance of word problem solving in the mathematics curriculum. The study would make teachers give much attention to the teaching of word problem solving in the mathematics classroom, so as to equip students with problem solving skills and strategies. This would then help students to handle real-life problem situations with much ease and also deal with future job careers with little or no difficulty.

Also the findings of this study would provide information for policy makers in education about teachers‟ word problem solving practices in the mathematics classroom. The results of the study can act as a guide to curriculum developers in planning and designing problem solving enriched mathematics curriculum for Ghanaian pre-university institutions. The findings of the study can also serve as the basis for organizing professional development courses and in-service training programmes for teachers in teaching mathematics word problem solving. Furthermore, the study would provide relevant literature to mathematics educators and researchers who wish to research in to mathematics word problem solving.

1.8 Delimitations

This study was conducted among JHS mathematics teachers and students in the Tema Education Metropolis (TEM) of the Greater Accra region of Ghana. Tema Education Metropolis consists of three (3) sub-metros. The selection of the metropolis depended on what the researcher wants to know, the purpose of the research, and what could be done with the available resources at hand (Patton, 2002). Hence the study involved a sample of 12 participants consisting of 6 mathematics teachers and 6 students in the three sub-metros.

Mathematics problem solving has wide coverage. However, the study considered only the following aspects: mathematics teachers‟ word problem solving practices, factors that militate against the teaching of word problem solving in the mathematics classroom, the extent to which students practice word problem solving and difficulties students encounter when solving word problems.

1.9 Limitations

Due to limitations in the design, data collection procedure and data analysis, one metropolis consisting of three (3) sub-metros was used in the study. The results of the study may therefore not be generalized to the entire region.

The organization and categorization of the data collected for analysis and discussions were the most demanding of the research design. It was particularly difficult to sieve all useful responses from the interviews and observations of teachers and analysis of students‟ class works/exercises into categories for presentation and analysis. The categories identified in this study were therefore shaped by the researcher‟s perception, interpretation, and building of meaning of the data collected with guidance from supervisor.

1.10 Organisation of the Study

The study is organised in five chapters. Chapter 1 includes background, statement of the problem, purpose of the study, research questions, significance of the study, delimitations and limitations. Chapter 2 discusses the conceptual framework and the review of related literature. Chapter 3 deals with the research methodology, which includes the research design, population, sample and sampling technique, instrumentation, procedure for collection and analysis of data. Chapter 4 presents the findings of the study. Chapter 5 discusses the summary of results, discussions, recommendations and suggestions for further study.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 Overview

This chapter discusses the conceptual framework of the study and related literature.

2.2 Theoretical Framework

This study"s theoretical framework is based on Shulman (1986) knowledge domains in teaching. Shulman proposed three content domains for teaching to include subject matter content knowledge (SMCK), pedagogical content knowledge (PCK) and curricular knowledge (CK). Teaching is far more than mere transmitting of concepts and ideas to learners, but it involves bringing out the accumulated ideas and experiences that students come to class with and working on those ideas and experiences together with the students by way of refining, reorganizing, co-constructing and repairing these ideas and experiences into meaningful and comprehensible form for students to assimilate (Shulman, 2000). This forms the basis on which teaching of mathematics problem solving should lean.

It therefore implies that for teachers to teach mathematics word problem solving, they need to have an in-depth comprehension and understanding of the mathematical content of word problem-solving, the pedagogical principles of problem solving and curricular materials that inform scope and direction of word problem solving. More importantly, teachers need to have an integrated knowledge of these knowledge domains. That is, what are the domains and categories of content knowledge in the minds of teachers? How for example are content knowledge and general pedagogical knowledge related? In which forms are the domains and categories of knowledge

represented in the minds of teachers? According to Shulman (2000) teaching is making the internal, external, and can only be achieved if teachers engage students in the classroom discourse. It is only when students are engaged in an interactive classroom environment that their ideas, conceptions, preconceptions and experiences are made bare to the teacher. Shulman (1986) knowledge domains offer a coherent framework for teaching mathematics problem solving.

2.2.1 Subject Matter Content Knowledge (SMCK)

Shulman (1986) refers to subject matter content knowledge (SMCK) as the amount and organization of knowledge per se in the mind of the teacher. He argues that to think properly of teachers‟ subject matter knowledge, requires going beyond knowledge of the facts, concepts and procedures. It requires understanding the structures of the subject matter in the manner defined by Schwab. According to Schwab (1978) the structures of a subject include both the substantive and the syntactic structures.

The substantive structures are the variety of ways in which the basic concepts and principles of the discipline are organized to incorporate its facts. Teachers therefore, will be able to use problem- solving instructional approaches to teach mathematics word problem solving well only when they comprehend the network of fundamental concepts and principles of problem solving in holistic manner (Shulman, 1986).

The syntactic structure of a discipline is the set of ways in which truth or falsehood, validity or invalidity is established. The syntactic structure is used to establish the most appropriate claim when there are competing claims about a particular phenomenon. The teacher‟s knowledge therefore must go beyond the mere definitions of accepted truths in the subject matter domain for students to the extent of explaining

why a particular proposition is deemed justified, the value of knowing it and how it relates to other propositions within or without the discipline and both in theory and in practice.

The understanding of mathematical concept should not mean so much to the teacher, but the teacher must further understand why it is so. He or she ought to know the grounds on which its warrant can be asserted and under what circumstances the belief in its justification can be weakened and even denied.

In order that JHS mathematics teachers can teach mathematics word problem solving effectively, they need to possess both the syntactic and the substantive structures of problem solving (Shulman, 1986). The syntactic and substantive structures will enable teachers to scrutinize, analyze, justify, compare and contrast students‟ solution processes so as to clarify their errors and misconceptions in the teaching and learning of word problem solving process. Building on Shulman (1986) knowledge domains, Ball, Hill and Bass (2005) noted that teachers‟ use of instructional materials, their ways of assessing students‟ progress and how they make sound judgements about representations, emphasis and sequencing depend on their mathematical content knowledge for teaching.

There is a “mathematical knowledge for teaching”- a kind of professional knowledge of mathematics different from that demanded by other mathematically intensive occupations, such as engineering, physics, accounting, or carpentry (Ball, 2005). Hence in teaching mathematics problem solving, teachers need to have thorough content knowledge for selecting, designing and using appropriate instructional materials that embody the concepts. In addition teacher‟s ability to choose useful

methods and pose appropriate examples to students in a problem solving lesson are enriched in their mathematical content knowledge for teaching.

Knowing mathematics for teaching demands a kind of depth and detail knowledge that goes well beyond what is needed to carry out the algorithm reliably to include considerations in choosing good examples for instructional purposes (Hill, Ball & Bass, 2005). Teaching mathematics word problem solving depends so much on teachers‟ subject matter knowledge because teachers need to evaluate problem-solving strategies often used by students to obtain correct solutions, but whose generalizability or mathematical validity are immediately not clear. In a situation where a teacher is deficient in the subject matter knowledge of problem solving it becomes practically impossible for him or her to effectively teach mathematics word problem solving.

2.2.2 Pedagogical Content Knowledge (PCK)

A second kind of content knowledge is pedagogical knowledge. According to Shulman (1986), pedagogical content knowledge combines the most regular taught topics, the most useful forms of representations of those ideas, the most powerful analogies and examples, illustrations, explanations and demonstrations in the art of teaching and therefore goes beyond the subject matter content knowledge to include the dimension of subject matter knowledge for teaching.

Furthermore, PCK includes the ways of representing and formulating the subject matter in a manner that makes it comprehensible to students with diverse views and understandings. In teaching word problem solving in mathematics, teachers need to be able to design and present mathematics lessons in a comprehensible manner for students. Since there is no single most distinct form of representations, teachers ought

to have at hand a veritable armamentarium of alternatives forms of problem solving representations. They need knowledge of pedagogical strategies most appropriate for reorganizing the understanding of learners who might appear before them as blank slates (Shulman, 2000).

In addition, according to Shulman (1986) pedagogical content knowledge implies an understanding of what makes the learning of specific topics difficult, the conceptions and preconceptions that, students of different ages and backgrounds often bring with them to the learning environment. Most of these preconceptions are often misconceptions and PCK helps teachers to anticipate students‟ learning difficulties and to provide available alternative models or explanations to mediate those difficulties. Shulman (2000) argues that if teachers will teach students to engage in active thinking about what they know and how they know it and can create conditions where students can discuss what they know with other learners, this will minimize the problem of illusory understanding. He also said that group-based strategies will enhance understanding among learners.

Ball and Bass (2000) delineated PCK for teaching mathematics as a specialized form of knowledge that combines mathematical knowledge with knowledge of students or learners, learning and pedagogy. This means that teachers need to have control of the subject matter, knowledge about learners, their strengths and weaknesses as well as resource with varied instructional strategies before they can teach mathematics word problem solving. They noted all the challenges in the work of teaching that draw on mathematical resources, and then analyzed the nature of such mathematical knowledge and skills and how they are held and used in the work of teaching. In cautioning, however, Ball and Bass (2000) said that no amount of PCK can prepare a

teacher for all classroom practice because a significant proportion of teaching is full of uncertainties.

Uncertainty of teaching does not mean that teachers cannot be prepared to know in practice. When teachers are prepared to harness all possible pedagogical strategies of teaching and learning and make use of them in the classroom it is likely to improve the teaching of mathematics word problem solving in the curriculum.

2.2.3 Curricular Knowledge

The mathematics curriculum is represented by a full range of programmes designed for the teaching of mathematics topics at a given grade level. It covers a wide variety of instructional materials available in relation to the subject matter to be handled, and the set of characteristics that guides the use of particular curriculum materials in particular circumstances (Shulman, 1986). In his presentation at a forum organized by the National Curriculum Board, Wardlaw (2008) revealed a focus on student problem solving learning through alignment of curriculum, pedagogy and assessment. This means that to ensure effective teaching and learning of word problem solving in the mathematics classroom, teachers must ensure proper interplay of this alignment.

It is important to stress that teachers ought to have full knowledge of the alignment for student learning at the basic level of education for effective teaching and learning of word problem solving in the mathematics classroom. Teachers need to think hard about students mathematical ideas, analyze textbook presentations, and judge the relative value of two different representations in the face of a particular mathematical issue (Ball & Bass, 2000). Mathematics teachers need to have thorough understandings of the curricular resources available for problem solving instructions

so as to make them available to students when teaching mathematics word problem solving. It is expected that the mature teacher possesses such understandings about the curricular alternatives available for instruction. In addition to the knowledge of alternative curriculum materials for a given subject or topic within a grade, there are two additional aspects of curricular knowledge. These include lateral curriculum knowledge appropriate in particular to the work of junior and senior high school teachers as it underlies the teacher‟s ability to relate the content of a given course or lesson to topics or issues being discussed simultaneously in other classes, and the vertical curriculum knowledge which is the familiarity with the topics and issues that have been and will be taught in the same subject area during the preceding and later years in school, and the materials that embody them (Shulman, 1986).

The professional teacher is expected to be familiar with the curriculum materials under study by his or her students in other subjects they are studying at the same time. The ideas of subject matter content knowledge, pedagogical content knowledge and curricular knowledge form a conceptual basis on which the concept of problem-solving approach in teaching mathematics is built. Hence for teachers to teach word problem or word problem solving effectively, they need to have a full grasp of curricular knowledge for teaching.

2.3 Conceptions of Problem and Problem-Solving

Evidence of research shows that there are varied conceptions of problem and problem solving and that teacher‟s classroom practices are influenced by these conceptions. Cooney, Davis and Henderson (1975), see a problem as “A question which presents a challenge that cannot be solved by some routine procedure known to the students” (p. 242). They further explained that a problem can also be described as some *sort of*

block before a goal. The block does not constitute a problem until the student is motivated to overcome the block and attain the goal. Okpoti (2004) asserted that a *problem* is a challenging question or statement presented in such a way that learners accept a challenge. In the learning and teaching of mathematics, „problems" can be used in the mathematics classroom to assess pupils" understanding of topics taught.

Frobisher (1994) stated that the commonly accepted view of a mathematics problem is the „word" problem. He therefore, defined a problem as a task presented in words with a question posed to define the goal a solver is expected to attain in carrying out the task.

In mathematics education, the term *word problem* is often used to refer to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation (Martinez, 2001). As word problems involve a narrative of some sort, they are occasionally also referred to as story problems and may vary in the amount of language used. For example, a mathematical problem in mathematics notation, which reads: Solve for J.

J = A - 20

J + 5 = (A + 5)/2 might be presented as a text or in a word problem as follows: John is twenty years younger than Amey. In five years" time he will be half her age. What is John"s age now? (MAG, 2005).

Krulik and Rudnick (1996) give three conditions to determine whether a situation is a problem. The first condition is that the individual be able to achieve a clear *goal* as a resolution to the situation. Secondly, there must be *obstacles* to achieving the goal; thirdly, the first two conditions will compel the individual *to explore* methods in overcoming the obstacles to reach the goal.

According to Dollah (2006), a problem is ***subjective*** in nature. A task or question can be a problem for one student, but merely a routine exercise for another. Thus, it is not unusual if, in a classroom there are tasks or questions that certain students manage to solve while others fail to find for a satisfactory answer.

Dollah (2006) said problem solving involves student‟s willingness to accept challenges. Whether the task at hand is difficult or not does not matter, as long as the student accepts it as a challenge. Accepting a challenge here means that the student is willing to find appropriate methods to solve the problem. Kaikow (2004) explained problem solving in mathematics as "thinking and working mathematically" but the converse is not true and that the process invariably calls for a problem solver who is engaged in a mathematical task to organise and deal with domain-specific and domain-general pieces of knowledge.

Lester and Kehle (2003, p. 510) typify problem solving as an activity that involves the students‟ engagement in a variety of cognitive actions including accessing and using previous knowledge and experiences. What does it mean for students to organize previous knowledge and experiences to generate new knowledge? It is clear that if students are to be engaged in problem solving activities they need to develop a way of thinking consistent with mathematical practices, in which problems or tasks are seen as impasses that need to be examined in terms of questions. Thus, students need to problematize their own learning.

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.

Traiton and Midgett (2001) said 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. Problem solving according to the Principle and Standards for School Mathematics (NTCM, 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; Lambdin, 2003; Van De Walle, 2001). Anderson, Peter and White (2004) described problem solving as the process by which students explore non-routine questions. The explorations involve using a wide gamut of strategies to solve unfamiliar tasks, as well as developing the processes of analyzing, reasoning, generalising and abstracting. In the exploration process students make mistakes and backtrack. Making mistakes and backtracking is a natural part of problem solving. According to Goldberg (2003), mathematical problem solving involves the ability to read, process and solve mathematical situations.

2.4 The Role of Problem Solving in School Mathematics

Stanic and Kilpatrick (1989) identify three general themes that have historically characterized the role of problem solving in school mathematics: these are problem solving as context, problem solving as skill, and problem solving as art.

2.4.1 Problem Solving as Context

The authors divide problem solving as a context for doing mathematics into several subcategories. Problem solving has been used as *justification* for teaching mathematics. To persuade students of the value of mathematics, the content is related to real world problem-solving experiences. Problem solving also has been used to *motivate* students, sparking their interest in a specific mathematical topic or algorithm by providing a contextual (real-world) example of its use. Problem solving has been used as *recreation,* a fun activity often used as a reward or break from routine studies. Problem solving as *practice,* probably the most widespread use, has been used to reinforce skills and concepts that have been taught directly. When problem solving is used as context for mathematics, the emphasis is on finding interesting and engaging tasks or problems that help illuminate a mathematical concept or procedure. To use problem solving as context, a teacher might present the concept of fractions, for example, assigning groups of students the problem of dividing two pieces of licorice so that each gets an equal share. By providing this problem-solving context, the teacher‟s goals are multiple: to create opportunities for students to make discoveries about fraction concepts using a familiar and desirable medium (*motivation)*; to help make the concepts more concrete (*practice*); and to offer a rationale for learning about fractions (*justification)*.

2.4.2 Problem Solving as a Skill

Advocates of this view teach problem solving skills as a separate topic in the curriculum, rather than throughout as a means for developing conceptual understanding and basic skills. They teach students a set of general procedures (or rules of thumb) for solving problems-such as drawing a picture, working backwards, or making a list-and give them practice in using these procedures to solve routine

problems. When problem solving is viewed as a collection of skills, however, the skills are often placed in a hierarchy in which students are expected to first master the ability to solve routine problems before attempting non -routine problems. Consequently, non routine problem solving is often taught only to advanced students rather than to *all* students. When defining the learning objectives of a problem-solving activity, teachers will want to be aware of the distinction between teaching problem solving as a separate skill and infusing problem solving throughout the curriculum to develop conceptual understanding as well as basic skills.

2.4.3 Problem Solving as Art

In his classic book, *How to Solve It*, George Polya (1945) introduced the idea that problem solving could be taught as a practical *art*, like playing the piano or swimming. Polya saw problem solving as an act of discovery and introduced the term "modern heuristics" (the art of inquiry and discovery) to describe the abilities needed to successfully investigate new problems. He encouraged presenting mathematics not as a finished set of facts and rules, but as an experimental and inductive science. The aim of teaching problem solving as art is to develop students" abilities to become skillful and enthusiastic problem solvers; to be independent thinkers who are capable of dealing with open-ended, ill-defined problems.

2.5 Problem- Solving Approaches

Research literature on problem solving identifies three problem solving approaches to include: teaching **for** problem solving, teaching **about** problem solving and teaching **through** problem solving (Schroeder & Lester, 1989; Siemon & Booker, 1990; Anderson, 2000; Fong, 2002). Each of these approaches has implications for the types of activities and strategies that might be presented to students in mathematics lessons.

All three approaches involve the use of problem- solving strategies and heuristics. However, while both teaching **for** and **about** problem solving entreat problem solving as an object of inquiry, teaching **through** problem solving entreats problem solving as a process of inquiry.

It has been argued that there is a place for all the three approaches in the teaching of mathematics, although teaching **through** problem solving is regarded the most appropriate approach. Schroeder and Lester (1989) also emphasized that all 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. They further indicated that teaching **about** problem solving can lead to problem solving being treated as another topic in the curriculum. Lastly, they advocated that teaching **through** problem solving is most likely to promote understanding.

2.5.1 Teaching about Problem Solving

Teaching *about* problem solving includes guidance concerning problem solving process and instruction about various problem- solving strategies. This often includes the recommendations of Polya (1985) problem solving strategies. When teaching about problem solving, learners learn to use variety of problem solving strategies or heuristics, which include: make a list, draw a diagram, act it out, and 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

unfamiliar problems or non-routine problems to teach thinking skills and problem solving heuristics (Fong, 2002). When teachers teach about problem solving (heuristics approach) to students the following points should be taken in to consideration (Downs cited in Higgeins, 1983),

- *Modelling useful problem solving method. S*tudents should follow some steps that lead them to solutions such as those suggested by Polya (1995).
- *Teaching within specific context. T*eaching problem solving to our students in the context in which they live enhances their problem solving skills.
- *Helping students understand the problem:* For successful problem solving, students should define the initial and final goal of problem solving.
- *Taking enough time:* To understand the problem, plan and carry out the problem, students should take enough time.

2.5.2 Teaching through Problem Solving

In this approach, problems are used as vehicle for learning mathematics (Anderson, 2002; Foong, 2002). Teaching *through* problem solving focuses more on students‟ understanding. This approach attempts to make sense of mathematical procedures needed to solve a problem and as such; students are engaged in doing mathematics (Foong, 2002). In this approach, problem solving is 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 organize their understanding in order to resolve the problem (Anderson, 2000). Learners 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 tales 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 learners to clarify their ideas and to acquire different perspectives of the concept 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) and Chapman (2008), 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) 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 them help find a solution. This process forces the reorganization of existing ideas and the emergence of new ideas as learners work on problems with the help of a teacher

who acts as a facilitator by asking questions that will aid students to review their knowledge and construct new connections.

The teacher‟s role in this approach is essentially non-judgmental rather than authoritarian. Instead of the teacher being the sole source of knowledge and solutions, he or she creates a classroom climate and culture that encourages and facilitates pupils own initiatives and stimulates interactive and collaborative problem solving (Corte, 2003). Norton, McRobbie, and Cooper (2002) therefore 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 conception, it has not been the subject of much research.

2.5.3 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 (Anderson, 2000; 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 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 (Fong, 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).

2.6 Problem Solving Strategies

Problem- solving strategies are procedures that can be used to solve various types of problems. Common problem solving strategies include: making a model, picture, or diagram; looking for a pattern; guessing and checking; making assumptions; creating an organized list, making a table or chart; solving a simpler problem; working backwards; and using logical reasoning (Ontario ministry of Education, 2007).

The Mathematical Association of Ghana (2005) noted that in problem solving or in solving word problems the following strategies are important. They include: understanding the problem, use a letter (variable) to represent the unknown, write a mathematical sentence (equation) in the unknown, solve for the unknown by writing equivalent equations and check your answer (if you can).

Polya (1985) proposed that good problem solving encompasses four phases. The four-stage model include: Understanding the problem, devising a plan, carrying out the plan, and looking back. Although these four stages of problem solving are listed in order of progression, for difficult problems it may not be possible to simply move through them consecutively to produce an answer. It is obvious that students move backwards and forwards between and across the steps in a problem solving process.

According to Polya (1985), there is no chance of being able to solve a problem unless you understand the problem first. Understanding the problem requires extracting and assimilating the relevant and valuable information from the given, determining the goal of the problem, reconstructing the problem if necessary, and introducing suitable notations whenever possible for easy reference and manipulation. This means that understanding the problem requires not only knowing what to do but also the key pieces of information that somehow need to be put together to obtain the answer. As one will often not be able to absorb all the important information of a problem at once, Polya advised that it is always necessary to read a problem several times both at the start and during working. During the solution process, one may find it necessary to look back at the original question from time to time to make sure that they are on the right path. He asserted that to understand the problem, the following questions can be asked: Do you understand all the words? Can you restate the problem in your own words? What are you trying to find or do? What information do you obtain from the problem? What are the unknowns? What information, if any, is missing or not needed?

Polya‟s second stage, devising a plan requires making a general plan and selecting relevant methods, or more appropriately, heuristics, that might be useful for solving the problem based on the understanding of the problem at the first stage. There are certainly problems where learners may find it necessary to play around with the information before they are able to think of a strategy that might produce a solution. At this stage one may ask: What is the relationship between the data and the unknown? Is this problem similar to another problem that you have solved? What strategies can you use? (Polya, 1985).

In Polya‟s third stage, carrying out the plan is to execute the plan, which has been decided at the preceding stage, and to keep the track to obtain the answer. This means the chosen strategy is used to solve the problem step by step and if the solution cannot be found, the strategy or plan is changed. The final stage, looking back involves checking the correctness of the solutions, reflecting on key ideas and processes of problem solutions, and generalizing or extending the methods or the results. This step is often overlooked in problem solving. As a mathematics teacher, one should remind his/her students to always check their answers. Some guidelines for looking back include the following: Reread the question. Did you answer the question asked? Is your answer correct? Does your answer seem reasonable?

Verschaffel, De Corte, Van Vaerenbergh, Bogaerts and Ratinckx (1999) designed, implemented and evaluated a learning environment that emphasized students‟ acquisition of an overall meta cognitive strategy for solving mathematical problems involving five stages. These stages are: (1) build a mental representation of the problem; (2) decide how to solve the problem; (3) execute the necessary calculations; (4) interpret the outcome and formulate an answer; and (5) evaluate the solution. Taking these stages into account during instruction is helpful and can improve students‟ problem solving ability.

The Institute for Advanced Study/ Park City Mathematics Institute International Seminar (IAS/PCMIIS) (2006) outlined the process of solving mathematical problems to include: understanding and defining the problem, exploring the problem, hypothesizing, testing, formalizing; and reflecting/evaluating. The most frequent solution strategies are making systematic list, guess and check, drawing diagram, writing equation, looking for pattern, making table, reasoning and simplifying the

problem. Success in solving a problem is directly related to the choice of the appropriate strategy (Cai, 2003). The strategies of problem solving that have been discussed above are not finite or are not the only ones. Several others are „invented" in the actual process of solving a problem.

2.7 Challenges of Teaching Mathematics Problem Solving

Challenges of teaching mathematics problem solving discussed in research literature can be grouped in to three broad categories. These are problems relating to: the teacher, the learners and the school curriculum.

2.7.1 Challenges Related to Teachers

Elementary school mathematics teachers are trained as generalists and they often do not have strong background in mathematics required to teach using problem solving strategies. As generalist teachers, they may not possess ample knowledge to anticipate anything other than limited curricular objectives or teaching styles and hence may be handicapped in realizing a problem solving orientation (Xenofontos, 2007). The situation in Ghana is not different from the observation made about teacher preparation. This phenomenon may lead to the fact that, teachers would not be well equipped in both content knowledge and pedagogical content knowledge to teach mathematics using problem solving strategies. Xenofontos 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.

Mclntosh, Jarrett and Peixotto (2000) said that teaching mathematics through problem solving is difficult among teachers because they have inadequate subject matter knowledge, pedagogical content 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 and 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/word problem 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 a problem solving situations as regards to when to give hints and to intervene.

A research study into language problem in problem solving in basic schools in Ghana by Mereku (1998) revealed that problem solving is unpopular in basic schools in Ghana. This he said is due to the fact that 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 or word problem solving.

JICA (2006) said that because in Ghana most teachers do not use problem solving as a teaching approach, they fail to teach students how to solve problems.

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 experienced 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).

Mathematical knowledge for teaching is an essential ingredient for 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 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).

Teachers‟ beliefs inform their classroom practices and decisions. For instance, the general belief that mathematics is formal body of knowledge and should be presented to learners 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 are of the

belief 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).

The non-linearity and unpredictability nature of problem solving may cause some teachers to resist the introduction of problem solving in the mathematics classroom (IAS/ PCMIIS, 2006). Besides these, uncertainty implicit in problem solving is an obstacle to its use in teaching mathematics (IAS/ PCMIIS, 2006). 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 solution 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.

Anderson (2000) stated that expectations of parents in terms of examinations results put pressure on teachers to teach for examination purposes instead of adopting problem solving strategies to teach for conceptual understanding. This hinders teachers from teaching word problem solving for students mathematical ability and understanding. Micintosh (2000) stated that many teachers are often pressured by policy makers to employ standard based problem solving approach. This indicates that there is lack of willingness on teacher‟s part to use problem solving approach in teaching. Similarly, as indicated in an official report of the Ministry of Education of Ethiopia (MOE, 2006) the major cause of the insufficient use of problem solving approach to teaching is either teachers' lack of dedication or lack of awareness.

The assertion by Alemayehu and Assaye (2009) is that mathematics textbooks for basic schools are not organized in such a way to promote problem solving skills and

word problem questions are scarce with regard to public examinations. Therefore, one of the factors which hindered teachers from applying problem-solving teaching method might be the nature of the textbook organization and the nature of examinations. In Ghana, it is common to see teachers teaching according to examination syllabuses to the neglect of teaching for conceptual understanding which is the central goal of problem solving or word problem solving.

2.7.2 Challenges Related to Students

Mahmud (2003) observed that the main source of secondary school students‟ difficulties in solving mathematical problems is an inability to understand the problem. She found that most of the students have difficulties in comprehending what a question required, did not pay much attention to strategies involved in answering the question and did not read the terms used in the problem very closely.

Similarly, Lim (2000) also found that students‟ weakness in solving word problems is that they make avoidable preliminary mistakes. Students‟ carelessness, as well as inabilities to understand what they read, to plan and to choose suitable mathematical operations, is among the factors that prevent them from solving word problems correctly. He said that students‟ inabilities to understand a question and their weak semantic skills involving symbols and meanings of terms as well as vocabulary are the main factors that cause difficulties in solving word or non-routine problems.

Students‟ inability to read and comprehend poses yet another problem to teachers when teaching mathematics using problem-solving strategies. Fletcher and 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.

Radzali (1997) found that moderate and weak students face difficulties in simplifying algebraic expressions that contain more than one unknown, and in determining the expansion of multiplication for two linear expressions. Results from interviews indicated that weak students face difficulties at the level of understanding. Moderately successful students have difficulties at the level of formulating processes.

Cofie & Mereku (2008) stated that learner‟s weak performance in mathematics was due to the inability to solve word problems and to comprehend the language of test.

Henderson (2002) in the study of Faculty conceptions about the teaching and learning of problem solving in introductory calculus-based physics described students‟ knowledge or 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 prefect their problem solving skills if they are exposed to problem solving instructional strategy (Adesoji, 2008). 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.

Anderson (2000) also found that students are sometimes so tuned to some laid down procedures in solving mathematics problems. Such students resist to 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.

Selke, Behr, and Voelker (1991) in their word problem study of seventh grade mathematics students found that students had problems with multiplication and division operations with real-life word problems because these students were taught on the premise that multiplying always makes a number bigger and division smaller. When students had a word problem with multipliers and divisors less than one, students questioned their ability to correctly solve word problems. In a study of the use of reciprocal teaching method to teach word problems in the mathematics classroom, Dr. Van Garderen (2004) said what makes word problems difficult to understand by students are: irrelevant information, mathematical terminology, vocabulary level and syntactic complexity.

According to Nosegbe-Okoka (2004) in a study focused on helping students make sense of word problems said, the reasons students avoid word problems is the problem with the instructional practices teachers use to teach word problems. He said that the focus of school mathematics should be to help students make connections between mathematics and real-life situations.

2.7.3 Challenges Related to the School Curricular

Anderson, Sullivan and White (2004) in the study of the influence of perceived constraints on teachers‟ problem solving beliefs and practices, identified textbooks and assessments regimes used in school and the time schedule for mathematics

lessons as impediments to the teaching of mathematics 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.

Mclntosh, et al. (2000) in a review of literature on teaching mathematics problem solving found that many textbooks do not provide an 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‟ achievements in teaching mathematics at elementary level, observed that traditional textbooks do not meet the criteria on problem solving approach. This phenomenon of textbooks not presenting sufficient problem solving questions has the possibility of precluding teachers from teaching mathematics using problem-solving approaches.

Zanzali (2003) in a study to document constraints that teachers face in implementing the aspiration of the curriculum identified the influence of examination on what and how mathematics should be taught to students as an obstacle to teachers towards the use of problem solving method in teaching. Since the hallmark of 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) study results indicated that limited time for mathematics lesson and problem solving method not needed in answering examination questions were some of the reasons hindering the teaching of

mathematics problem solving. The teachers in the study believed that teaching of mathematics word problem solving was time consuming

It is noted by Anderson (2000) the culture of 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 the lack of resource materials available for teaching problem solving (Foong, Yap, & Koay, 1996). Research literature has emphasized the importance of teaching word problem solving and teaching 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).

2.8 Summary

Domains of knowledge for teaching proposed by Shulman (1986) include: subject matter content knowledge, pedagogical content knowledge and curricular knowledge. For teachers to use problem-solving as an instructional strategy for teaching mathematics, they need to possess the subject matter content knowledge, pedagogical

content knowledge and curricular knowledge of problem solving. Thus, Shulman‟s knowledge domains formed a coherent framework for this study.

Three general themes have historically characterized the role of problem-solving in school mathematics in research literature. These themes are: problem-solving as context, problem solving as skill, and problem-solving as art (Stanic & Kilpatrick, 1989). The problem-solving literature also revealed that teachers and students‟ knowledge of problem-solving strategies and heuristics will enable them practice word problem-solving in the mathematics classroom (Polya, 1985; Verschaffel, et al., 1999).

Teachers‟ conceptions of problem solving varied from teacher to teacher. Some teachers conceived problem-solving as solving difficult word problems involving real life situations (Saleh, 2009). Others teachers think that problem-solving is a process of accepting and solving challenging mathematical problems (Dollah, 2006). Teachers also conceived problem solving to be solving open ended problems which have no apparent method of solution (Hiebert, 2003; Van De Walle, 2003). Also some teachers conceive word problem-solving as mathematics problem where significant background information is presented as text, rather than in mathematical notation (Martinez, 2001).

Challenges of teaching mathematics problem solving are related to the teacher, the student and the school curriculum. Teacher‟s beliefs about problem-solving, their content knowledge of problem solving and their pedagogical content knowledge of problem solving affect their classroom practices of problem solving in mathematics instructions (Anderson, Sullivan & White, 2004; Ball & Bass, 2000; Xenofontos,

2007; Mereku,1998). Mathematics textbooks for basic schools are not organized in such a way to promote problem solving skills and word problem questions are scarce with regard to public examinations (Alemayehu & Assaye, 2009). Thus, some of the factors hindering teachers from applying problem solving method might be the nature of textbook organization and the nature of examinations. In addition, constraints from school timetable and conservative teaching methods are some challenges the school curriculum posed on teachers in their attempt to use problem solving approaches in mathematics instructions (Midgett, 2001). Studies have shown that problem solving is more challenging for students with low ability (Adesoji, 2008; Saleh, 2009).

Ways of encouraging teachers to teach word problem solving are identified in research literature as: organizing in-service training for practising teachers to improve their knowledge in problem solving (Ali, et al., 2010); Creating teacher collectives where teachers will meet to share ideas and discuss pedagogy (IAS/PCMIIS, 2006) and make provision for adequate teaching resources (Ali, et al., 2010).

CHAPTER 3

METHODOLOGY

3.1 Overview

This chapter discusses the methodology employed in the collection and analysis of data. The chapter is organised under the following headings: research design, population, sample and sampling techniques, research instruments and trustworthiness of instruments, data collection procedures and data analysis procedures.

3.2 Research Design

Research design is the plan and procedure for research that span the decisions from broad assumptions to detailed methods of data collection and analysis (Creswell, 2009). The design of this study is case study. This design was used to examine JHS mathematics teachers‟ word problem solving practices as delineated by the JHS mathematics curriculum and the difficulties‟ students encounter when solving word problems in the Tema Education Metropolis (TEM) of the Greater Accra region of Ghana.

A case study is an empirical inquiry that investigates a contemporary instance or event within its real-life context, boundaries between instance, or event or example and context are not clearly evident (Silverman, 2005). Case study research is used to conduct an in-depth investigation of an issue at a specific instance and location. It involves collecting in- depth information in a limited area. Basically, a case study is an in-depth study of a particular situation rather than a sweeping statistical survey (Yin, 2002). It is a method used to narrow down a very broad field of research into

one easily researchable area. It is for this purpose that the Tema Education Metropolis of the Greater Accra region of Ghana was used for the study.

Case study research design takes place in natural settings and enables the researcher to develop a level of detail understanding about the individual or place. It provides more realistic responses than a purely statistical survey. That is whilst a statistical survey might show how much people do something, case study, on the other hand will determine why such a phenomenon is occurring and why it is so. The first foundation of the case study is the subject and relevance and you are deliberately trying to isolate a small study group, one individual case or one particular population (Shuttleworth, 2008). Hence teachers and students of the three sub-metros of the Tema Education Metropolis were used for the study.

Consequently, this study was conducted in a classroom setting where students and teachers interacted freely. In the classroom, teachers and students were familiar with each other and classroom interactions were seen natural. The structure of the research design therefore enabled the researcher to develop thorough understanding of how teachers practise word problem solving with their students. The interactions of the researcher with the participants gave an opportunity for him to gain in-depth information concerning their word problem solving practices. This design involves participants in data collection and seeks to build rapport and credibility with the individuals in the study (Patton, 2002).

Since the design of the study employed mostly qualitative approach in its data collection and analysis, it was necessary to survey teachers and students to inform the selection of participants for the interview, observation and analysis of work books for

better understanding of the phenomenon. The survey provided useful quantitative data also for the study. As such, interviews, observations and analysis were used concurrently in the data collection process.

3.3 The Research Context

This study was conducted in Tema Education Metropolis (TEM) consisting of three (3) sub-metros namely: Kpone- Katamanso, Tema East and Tema West in the Greater Accra region of Ghana. These sub- metros have schools located in both rural and urban communities. However, infrastructural facilities such as classrooms, furniture and curriculum materials are not adequate enough to meet the demand of the increasing numbers of school going age children, especially in the rural communities.

Teacher-student ratio is very high especially in the rural communities. Majority of teachers who teach mathematics at the JHS are 3-year post secondary teacher certificate „A" holders and a small number of graduate professional and non-professional teachers. The indigenes of these sub-metros are mostly fisher folks and petty traders. The students in the urban communities have varied socio-economic backgrounds and this is because most students have parents who migrated to the place either as government workers or private business people. This creates diversity in the classroom and poses a challenge for teachers to cater for the individual needs in class.

3.4 Population

Awanta and Asiedu-Addo (2008) refer to population as the total number of subjects of your research that conform to a clearly defined set of characteristics. The population for the study consisted of all JHS mathematics teachers in the Tema Education Metropolis of the Greater Accra region of Ghana.

3.5 Sample, Sampling Technique and Sample Size

Sampling is the process of selecting a portion of the population to represent the entire population (Alhassan, 2006). A sample consists of a carefully selected subset of the units that comprise the population. Purposive sampling technique was used in the data collection process. According to Creswell (2009), purposive sampling technique enables the researcher to reach the participants quickly and to use those participants to collect meaningful information for deeper understanding. In other words, purposive sampling enables the researcher to select individuals with requisite expertise and experiences that are central to the phenomenon under study. Purposive sampling technique was used to select only Tema Education Metropolis where the researcher happened to stay, in the Greater Accra region of Ghana for the study.

According to Patton (2002) there are no rules for determining the **sample size** in a qualitative study. The sample size in qualitative study „depends on what the researcher wants to know, what is at stake, the purpose of the research, what will be useful, what will have credibility and what can be done with the available resources" (p.244). Taking Patton"s words into account, the three sub-metros: Kpone-Katamanso, Tema East and Tema West were considered for the study. The choice of the sub-metros was based on: (1) familiarity with the geographical area; (ii) diversity, as the sub-metros have both deprived and well-endowed JHS; and (iii) easy access to the schools.

The researcher purposively sampled 12 participants consisting of 6 teachers and 6 students from the three (3) sub-metros because of the use of interview, observation and analysis of document (students" exercise books) as instruments for this study.

3.6 Research Instruments

Acquiring in-depth understanding of JHS mathematics teachers‟ word problem solving practices and difficulties‟ students encounter when solving word problems in algebra, require collecting a variety of information using three research instruments. Specifically, interviews, observations and document analysis were used in the study. These instruments were used to offset the weaknesses of one instrument.

3.6.1 Interview

Thomas (2003) describes interviews as an effective means of eliciting responses from participants in a research study. It usually involves a researcher orally asking questions for respondents or individuals to answer orally. Interviewing provides the researcher with greater flexibility and personal control. Interviews traditionally have been conducted face-to-face and one-to-one, with the researcher speaking directly with the interviewee at a time. They provide elaborate responses and a forum for sincere participation in the study. As such, semi-structured interview guide was used to collect qualitative data about mathematics teachers‟ word problem solving practices, constraints in teaching word problem solving and the difficulties‟ students encounter in solving word problems in the mathematics classroom.

I used a set of general questions to serve as a guide to the kind of information that was required. I conducted the interviews on one on one basis in the school settings. This enabled the respondents/participants to express their views and concerns freely.

3.6.2 Observation

Gathering information by means of observation involves watching and/or listening to events, then recording what occurred. As a direct observation, the researcher immediately sees and hears what is happening. Data obtained from observation are

said to be imperative as it affords the researcher the opportunity to gather „live data" from „live situations" rather than at second hand (Padgett, 2004). This is because the researcher becomes the instrument and feels the reality of the situation or concept under investigation. Observation can be used to collect data on what is happening regarding a situation or to set in perspective data obtained by questionnaire or interviews (Robson, 1995). Since this study sought to examine and interpret among others, JHS teachers" word problem solving practices in the mathematics classroom and students" difficulties in solving word problems, observation was used as one of the data gathering instruments, because it provided the opportunity to come to terms with what happens in the mathematics classroom.

In this study, observation checklist was used to collect data. The items in the checklist were adopted from Anderson (2000) and Hamza (2007) in their respective studies on teachers" problem solving beliefs and practices. The items were modified to meet Ghanaian classroom context. This was done by selecting only the items which in the researcher"s view best suit the Ghanaian classroom situation. The checklist included 15 items concerning teachers" classroom instructional practices. The 15 items sought data on how teachers" practise word problem solving in the mathematics classroom.

3.6.2 Document Analysis

Document analysis is a systematic procedure for reviewing or evaluating documents-both printed and electronic (computer-based and Internet-transmitted) material. Like other analytical methods in qualitative research, document analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge (Glenn, 2009). Documents contain text (words) and images that have been recorded without a researcher"s intervention. Glenn (2009) said

document analysis is often used in combination with other qualitative research methods as a means of triangulation.

Documents that are used for systematic evaluation as part of a study take a variety of forms and these include: background papers; books and brochures; diaries and journals; attendance registers; and minutes of meetings etc. Documents reveal what people do or did and what they value. This behaviour occurred in a natural setting, so the data is strong validity. Hence the researcher undertook document analysis of six consented student participants‟ mathematics class work/ exercise books. The analysis gave the researcher the opportunity to know the extent to which students practise word problem solving in and outside the classroom.

3.7 Trustworthiness of the Instruments

Trustworthiness in a qualitative research is used to establish that the research findings are “worth paying attention to” (Lincoln & Guba, 1985, p.290). In any qualitative research project, four issues of trustworthiness demand attention. These issues include credibility, transferability, dependability, and confirmability.

3.7.1 Credibility

Credibility is an evaluation of whether or not the research findings represent a “credible” conceptual interpretation of the data drawn from the participants‟ original data (Lincoln & Guba, 1985, p.296). That is in addressing credibility, researchers attempt to demonstrate that a true picture of the phenomenon under scrutiny is being presented. Credibility seeks to ensure that a study measures or tests what is actually intended. According to Merriam (1998), credibility, deals with the question, “How congruent are the findings with reality?” Lincoln and Guba (1990) stated that ensuring credibility is one of most important factors in establishing trustworthiness. Credibility

which pertains to the constructivist paradigm and analogous to internal validity in the positivist research (Mertens, 1998), tests the correspondence between the research participants‟ social constructs and the way the researchers interpret their viewpoints.

Contextualizing the study and member checks (Merriam, 1998) have been suggested among others as strategies for establishing credibility of a qualitative study. Kuzel and Like (1991) explained that member checking consists of the researcher restating, summarizing, or paraphrasing the information received from a respondent to ensure what was heard or written down is the correct response or member checking consists of reporting back preliminary findings to respondents or participants, seeking critical commentary on the findings, and potentially incorporating these critiques into the findings. Both forms of member checking may add accuracy and richness thereby ensuring that the final results are credible.

To establish the credibility of the research findings, transcriptions of the interviews were given back to the interviewees to check whether what were transcribed were true reflection of their responses. They were allowed to offer comments on whether or not they feel the data were interpreted in a manner congruent with their own experiences. Gaining feedback on results from the participants increases credibility.

3.7.2 Transferability

Transferability is the degree to which the results of a research study or experiment can be generalized to other groups, settings or situations (Lincoln & Guba, 1985). Merriam (1998) writes that external validity “is concerned with the extent to which the findings of one study can be applied to the other situations.” Transferability is identified as the qualitative analogue to external validity (Guba & Lincoln, 1994).

Merriam (1998) suggests *thick descriptions* as a means of establishing transferability. Thick description is a detailed description of a phenomenon that includes the researcher‟s interpretation in addition to the observed context and processes. It may also include providing vivid explanation of the methods and procedures followed during and after data collection (Kuzel & Like, 1991). I used thick descriptions to substantiate and illustrate assertions made by individual participants to illuminate the contexts. I discussed thoroughly the research methods and procedures I followed during and after data collection.

3.7.3 Dependability

Dependability is the consistency of observing the same findings under similar circumstances (Lincoln & Guba, 1985). In the constructivist paradigm, dependability is analogous to reliability in the post positivist paradigm (Guba & Lincoln, 1994) and is used to describe the stability of data over time. In order to address the dependability issue more directly, the processes within the study should be reported in detail, thereby enabling a future researcher to repeat the work, if not necessarily to gain the same results. In this study both research methods and data analysis documents were audited by my supervisors who have expert knowledge and experience with qualitative research (Lincoln & Guba, 1985). Lincoln and Guba cited in (Shenton, 2004) stress the close ties between credibility and dependability, arguing that in practice, a demonstration of the former goes some distance in ensuring the latter. Their suggestions were factored into the work and based on precedent in qualitative research, dependability of the research methods and data analysis procedures were established.

3.7.4 Confirmability

Confirm ability refers to the extent to which the research findings can be confirmed or corroborated by others or it may also be considered as an assessment of the quality of the integrated processes of data collection, data analysis, and theory generation (Lincoln & Guba, 1985). Here steps are taken to help ensure as far as possible that the work‟s findings are the result of the experiences and ideas of the informants, rather than the characteristics and preferences of the researcher (Patton, 1998). Confirm ability is analogous to objectivity, that is, the extent to which a researcher is aware of or accounts for individual subjectivity or bias. The role of triangulation is very important in confirmability and this leads to reduction in researcher bias.

To address confirmability in this study, interviews and observations were used to minimize instruments‟ bias. In addition my research methods were audited by a competent expert (Lincoln & Guba, 1985; Patton, 1990) in a qualitative study.

3.8 Data Collection Procedures

This section discusses the data collection procedures. Specifically, the following are discussed: conducting the interviews, observing the participants and analyzing document materials.

3.8.1 Conducting of Interviews

The interview was conducted in two phases: pre-interview was conducted to rehearse, and to ascertain the suitability of the instrument and the actual interviews.

3.8.2 Pilot Interviews

The main aim of the pre-interviews was to enable the researcher find out the suitability of the responses in answering the research questions (Kumekpor, 2002). The pre-interviews also provided the researcher the opportunity to rehearse and gain prior knowledge to the appropriate technique that was adopted during the actual interviews.

In this regard, one JHS mathematics teacher was initially interviewed, audio-taped and interactions examined. The responses were scrutinized and peer-debriefed after listening to the recorded version (Merrian, 1998). The responses were found to be appropriate for answering the research questions. However, it was realized that I was too mindful of time to end the interview and did not allow the interviewee to come out with the views about the questions very well or to explain further. My voice was also too dull. Consequently, another teacher was also interviewed and the responses examined. There was an improvement in this trial, since the shortfalls of the previous trial had been factored into it.

3.8.3 Actual Interviews for Teachers

The researcher interviewed six consented participating teachers who indicated that they teach word problems/word problem solving. This number was deemed appropriate after considering the time frame for this study and the depth of the interview required (Kumekpor, 2002). The choice of interviewing only six teachers was necessitated by the challenges associated with organising and managing large qualitative data from interviews. Besides, the quality of the data was considered much more important for the purpose of this study than the issue of representativeness of the target to population (Creswell, 1999). Each interview lasted between 35-45 minutes. I

recorded all questions and their corresponding responses of each of the six interviewees. The interviews were conducted from March 8 to March 21, 2012.

3.8.4 Interviews for Students

The researcher interviewed three students on difficulties‟ they encounter when solving word problems in the mathematics classroom. This number was deemed appropriate, considering the time frame and the depth of the interview required for this study (Kumekpor, 2002). The decision to interview only three students was prompted by the challenges associated with organizing and managing large qualitative data for interviews. Also, the quality of the data was considered much more important for the purpose of this study than the issue of representativeness of the target population as in qualitative studies (Creswell, 2009). Each interview lasted between 25-35 minutes. All questions and their corresponding responses of each of the three interviewees were recorded by the researcher. The interviews were conducted from March 20 to March 26, 2012.

3.8.5 The Observation Processes/Observing Participants

Observing the participants provided the researcher the opportunity to come to terms with the realities of teachers‟ problem solving practices in the classroom. In participant observation, researchers typically become members of a culture, group, or setting, and adopt roles to conform to that setting. In doing so, the aim of the researcher is to gain a closer insight into the culture‟s practices, motivations and emotions. I observed the classroom practices of six participants who were identified as teachers who teach word problem solving in mathematics from the responses the researcher had in an earlier conversation with them. The observations were done using modified observation checklist adopted from Anderson (2000) and Hamza

(2007) in their studies on teachers‟ problem solving beliefs and practices. The observation sought for data concerning teachers‟ classroom problem solving instructional practices.

While observing teachers during lesson delivery, I made a tick on the checklist against any problem-solving practice being practised. Each participant was observed once in an 80 minutes lesson. One participant was observed per day. Observation notes which are the eyes, ears and perceptual senses for readers (Pattern, 2002) were also taken to compensate the shortfalls of the observation checklist and also to provide further detail data to inform readers. The observation lasted from March 8 to March 21, 2012.

3.8.6 Analysis of Document Materials (Class Work/Exercise Books)

Documents reveal what people do or did and what they value. This behaviour occurred in a natural setting. Hence the researcher undertook document analysis of fifteen (15) consented student participants‟ mathematics class work/ exercise books in the classroom setting. This enabled the researcher to make analysis of:

- Amount of class works/exercises done;
- Amount of class works/ exercises done on word problem solving;
- Amount of corrections done on class works/ exercises; and
- Amount of corrections done on class works/ exercises on word problem solving.

The analysis gave the researcher the opportunity to know the extent to which students practise word problem solving in the classroom.

3.9 Data Analysis Procedures

Data was collected from interviews, observations and analyses of class work/exercise book to answer the research questions in the study. As stated earlier, the case study design employed qualitative and quantitative approaches in the research. As such both qualitative and quantitative data were collected. Consequently, data analysis took two analytical approaches: qualitative and quantitative data analyses. The two analytical processes are discussed below:

3.9.1 Analysis of Quantitative Data

Analysing results of a case study tends to be more opinion based than statistical methods. The usual idea is to try and collate your data into a manageable form and construct a narrative around it (Shuttleworth, 2008). Hence, the quantitative data was analysed using descriptive statistics. Analysis of students‟ work books were calculated in percentages and the presentation and interpretation were done to reflect qualitative analysis.

3.9.2 Analysis of Qualitative Data

The interview data which was mainly qualitative was transcribed by listening to a playback of the tape recorder and writing down word-for-word all the questions and responses for each of the nine interviewees. The analysis was reported using narrative style with embedded direct quotations which revealed participants‟ depth of emotions, their thoughts about word problem solving and their practices and difficulties (Patton, 2002).

The qualitative data obtained from the observation checklist was described based on the research questions. Observation notes taken during the observation periods were factored into the analyses. The observation data was analysed using qualitative data

analysis model proposed by Seidel (1998). This involves an iterative process of noticing, collecting and thinking about observed data and writing the report. Textual matrix was used to present the summary of the data in a manageable form for easy discussions.

3.10 Ethics

Permission was sought from the metropolitan director of education to use JHS mathematics teachers and students as subjects for the study. Headmasters/ mistresses of schools involved in the study were contacted with official letters of introduction from the University of Education, Winneba for their permission. Participants consent was sought before conducting the interviews, observations and analysis of documents. I stated clearly the purpose of the study and indicated that the study was purely academic. I also assured participants of anonymity and that the data collected will be treated with confidentiality. Participants were assured that their participation in the study was voluntary and that they can withdraw from the study without any consequence.

CHAPTER 4

RESULTS

4.1 Overview

The study examined JHS mathematics teachers‟ conceptions and practices of word problem solving in the mathematics curriculum, the challenges of teaching mathematics word problem solving and the difficulties students encounter when solving word problems. The study was guided by the following research questions:

1. What are JHS teachers‟ conceptions of word problem solving in the mathematics curriculum?
2. How is word problem solving practiced by JHS teachers in the mathematics classroom?
3. What problems militate against the teaching of word problem solving in the JHS mathematics classroom?
4. What difficulties do JHS students encounter when solving word problems in the mathematics classroom?
5. How can the teaching of word problem solving be encouraged among JHS teachers in the mathematics classroom?

Data was collected using three instruments. Namely: interview, observation and document analysis. Results of the data analysis are presented in this chapter. The results are presented in three parts. The first part presents the results of the interview. The second part presents the results of the observation and the third part presents the results of the document analysis.

4.2 Results of Interviews

The interviews were conducted on six JHS mathematics teachers from the three subs –metros of Tema Education Metropolis (TEM). Two teachers were interviewed from two schools in each sub-metro. That is one teacher from each of the two schools was interviewed. The interview was conducted to enable the researcher obtain an in-depth understanding of the study. The six teachers were selected based on their regularity to school observed from the school‟s teachers‟ attendance books and the concern expressed by the teachers when approached by the researcher on the issue of word problem or word problem solving in the mathematics curriculum. The interview results are presented under these headings:

- Junior high school mathematics teachers‟ conceptions of word problem solving;
- Junior high school mathematics teachers‟ problem solving strategies;
- factors militating against the teaching of mathematics word problem solving;
- Junior high school students‟ difficulties in solving word problems in algebra;
- Junior high school students‟ word problem solving practices in the mathematics classroom; and
- Factors that encourage the teaching of mathematics word problem solving.

The abbreviation *T* followed by a *number* in the presentation is the code of the teacher interviewee (e.g. *T1*and *T3* mean first and third teacher interviewees respectively as labelled in the transcription report in the Appendix) and abbreviation *S* is the code for student interviewee (e.g. *S1* and *S2* mean first and second student interviewees respectively) and *Q* stands for questions the researcher asked.

4.2.1 JHS Mathematics Teachers' Conceptions of Word Problem Solving in the Mathematics Curriculum

Teachers are implementers of the mathematics curriculum. The decision to carry out or implement word problem solving in the mathematics curriculum relies on the teacher‟s conception of what WPS is all about. To obtain an in-depth understanding of the study, six JHS mathematics teachers were interviewed on what word problem or word problem solving is all about.

Q: In your own opinion what do you think word problem solving is all about?

In responding to the question *T3* and *T6* said:

T3: Mathematics word problem solving has to do with the effort that one makes to solve or find solution to a problem that has been posed in a sentence form or case study form that might not have one way of solving.

T6: It is finding out solution to mathematical problems that are in sentences or story form that you have to change to equations in variables as you solve the problem. They have no direct approaches of solving but one tries so many ways or several ways to be able to find solution to it. The responses indicate that *T3* and *T6* conceived word problem solving as finding solution to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation and do not have immediate method of solving.

In responding to the same question, *T1* and *T5* stated:

T1: Word problem solving is about getting solution to unfamiliar mathematics story problem which involves everyday real life situations. In an attempt to seek clarification on what unfamiliar mathematics story problems are, *T1* responded as: Unfamiliar mathematics story problems are problems for which there is not a direct

way of solving unless several approaches are engaged, such as, making guess and check, trial and improvement etc.

T5: It is about solving a mathematics problem that is not known initially, it could be probably a difficult mathematics story problem or a problem narrated in words which need an equation to be developed in variables to be able to solve.

It could be deduced from the responses of *T1* and *T5* that teachers conceived word problem solving as solving difficult mathematical story problems which involve everyday life or real life situations.

Also, *T2* in responding to the same question said:

T2: I think mathematics word problem solving has to do with accepting challenge to solve complex or complicated mathematical concepts, puzzles or such word problems by doing critical thinking through several ways. As a follow up question to understand what *T2* meant by accepting the challenge to solve complex mathematics word problem, the response was: Accepting the challenge to solve means the problem should match the interest and curiosity of students, such that they will be ready to solve it since the problem is relative to the student involved. What is a problem to a primary four pupil may not be a problem to junior high school students.

In this case, *T2* conceived word problem solving as accepting a challenging mathematical problem and striving hard to solve it.

The interview results indicate that Junior High School mathematics teachers had different conceptions of word problem solving. The three different conceptions of word problem solving indicated by the teachers are: Word problem solving as accepting a challenging mathematical problem and striving hard to solve it, word

problem solving as solving difficult mathematical story problems which involve everyday life situations and word problem solving as finding solution to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation and do not have immediate method of solving.

4.2.2 JHS Mathematics Teachers' Problem Solving Strategies

In order to know how JHS mathematics teachers" practice teaching word problem solving in the classroom, the researcher asked what strategies they often used in their word problem solving lessons.

Q: Mention some of the strategies you often use in teaching your word problem solving lessons?

In responding to the question, *T1* states:

Teaching starts from known to unknown so I normally start my word problem solving lessons from the child"s environment. I sometimes use a story or puzzle telling and make a table or chart, draw a diagram to simplify the problem, make a model, look for a pattern, work backwards. Sometimes I use equation or a formula, use guess and check. I asked to understand how *T1*uses the strategies in teaching and the response T1 gave was: I lead students through the strategies, work examples with them using the strategies in real life context and then give them problems that need the application of the strategies.

T2 in responding to the question, states:

T2: Strategies vary based on topics. Sometimes I lead students to draw diagram to bring out the concept in the problem. I also make tables to simplify problems, use trial and improvement to solve problems.

Similarly, T3 in responding to the same question, said:

T3: In teaching, you have to relate it to the child"s environment by contextualizing it. You have to let the students understand the problem given, make a way or plan, this can be making a table or an equation, then carryout the plan to solve the problem and also check on the correctness of the answer.

In responding to the question, *T5* states:

T5: I try to let my students first understand the problem at hand, I then devise a plan that we can use, execute or carry out the plan to arrive at the solution and to be sure of what we are doing, we check on our solution.

Teachers adopt different strategies in order to achieve curriculum objectives as captured in the responses they gave to the interview question. The excerpts of the responses of *TI, T2, T3* and *T5* indicate that JHS mathematics teachers use problem-solving strategies such as understand the problem, develop a plan, execute the plan and evaluate the solution process. Also, they use problem solving heuristics such as draw a diagram, make a model, make a table or chat, act out the problem, trial and improvement, simplify the problem and look for a pattern. Based on the teachers" responses, one can conclude that there are no definite word problem-solving strategies that teachers ought to use to achieve mathematics curriculum objectives.

4.2.3 Problems Militating Against the Teaching of Mathematics WPS in the JHS Classroom

The researcher in trying to understand the *problems militating against the* teaching of word problem solving in the mathematics classroom, asked the following question.

Q: What do you think are some of the challenges of teaching word problem solving?

The responses to the interview question are captured in the following main headings:

- Teaching mathematics word problem solving is difficult,
- It is time consuming to teach mathematics word problem solving, and
- Incompetence of mathematics teachers in teaching mathematics word problem solving.

4.2.3.1 Difficulties in Teaching Mathematics Word Problem Solving

The interviewees mentioned difficulty in teaching word problem solving as one of the challenges that prevent mathematics teachers from teaching mathematics word problem solving. They indicated the causes of these difficulties to include: students lack of understanding of language of text and not willing to be actively involved in class, students‟ beliefs about the difficulty of word problem solving, inadequate teaching and learning materials and difficulty in preparing for word problem-solving lessons.

The responses of the interviewees indicate that some students believe that teaching mathematics word problem solving is very difficult and this belief has influenced their attitude and interest towards word problem solving. For example *T1* stated:

T1... students believe that mathematics is very difficult much more to talk about mathematics word problem solving, so whenever you say something concerning word problem solving, pupils get scared. To be better informed, I asked *T1*if there is something particular that often puts students away from mathematics. In responding to this question, *T1* states: *May be it is the way teachers teach and talk about mathematics. Also, by the time students come to junior high school, they hold already the belief from the primary school that mathematics is very difficult and it is formula work, so teaching and learning mathematics word problem solving which requires*

reading, reasoning, understanding of sentences and series of inquiries become a problem to students.

The preparation teachers need to do before conducting a word problem solving lesson was indicated by the interviewees as one of the challenges of teaching mathematics word problem solving. They indicated that teaching word problem solving requires the use of multiple methods and can sometimes leads to multiple solutions. As such, teachers need to prepare adequately to face the various problem- solving strategies that students might use in solving a problem. This was clearly captured in *T4* and *T3* responses as:

T4: *You need ample preparation since outcomes are not straight forward when you give students work on word problem solving. You are likely to see various outcomes from them and so as the teacher, you need to think a lot about possible answers or solutions to the problem. This means it requires a lot time and planning.*The researcher asked *T4* if he is implying that teachers are not competent enough to teach mathematics word problem solving and that is the reason why they need a lot of time to do preparation. *T4* in response states*: It is probably true because in a way word problem solving is something not very common, and so many teachers are not knowledgeable in it.*

In an attempt to know from *T3* why the teaching of word problem solving requires a lot of preparation, *T3* responded as: *It requires a lot of planning because you need to look for teaching and learning materials that the students can manipulate with in order to develop the concept the teacher intend to teach and also because teachers themselves may not competent enough, they have to prepare well to be able to facilitate students' activities during lessons.*

In teaching mathematics word problem solving, students are expected to take active role in the construction of their meaning and understanding. The teacher‟s role is transformed from knowledge transmitter to a guide and facilitator. The interviewees stated that students hardly involve themselves when word problems are posed to them to explore and solve. This makes the teaching of mathematics word problem solving quite uninteresting. This was clearly expressed by*T2* who states:

T2: *...the students themselves are not willing to think to me that is how I see it. You can pose a problem to them and they will sit down and look at you without participating.* I was eager to know why students will fail to participate in word problem solving lesson. In responding to this question, *T2* states: *It may be that many students in junior high school cannot read very well and because of that their understanding of questions presented in story form is far below expectation. Furthermore, most cannot translate the words in to algebraic equation. For example, when children are given the equation 1/3x + 1/2x = 4, they are able to do it without problem. However, if the same problem is posed in words, that is, half of a number is added to one-third of the same number and the result is four, what is the number? Translating or transforming this text into an algebraic equation becomes a big problem. Also students cannot communicate effectively with their peers during group discussions.*

The interviewees also mentioned inadequate teaching and learning materials as some of the challenges of teaching mathematics word problem solving. T5 and T6 emphasized the fact that inadequate resource materials in problem solving are serious challenges teachers face:

T5: *You see sometimes concrete representations are to be made or the need to use pictures or make illustrations about the problem or to use concrete ways to let the*

pupils understand how you can solve the word problems in various forms, various strategies. The challenge here is that we do not have those readily available concrete materials.

T6...others are lack of curriculum materials, most of the books that have been designed for use, the textbooks, have insufficient word problem solving activities and questions for teachers and students' use and this is a big problem.

4.2.3.2 Teaching Mathematics Word Problem Solving is Time Consuming

The teaching of mathematics word problem solving was said by the interviewees to be time consuming. This was noted in their responses. The interviewees explained that it takes a lot of time to prepare for a word problem lesson. Students also need to explore problems by using various strategies in order to solve problems posed to them. Unfortunately, the inflexible school timetable does not provide enough time for such explorations. Because of this, many mathematics teachers tend to avoid teaching mathematics word problem solving. Four teachers explained that teaching mathematics word problem solving is time consuming by saying:

T5: *It consumes a lot of time. A lot of time is needed to teach word problem solving as you have to think well to plan the lesson. In the teaching process, more time is needed to guide and facilitate for students' understanding. Ample time has to be used in explaining very important elements in problems posed.*

T2: It is time consuming. Students also need enough of time to investigate problem situation. I asked why students why students should need enough of time to investigate problems posed. T2 says: You can see there is not that clear or direct way of solving a word problem. Students need to read well the problem, understand what the problem

is about, get a plan to solve the problem, implement the plan and do a check to see the correctness of the solution. At times the strategy used may not work and an alternative ways would have to be sought in order to solve the problem.

T3: It consumes a lot of time. When you are solving word problem, it consumes a lot of time. If you look at the time allocated to a period on the timetable, you will find that it is always good that you spend extra time and in that less is covered on the part of the syllabus which coverage is needed within a given time. Assessing students on word problem solving is very cumbersome and lot of time to this with students.

T6: another problem with word problem solving is that it waste time because to solve a problem you can use about 40 minutes, so assuming you want to teach a class word problem solving; you can use the period to tackle just a problem, so you end up by consuming if not all but most of the time. T6: Says also that the shift system of schools place high constrain on the already insufficient time that teaching word problem solving grapple with.

4.2.3.3 Incompetence of Mathematics Teachers in Teaching Word Problem Solving

The interviewees acknowledged that many teachers lack requisite knowledge and expertise in teaching mathematics word problem solving as captured in the interview response. Three of the teachers express that this challenge teachers‟ instructional practices.

T5: ... even teachers too have problem because the teachers must also know how to solve the problem before they can take the students out to solve the problem. If the teachers or the masters are not conversant with teaching word problem solving in mathematics, it will be very difficult for the teachers to teach the student. The

researcher asked T5 what is meant by teachers are not conversant with the teaching of mathematics word problem solving and the response was: I think we teachers do not understand so many ourselves to be precise. We are only trying to do something in a way to represent it. For example, in confirming this point T5 said*: I remember a mathematics workshop we attended and some word problems were given for us to solve. How to go about solving these questions was a problem to most of us teachers. Only few teachers had done something. So subject matter knowledge of teachers needs attention by mathematics authorities in the Ghana Education Service.*

T4: ...I think teachers are not all that conversant with the skills of teaching word problem and word problem solving. I enquired from T4 what he meant by teachers are not conversant with word problem solving. In responding to this question T4 states: Many teacher lack both the subject matter knowledge and methodology to do the teaching.

T6: ... is like teachers are not of that knowledge in word problem solving, they lack the required content and the pedagogy they call it, as such teaching it is difficult for them.

A teacher might intend to teach mathematics word problem solving but may have to avoid it because of lack of his or her inadequate knowledge in problem solving. Teachers who have inadequate content and pedagogical content knowledge of word problem solving are more likely to avoid teaching word problem solving as emphasized by the teachers in this study.

4.2.4 JHS Students' Difficulties When Solving Word Problems in Mathematics

The researcher in trying to understand the difficulties JHS students" encounter when solving mathematics word problems in the classroom, asked the following question:

Q: What is the difficulties students" encounter when solving word problems?

In responding to the question, *T1*, *T2 and T5* said:

T1: The main source of students" difficulties in solving mathematical word problems is an inability to understand the problem. Students have difficulties in comprehending what a question required, do not pay much attention to strategies involved in answering questions and do not read the terms used in problems very closely.

T2: Students" weakness in solving word problems is that they make avoidable preliminary mistakes. Students" carelessness, as well as inabilities to understand what they read, to plan and to choose suitable mathematical operations, is among the factors that prevent them from solving word problems correctly.

T5 in responding to the question, states:

T5: Learners' difficulties in solving word problems are due to their inability to read and to comprehend the language of test.

The excerpts of the responses of T1, T2 and T5 indicate that reading and understanding/comprehension of the language of the problems posed are the main challenges that students encounter when solving algebraic word problems.

Similarly, T3 in responding to the question, said:

T3: … students are sometimes so tuned to some laid down procedures in solving mathematics problems and such students resist to teacher"s initiatives or plans to adopt problem-solving approaches of teaching word problems in mathematics. They prefer to be told mathematics rather than to be guided by the teacher to explore and

construct their own understanding and so show lack of interest during word problem solving lessons where they have to explore.

T6: Students usually have problems with multiplication and division operations with real-life word problems because these students are taught on the premise that multiplying always makes a number bigger and division smaller. So when students have a word problem with multipliers and divisors less than one, they questioned their ability to correctly solve word problems.

T4: ...is like what makes word problems difficult to understand by students are: mathematical terminology and the vocabulary used. In addition, students avoid word problems because of the instructional practices teachers use to teach word problems. He said that the focus of school mathematics should be to help students make connections between mathematics and real-life situations.

The responses of T3, T6 and T4 indicate that students‟ difficulties in solving word problems are as a result of the following: Students‟ unwillingness to explore various ways to find solution to problems posed instead of relying on known formulas, inaccurate concept of multiplication and division operations with real-life word problems and the instructional practices used by teachers to teach word problem solving.

4.2.5 How Teaching of Word Problem Solving can be Encouraged in the Mathematics Classroom

The researcher asked the interviewees to express their views on what can make or encourage teachers to teach word problem or word problem solving in the mathematics classroom.

Q: From your own opinion experiences, how can JHS mathematics teachers be encouraged to teach effectively word problem solving?

In responding to this question, *T2*, *T3* and *T5* stated that organizing of in-service trainings to equip teachers with the requisite knowledge in problem solving will encourage teachers to teach mathematics word problem or word problem solving.

T2: To achieve our objective, in-service training for teachers needs to be organized to help improve the teaching of word problem solving. I believe when teachers are knowledgeable in a discipline or subject they can perform.

T3: Ghana Education Service should organize in-service training courses for teachers especially on mathematics word problem solving because we teachers ourselves were raised up by tutors who did not have that interest in mathematics, so they made mathematics to look like it was a very difficult subject and was for only some special people to study.

T5... also refresher courses need to be organized because as teachers get more of such courses refreshed in their subject areas, they become comfortable to teach because they are equipped with the requisite skills to be able to teach.

Furthermore, *T3, T4 and T6* in responding to the same question suggested that providing incentive packages for mathematics teachers will encourage them to teach mathematics word problem solving as indicated in their responses as:

T3: In addition, motivation will also come because if you are a teacher too you have to be motivated either by the government or the district or municipal or metropolitan assembly or any other agency or people who may help the teacher to come and help the students. So motivation is very important in the teaching of problem solving.

T3: ... when teachers are well motivated the interest will there and they will have that peace of mind to teach very well.

T4: I think teachers should be motivated in a way, incentives packages like allowances for mathematics teachers ... so incentives packages are very welcome.

T6 in responding to the same question suggested the provision of teaching and learning materials as a way of encouraging teachers to teach word problem solving as captured in his response:

T6: *Teachers will be motivated enough to do well in many areas especially, if they are supplied with the right logistics, teaching materials, enough textbooks, and other materials, talk of chalkboard, drawing board and all materials that are necessary for teaching.*

Also, I think textbooks can provide a lot of word problem solving activities and questions; it can be of much help.

From the responses, organizing in-service training and refresher courses for teachers on word problem solving to equip teachers and develop teachers knowledge, providing teaching and learning materials and providing incentive packages for teachers will encourage mathematics teachers to teach mathematics word problem solving in the classroom.

4.2.6 JHS Students' Word Problem Solving Practices in the Mathematics Classroom

Students/learners are the recipients of the contents of the mathematics curriculum so that they are equipped with such values, skills, attitudes and insight to handle life problems of today and in the future. Hence students‟ word problem solving practices

in the mathematics classroom cannot be overemphasized, since this will enable them to become effective problem solvers. To ascertain if students practice word problem solving in the classroom, the researcher asked three student interviewees, one from each of the three sub-metros of the TEM, the following question;

Q: How often do you solve word problems in the class room or in the house?

The responses of the interviewees indicate that students practice word problem solving in the mathematics classroom by doing class work/exercises, assignments, home works and class tests. This was explicitly captured in S1, S2 and S3 responses as:

S1: Yes, any day we have class we do exercise, class assignments, we do home works in the house to practice and class tests. Because word problem if you learn it once and refuse to practice within shortest possible time you can forget it. So they give us exercises, assignments, textbook works to practice. Some of the word problems are tricky and confusing.

S2: ...: We solve it in class as teacher teaches us and she gives us work to solve it. At the home too we send our works to do. We practice to solve problems in groups when teacher is not in the classroom. We solve word problems on our own and when we do exercises and tests.

S3: I use to solve some from textbooks, in class works and exercises given to us. When we have free time we practice solving word problem questions and we do some in the houses.

Since the interviewees" responses indicate that they do practice word problem solving in and outside the classroom, it was expected that the analyses of their class

works/exercise books will show a practical confirmation of an ample practice of word problem solving. On the contrary, virtually very little work was done in this regard in the classroom as shown in Table 4.2.

This indicate that very little work is done by teachers in the teaching of word problem solving in the mathematics curriculum and this definitely will adversely affect students/learners in the overall expected mathematics achievement.

4.3 Results of Observations

In this study, observation was necessary because there was the need to see and understand how mathematics teachers teach word problem solving in real classroom setting. The six JHS mathematics who were interviewed were also observed when they were having mathematics lessons. There was also a post-observation interview for two teachers. The purpose of the observation was to see how word problem solving is being practiced by JHS teachers in the mathematics classroom. The post-observation interview was to understand why some instructional practices were not practiced by teachers during their word problem solving lessons. Each teacher observed taught for 70 minutes.

The observation was guided by an observation checklist (see Appendix) which had 15 classroom instructional practices. The researcher observed and ticked any problem solving practise practiced by the teacher in the lesson delivery process. The matrix of instructional practices used by teachers is shown in Table 4.1.

Table 4.1: Instructional Practices Used by JHS Mathematics Teachers in the Classroom

Instructional practices	T1	T2	T3	T4	T5	T6
Explain in detail what students have to do to solve problems	√	√	√	√	√	√
Set application problems which allow students to practice the skills they have just learnt	√	√	√	√	√	√
Provide concrete materials for students	×	×	√	×	√	×
Discuss useful problem solving strategies	√	√	√	√	√	√
Encourage students to use variety of approach to solve problems	√	×	×	√	√	×
Pose open-ended problems that require open Investigations	×	×	×	×	×	×
Give opportunities for students to explore solutions by their own ways before being shown by teacher	√	√	√	√	√	√
Serve as a facilitator, a guide by allowing students to construct their own knowledge during problem solving lesson	×	×	×	×	×	×
Help students to model word problems into equations or diagrams	√	√	√	√	×	√
Encourage students-centred instruction	√	√	√	√	√	√
Use problems which arise from school context or which relate to students‟ past experiences	×	√	×	×	√	×
Allow students to work in cooperative groups	√	×	×	√	√	×
Ask students to present their solutions to the whole class on Chalkboard	√	×	×	√	√	×
Explain the key elements in a problem to students	√	√	√	√	√	√
Encourage students to pose their own problems	×	×	×	×	×	×

Key: √= practice performed and ×= practice not performed during teaching

T1= First teacher observed, T2= Second teacher observed, etc.

As indicated by (Table 4.1) all the six teachers explained in detail what students have to do to solve problems during word problem solving lessons. They discuss such problem solving strategies such as: understand the problem, plan a solution strategy, carry out the plan and evaluate the process of solution. Problem –solving heuristics that were commonly observed include: making a table, drawing diagrams, guess and check, trial and improvement, etc. It was observed that all the six teachers (Table 4.1) give opportunities to students to explore solutions by their own ways before being shown by teacher. They also explained key elements in problems to students and encouraged students-centred instruction (Table 4.1).

Whilst application problems which allowed students to practise skills and concept they have just learnt were posed by all six teachers (Table 4.1), only two teachers were seen using problems which arise from school context or which relate to students‟ past experiences (Table 4.1).

Three critical instructional practices were completely missed out during lessons observation. These practices were: posing open-ended problems that require open investigations, allowing students to construct their own knowledge during word problem solving lessons, while teachers serve as facilitators and guides, and encouraging students to pose their own problems (Table 4.1). The researcher then enquired from two of the teachers observed to understand why these instructional practices were not practiced, they expressed:

T5: It is a fact, yes that open-ended problems lead to open investigations and multiple solutions which are not that easy to find right answers to. This makes it takes a lot of time and difficult to prepare lessons for since you have to make provisions for most of the possible solutions that students may produce.

T3: Majority of students lack vocabulary to enable them to construct their own problems. Now on the issue of allowing students to explore problems, I will say the syllabus is too loaded and this practice will waste time leading to the incompletion of the syllabus.

The responses above indicate that teachers‟ inadequate pedagogical content knowledge of word problem solving, students‟ low ability and lack of curricular materials were some of the reasons why those practices were not practiced by the teachers observed.

It was observed from (Table 4.1) that five of the teachers were assisting their students to model word problems into equations or diagrams especially problems like “take a number” game in Algebraic expressions and word problems involving ages in Linear equations. The provision of concrete materials for students to manipulate during lessons was not left out as it was seen being practiced by four of the teachers (Table 4.1). From (table 4.1) three teachers were seen encouraging pupils to discuss their ways of answers with their peers in small groups and present their answers or solutions on the chalkboard for a whole class discussion.

The six teachers observed in this study practiced such problem-solving approaches as teaching *for* problem solving and teaching *about* problem solving (Schroeder & Lester, 1989; Siemon & Brooker, 1990; Fong, 2002). However, the approach of teaching *through* problem solving was less practiced by the teachers. Meanwhile, teaching through problem solving starts with a problem, by teachers posing problems to challenge students‟ knowledge thus providing a need for the students to organize their understanding in order to resolve the problem. In this approach too, the teacher‟s role is transformed from knowledge transmitter to a guide and a facilitator.

4.4 Results of JHS Students' Class Works/Exercises on Word Problem Solving

The purpose of the study of students" class work/exercise books was to enable the researcher to find out if JHS students practice word problem solving in the mathematics classroom and how often they do it in the schools as indicated in the curriculum. Six students" that is 2 students from each of the two sub-metros of TEM (including the three interviewee students) class work/exercise books were checked. The practice of word problem solving will help the students to achieve the set goals of the curriculum. It will provide them with the necessary skills, values and insight to handle effectively, everyday life issues, situations and problems. As a result data was collected based on pre-determined categories to sort out class works/exercises done on word problem solving for the three terms in each of the six schools under study. The results from the class work/exercise books are shown in table 4.2.

Table 4.2 Summary of class works/exercises on word problem solving

Serial Number	No. of Class Work/Exercises	No. of Class Work/Exercises on WPS	No. of Corrections on Class Work/Exercises	No. of Corrections on WPS Class Exercises
TKE x Bk I	21	0	4	0
TKE x Bk II	43	1	11	1
TEE x Bk III	33	1	6	0
TEE x Bk IV	44	3	6	2
TWE x Bk V	63	4	30	2
TWE x Bk VI	62	3	11	1
TOTAL	266	12	68	6

Key: TKExBkI = Tema Kpone Sub-metro Exercise Book One
TEExBkIII = Tema East Sub-metro Exercise Book Three
TWExBkV = Tema West Sub-metro Exercise Book Five
WPS = Word problem solving

As indicated by table 4.2, out of the 21 class work/exercises checked, no class work/exercise was done on WPS. Similarly, out of 43 class work/exercises checked, 1 class work/exercise was done on WPS. This further indicates from (Table 4.2) that out of a sum of 64 class work/exercises checked in TK sub-metro (TKE x BkI & TKE x BkII), only 1 class work/exercise was carried out on WPS. Table 4.2 again indicated that out of 33 class work/exercises checked, 1 was on done WPS. Similarly, out of 44 class work/exercises checked, 3 class work/exercises were done on WPS. This means that out of a total of 77 class work/exercises checked in TE sub-metro (TEE x BkIII & TEE x BkIV), only 4 class work/exercises were carried out on WPS (Table 4.2). Also, table 4.2 showed that out of 63 class work/exercises analysed, 4 were done WPS and out of 62 class works analysed, 3 class work/exercises were done on WPS. This revealed from table 4.2 indicated that out of a total of 125 class work/exercises checked in TW sub-metro (TWE x BkV & TWE x BkVI), only 7 class work/exercises were done on WPS (Table 4.2).

The results from table 4.2 indicates that out of a total of 266 class work/exercises checked, only 12 of them were on WPS which represents 4.5 % (see Appendix).

Furthermore, table 4.2 indicated that of the 15 corrections done on class work/exercises in TK sub-metro, only 1 was on WPS. Similarly, of the 12 corrections done on class work/exercises in TE sub-metro, only 2 were on WPS. Table 4.2 also indicates that of 41 corrections done on class work/exercises in TW sub-metro only 3 corrections were done on WPS. The results from table 4.2 indicates that out of 68 corrections done on class work/exercises, only 6 were on WPS which represents 8.8 % (see appendix).

Mathematics WPS practices is critical for learners at JHS to achieve curriculum objectives. Teacher knowledge of problem solving and for that matter word problem solving is needed to attain the goals of the mathematics curriculum. Special time should be given on the school timetable for mathematics teachers to teach the WPS and to give practice work to learners in the schools. In addition, as a way of encouraging teachers to teach WPS and its practices, much emphasis should be given to WPS in public examinations and standardized tests. This will help to avert the situation as indicated from Table 4.2 so that students will attain the expected mathematics standards.

4.5 Summary

In the response to research question **(1)** which reads: **What are JHS teachers' conceptions of word problem solving in the mathematics curriculum?**

The results showed that teachers‟ conceptions of word problem solving were seen from three different perspectives to include: accepting a challenging mathematical problem and striving hard to solve it, solving difficult mathematical story problems which involve everyday life situations and finding solution to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation and do not have immediate method of solving.

In the response to research question **(2): How is word problem solving practiced by JHS teachers in the mathematics classroom?**

The result indicated that teachers use Polya‟s (1985) four-stage problem solving model such as understand the problem, develop a problem, execute the plan and evaluate the solution process. Also, they use problem-solving heuristics such as draw a diagram, make a model and make a table or chat act out the problem, trial and

improvement, simplify the problem and look for a pattern in the practice of teaching mathematics word problem solving.

Responding to research question **(3): What problems militate against the teaching of word problem solving in the JHS mathematics classroom?**

Teachers‟ inadequate knowledge in WPS, difficulties teachers face in teaching mathematics WPS, the teaching of mathematics WPS being time consuming, inadequate word problem solving activities in mathematics textbooks, teachers beliefs about the teaching of mathematics, difficulty in preparation for a word problem solving lesson, problem solving approach putting high cognitive demand on students, low linguistic ability of students and inadequate time slots for mathematics in the school timetable were identified as the challenges of teaching mathematics WPS. These challenges were said to further affect students‟ mathematics WPS practices in the schools.

Also, in response to research question **(4)** which stated: **What difficulties do JHS students encounter when solving word problems in the mathematics classroom?**

The result indicates that reading and understanding/comprehension of the language of the problems posed, students‟ unwillingness to explore various ways to find solution to problems posed instead of relying on known formulas by students, inaccurate concept of multiplication and division operations with real-life word problems and the instructional practices used by teachers to teach word problem solving are the main difficulties students encounter when solving algebraic word problems.

The research question **(5)** which reads: **How can the teaching of word problem solving be encouraged among JHS teachers in the mathematics classroom?**

The response indicated that, organizing in-service trainings and refresher courses for mathematics teachers on word problem solving, improving the conditions of service of teachers and providing teaching and learning materials, increasing time slots for mathematics lessons in the school timetable and emphasizing word problem solving in standardized tests and public examinations were identified as ways of encouraging the teaching of mathematics WPS in the mathematics classroom.

CHAPTER 5

DISCUSSION, SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Overview

The study became necessary because of the need to encourage or promote the implementation of algebraic word problem solving pedagogy in the mathematics classroom. As stressed in Ghana‟s MOE (2010) mathematics syllabus, little is practically known or documented about the implementation difficulties and the way forward in the classroom. The focus of this study was therefore to examine JHS mathematics teachers‟ conceptions of WPS and how they practice word problem solving in the mathematics classroom. It was also to interpret from teachers‟ perspective, the challenges of teaching WPS, the difficulties students encounter when solving algebraic WPS and the ways of encouraging the teaching of mathematics WPS in the JHS classroom.

Six teachers were selected for in-depth interviews and classroom observations. Class work/exercise books of students were also analyzed. The results of the study were presented in the preceding chapter. This chapter presents the discussion, summary of results, conclusion, recommendations and suggestions for further study.

5.2 Discussion

The teaching and learning of mathematics is primarily based on the conception that mathematical knowledge can be applied to solve every day, real life problems. Due to this, Ghana‟s recent Education Reform Review Committee (MOE, 2002) recommended a problem solving curriculum for pre-university education.

Subsequently, the MOE (2007, 2010) revised syllabuses stressed teaching mathematics for real life applications by using problem- solving strategies and approaches. Since 2007, mathematics teachers are expected to teach mathematics problem solving or word problem solving so that curriculum objectives could be achieved. Hence this study was conducted to ascertain what pertains in the JHS mathematics classroom.

Teachers‟ conceptions implicitly inform their decisions in the classroom. What teachers teach in class, how they teach it using particular teaching resource materials and why they teach it using a particular strategy is largely influenced by how they conceive it in the curriculum. As Shulman (1986) stated, the school curriculum covers a wide variety of instructional materials available in relation to the subject matter to be handled, and the set of characteristics that guides the use of particular curriculum materials in particular circumstances. It was found in this study that JHS mathematics teachers have different conceptions of word problem solving as contained in the mathematics curriculum. Three different conceptions of problem solving were identified. Some teachers in this study conceive word problem solving as finding solution to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation and do not have immediate method of solving. This finding is consistent with Martinez (2001) conception of word problem solving. Teachers with this conception in mind believe that there is no word problem solving that has direct algorithm that can be applied to arrive at the solution. Other teachers also conceive word problem solving as accepting a challenging mathematical task or problem and striving hard to solve it. Teachers in this category believe that problem exists only when students

accept a challenge and willing to resolve it. This conception is consistent with Okpoti (2004) and Dollah (2006) previous findings.

In another perspective, word problem solving is conceived by teachers in this study as solving difficult mathematical story problems which involve everyday life situations. Earlier study conducted by Frobisher (1994), Saleh (2009) supports this conception. The fact that teachers who are implementers of problem solving in the mathematics curriculum conceive WPS differently; it should be seen as national concern because teachers‟ classroom practices are informed by their conceptions.

Teachers who indicated in their responses that they teach mathematics WPS, said they use instructional strategies that are in line with problem solving strategies proposed by Polya (1985). These problem solving strategies are: understand the problem, devise a plan, carry out the plan, and evaluate the solution process. Problem-solving heuristics such as; draw a table, act the problem, guess and check, trial and improvement and looking for a pattern were also mentioned by teachers. The Ontario ministry of Education (2007) had earlier on approved these same problem solving strategies for effective teaching of mathematics.

Teachers in this study mentioned several challenges of teaching mathematics WPS in JHS. These challenges were categorized into three major headings for the purpose of this discussion. They include teachers‟ inadequate subject matter content knowledge of problem solving: their inadequate pedagogical content knowledge for teaching mathematics WPS and their inadequate knowledge of curricular materials. These findings were in line with Shulman‟s (1986) knowledge domains for effective

teaching. According to Shulman (1986), for teachers to teach effectively, they need an integrated knowledge of content, pedagogy and curricular materials.

Incompetence on the part of mathematics teachers and difficulties teachers face in teaching mathematics word problem solving as identified in this study are attributes of their inadequate subject matter knowledge in the area of problem solving. Earlier studies conducted by Mereku (1998), Mclntosh, et al. (2000), Anderson (2000), Sullivan and White (2004) attest to the fact that teachers do not teach mathematics WPS because they lack expertise knowledge in the area of problem solving. Teachers‟ subject matter knowledge informs their choice of instructional approach and the curricular materials to use in teaching since effective teaching combines content, pedagogy and instructional materials. This is a pointer to the fact that teachers‟ knowledge of content and pedagogy must be interwoven in order to achieve curriculum objectives (Ball & Bass, 2000).

The study identified students‟ difficulty in understanding mathematics WPS as being cognitively demanding and students not prepared to think as challenges of teaching word problem solving. These challenges are related to teachers‟ pedagogical content knowledge of teaching mathematics WPS. Shulman (1986) said that PCK enables teachers to anticipate students‟ learning difficulties and to provide available alternative models or explanations to mediate those difficulties. If mathematics teachers understand that students come to class with vast ideas and experiences and bring out these ideas and experiences, reorganize them together with students for students to assimilate Shulman (2000) during word problem solving lessons, students will be actively involved in the process of construction of their own knowledge and understanding. Studies by Mclntosh, et al. (2000), Ball and Bass (2000), Mereku

(1998) and Taplin (1998) have already identified that many teachers still do not know how best to teach WPS.

Also inadequate word problem solving activities in mathematics textbooks was identified in this study as problem militating against the teaching of WPS in the JHS mathematics classroom. Shulman (1986) classifies this as knowledge of curriculum materials. Anderson, Sullivan and White (2004), Mclntosh, et al. (2000), Ali, et al. (2010) have also identified inadequate problem solving activities in mathematics textbooks in their respective studies as a challenge of teaching mathematics WPS. Many mathematics teachers in Ghana rely on mathematics textbooks as their primary source of information for teaching. So in a situation where the textbooks are not readily available or have inadequate information, such as problem solving activities and questions that grant the teaching of mathematics WPS, teachers‟ initiatives become challenged.

Linguistic inability of learners was indicated as a challenge of teaching mathematics word problem solving in this study. This was in line with previous studies carried out by Mereku and Cofie (2008), Fletcher and Santoli (2003), Adesoji (2008 and Saleh (2009). The ability of students to read and understand text is an essential ingredient in learning mathematics word problem solving. When students lack the vocabulary to interpret a mathematical task, their ability to explore the solution process of the problem is limited.

Also, to facilitate the teaching of word problem solving, learning and teaching materials was indicated to be non-available in the junior high schools. Meanwhile, teaching and learning materials are indispensable in classroom instructions to achieve lesson objectives and form an integral part of the school curriculum. As Shulman

(1986) indicated, the school curriculum covers a wide variety of instructional materials available in relation to the subject matter to be taught. In view of this if teaching and learning materials are not readily available in schools; the teaching of mathematics word problem solving may not be realized. Previous studies by Foong, Yap and Koay (1996) also identified inadequate teaching and learning materials for teaching mathematics problem solving as challenge to mathematics teachers.

Teachers in this study indicated that teaching mathematics word problem solving is time consuming. Conversely, the time slots for mathematics lessons in JHS classroom are inadequate to allow students to investigate given mathematics problems. This could be seen as a problem posed by the school curriculum since the school curriculum includes what is to taught and at what particular time frame (Shulman, 1986).

The preparation teachers make before teaching or conducting a lesson in the actual classroom setting determines the effectiveness of the teaching and learning. However, the teachers in this study indicated that preparing for word problem solving lesson is difficult. According to the teachers, the difficulty is as a result of the likely multiples methods that students will use in their solution processes which are expected to anticipate in their lesson preparations. This finding is consistent with Anderson (2000) and Zanzali (2003).

Organizing professional development courses for teachers is essential for effective teaching and learning of mathematics. As such, teachers in this study suggested that organizing in-service training, refresher courses to sensitize and give training to mathematics teachers on word problem solving will equip them with such content

knowledge, pedagogical content knowledge and knowledge of curricular materials (Shulman, 1986) to enable them to teach mathematics word problem solving. In line with this, Ali, et al. (2010) recommended in their previous study that, organizing extensive training programme; seminars and workshops for mathematics teachers in elementary schools will enable them to employ problem solving method in the classroom They further suggested organizing training sessions for untrained teachers to be trained in problem solving.

Improving condition of service of teachers and providing teaching and learning materials were suggested by the teachers in this study as ways of promoting the teaching of mathematics word problem solving in the mathematics classroom. Provision of better conditions of service for teachers motivates them to put in their maximum. Teaching and learning materials also ensure students‟ active involvement in classroom activities which in a way enable students to construct their own knowledge with little teacher supervision.

The teachers also suggested that placing sufficient emphasis on WPS in public examinations will encourage teachers to teach mathematics word problem solving. Parents and students‟ expectations in competitive public examinations most often dictate to teachers the approach to use in teaching. Consequently, mathematics teachers teach for examinations instead of conceptual understanding. This corresponds with an earlier study by (Alimayehu and Assaye Ayalew 2009). As stated by Anderson (2009), providing valuable resources and more time are important steps, in encouraging the teaching of problem solving, it is also possible that word problem solving in the mathematics curriculum will only become valued when it is included in high-stakes assessment. An equally imperative suggestion given by the teachers in

this study was that the timetable slots for mathematics lessons need to be increased so that teachers can allow students to explore, investigate, discuss and construct their own meaning and understanding rather than telling them mathematics in the classroom.

5.3 Summary of Findings and Conclusions

This study examined Junior High School mathematics teachers‟ conceptions and practices of word problem solving in the mathematics classroom. The teachers in this study had different conceptions of word problem solving as contained in the JHS mathematics curriculum.

They include:

- Accepting a challenging mathematical problem and striving hard to solve it,
- Solving difficult mathematical story problems which involve everyday life situations, and
- Finding solution to any mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation and do not have immediate method of solving.

Teachers‟ classroom practices are determined or influenced by their conceptions. As teachers conceive word problem solving differently, their approaches to word problem solving were also different. Some of the teachers mentioned Polya‟s (1985) four-stage problem solving model which are: understand the problem, look for a plan, carry out the plan and evaluate the solution process. Others said they use problem solving heuristics such as make a table, draw a diagram, act the problem, trial and improvement and look for a pattern.

The difficulties of teaching word problem solving were identified in this study to include:

- Teaching mathematics WPS is time consuming,
- Teachers and students‟ belief about the way mathematics should be taught,
- Incompetence of mathematics teachers in teaching mathematics WPS,
- Textbooks present few mathematics word problem solving questions and activities,
- Mathematics word problem solving is too difficult to teach,
- Teaching mathematics word problem solving make cognitive demand of students,
- Insufficient word problem solving questions in public examinations,
- Students‟ difficulty in understanding mathematics word problem solving due to low linguistic ability.

Teachers in this study suggest that organizing in-service training and refresher courses for teachers, provision of teaching and learning materials and giving of incentive packages for teachers will motivate teachers to teach WPS. These findings indicate that a lot need to be done if mathematics word problem solving should be effectively taught to achieve the set curriculum goals in the JHS level in Ghana.

5.4 Recommendations

The findings of this study indicated that JHS mathematics teachers less emphasize the teaching of mathematics word problem solving in their instructional practices. The study identified in a broader perspective the challenges of teaching mathematics WPS to include teacher‟s inadequate subject matter content knowledge, inadequate

pedagogical content knowledge and inadequate knowledge of curricular materials. Based on these findings, the researcher recommends that:

- The Ghana Education Service should design a scheme or put in place a scheme that will address the professional development needs of mathematics teachers on teaching mathematics WPS.
- The Colleges of Education and the teacher training Universities in the country should embark on rigorous training of mathematics teachers on how to mathematics WPS.
- The Ghana Education Service in collaboration with the Ministry of Education should be engaged in a well structured and regularly organized in- service training and refresher courses for teachers on the teaching of mathematics WPS in the Junior High Schools in the country.
- More Colleges of Education should be made to train mathematics majors to teach in the JHS instead of generalist teachers who sometimes may lack content and pedagogical content knowledge for teaching mathematics.
- Improvement of condition of service of teachers and provision of incentives will help to motivate teachers to give of their ultimate since teaching of mathematics WPS has been identified as time consuming and as an approach demanding teacher resourcefulness.
- The Ghana Education Service and the Ministry of Education should re-examine the kind of problems that are eligible for teaching WPS and produce the required mathematics textbooks to that effect so that mathematics teachers can give students enough class works/ exercise for practice during lessons on WPS. These textbooks should be accompanied

with teaching and learning materials especially those that cannot be improvised.

- The Ghana Education service should re-introduce storytelling, folktales , riddles, puzzles and reading of simple story books in the basic schools in the country since this will ensure that learners have adequate linguistic ability and their understanding increased.
- The Curriculum Research and Development Division of the Ghana Education Service should revise the syllabus to reduce the number of topics at each grade level so as to enable teachers have ample time to teach mathematics word problem solving and still be able to complete the syllabus.
- Inspectorate Division of the Ghana Education Service should be empowered to do very effective supervision of teachers beyond vetting of lesson notes to what actually pertains in the classroom settings. This will ensure that teachers do enough preparation before teaching.

5.5 Suggestions for Further Research

The researcher suggests that future research study should examine the relationship between JHS mathematics teachers‟ beliefs about word problem solving and their classroom practices.

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APPENDIX A

INTERVIEW GUIDE FOR JHS MATHEMATICS TEACHERS

I am a graduate student of University of Education, Winneba who is conducting a study on word problem solving. This interview is to give you an option to express your view and experience about word problem solving as an integral part of basic school mathematics education. Your views will remain confidential and will be used for only this research purpose. I am pleased to have you for this interview. The interview shall last for about 35 minutes and I wish you will permit me to audiotape your voice for later transcription. You may ask for clarification if you are in doubt.

1. In your own opinion what do you think word problem solving is all about?
2. How do you practice or teach word problem solving in the mathematics classroom?
3. What problem solving strategies do you use in teaching?
4. What do you think are some of the challenges of teaching word problems solving in the JHS mathematics classroom?
5. How do students practice word problem solving in the JHS mathematics classroom?
6. What difficulties do students encounter when solving word problems?

APPENDIX B

INTERVIEW GUIDE FOR JHS MATHEMATICS STUDENTS

This interview is to give you an opportunity to express your vies about word problem solving in the mathematics classroom. Your views will be kept confidential and will be used for only this research purpose. I am pleased to have you for this interview. The interview shall last for about 20minutes and I wish you will allow me to audiotape your voice for later transcription. You may ask for clarification of question if you are in doubt.

1. What do you think are word problems in mathematics?
2. How often do you solve word problems in the classroom or in the house?
3. What are the difficulties you encounter when solving word problems?
4. What do you think can be done to eliminate the difficulties?

APPENDIX C

OBSERVATION CHECKLIST FOR TEACHERS' CLASSROOM INSTRUCTIONAL PRACTICES

Instructional Practices	
Explain in detail what students have to do to solve problems	
Set application problems which allow students to practice the skills they have just learnt	
Provide concrete materials for students	
Discuss useful problem solving strategies	
Encourage students to use variety of approach to solve problems	
Pose unfamiliar and non routine problems rather than routine problems to students to solve	
Pose open-ended problems that require open investigations	
Give opportunities for students to explore solutions by their own ways before being shown by teacher	
Serve as a facilitator, a guide by allowing students to construct their own knowledge during problem solving lesson	
Help students to model word problems into equations or diagrams	
Encourage students-centered instruction	
Use problems which arise from school context or which relate to students" past experiences	
Ask students the application of the concept in the real life situation	
Allow students to work in cooperative groups	
Ask students to present their solutions to the whole class on chalkboard	
Explain the key elements in a problem to students	
Encourage students to pose their own problems	

APPENDIX D

ANALYSIS OF STUDENTS EXERCISE/CLASS WORK BOOK ON WORD PROBLEM SOLVING

Amount of mathematics class works/exercise done by JHS students on word problem solving

Class Work/Exercises	**Amount of Work Done**
Class work/exercises.	
Class work/exercises on word problem solving.	
Corrections done on class work/exercises.	
Corrections done on class work/exercises on word problem solving.	

Sub-Metro 1 JHS 2 of Tema Education Metropolis (Tema) School 1

Term 1: Year-2011/2012

Amount of exercises/class works. ✓

Amount of exercises/class works on word problem solving. ✓

Amount of reworked/corrections on exercises/class works. ✓

Amount of reworked/corrections of exercises/class works on word problem solving. ✓

Term 2

Amount of exercises/class works. ✓

Amount of exercises/class works on word problem solving . ✓

Amount of reworked/corrections on exercises/class works. ✓

Amount of reworked/corrections of exercises/class works on word problem solving. ✓

Term 3

Amount of exercises/class works. ✓

Amount of exercises/class works on word problem solving. ✓

Amount of reworked/corrections on exercises/class works. ✓

Amount of reworked/corrections of exercises/class works on word problem solving. ✓

(Note: At the time of the data collection no exercise was done for the term)

APPENDIX E

SAMPLE OF TRANSCRIBED INTERVIEWS

Transcription of Interviewee # 1 (T1)

Date: Monday, 26-03-2012

Q: In your own opinion what do you think word problem solving is all about?

R: In mathematics word problem, word problem has got to do with generally unfamiliar mathematical story problems Emm, on things that surround us. Basically things that do surround us. We know in everything in real life situations that we find ourselves doing there is mathematics involved. Things, since they have computation here and there. So word problem has got to do with basic things of life. **It has to do with real life situations.**

Q: How do you practice teaching word problem solving in the mathematics classroom?

R: How do I practice how do I practice, how the presentation is done? Em as it goes, it normally starts from, teaching normally starts from known to unknown. I normally start from the child"s immediate environment the child"s immediate environment. That is to say probably talk about the ages of children compared to that of their emm sisters or brothers, like ages of children compared to may be other people in their homes. So I basically start with things around them, things that they are aware of, things that they know, things that are around them and that is how basically I start or practice teaching word problems.

Q: What problem solving strategies do you use in teaching?

R: Problem solving strategies ah many a time I use em, sometimes in a way of puzzles, like riddles yeh story telling. So far they are things I mostly use in teaching word problems. Ok at times you put a question and help them, lead pupils to understand the question, create an equation or make diagram or table to solve for answer and even check backwards for correct solution. This is able to involve children in the learning process and keep their interest level. **Strategies and heuristics**

Q: What do you think are the challenges of teaching word problem solving in the JHS mathematics classroom?

R: Yes challenges, the main challenge is that as you know em English is the medium of exchange, is like the base in all other subjects. So one thing I have identified is the standard of English language of late. I don"t know, not very much what a lot of great variation might be. But the standard of English is just going down the drain and in view of that, when, you know word problem has got to do with the mathematics question being posed to children in sentences form and all that. So many at time deducing or translating the equations from the sentences becomes a problem sometimes for them. Because there are some of the things that depict that you should multiply others also may be depict that you should subtract, you should add and all that. But because their understanding of the language is quite difficult for them, it hence makes the computation also that is getting the equation quite difficult. Hence the students inability to solve most word problems. That is the major challenge that I have identified so far.

Q: How do students practice word problem solving in the JHS mathematics classroom?

R: Sometimes in their groups, they practice. On their own sometimes they pose problems to themselves and then they try to solve it. And sometimes also individually they try to sit down and try to also learn on their own. Sometimes we give them oh yes exercises and assignments and home works in which they practice solving word problems. They also at times write word problems on equations we give to them and try to solve among themselves.

Q: What difficulties do students encounter when solving word problems?

R: The main thing here is also got to do with the language, the English language, that is the medium of exchange. As I said earlier, because the standard of English is low so getting the equations or writing down the equations from the sentences using the variables like a b c or x y z to solve becomes a big problem. They also lack understanding due to poor reading ability. Most students can't read to get good understanding to get the expected equations to do what is expected of them. Being able to read well and comprehend the sentences and translate for the equation is a big challenge.

Transcription of Interviewee # 2 (T2)

Date: Tuesday, 27-03-2012

Q: In your own opinion what do you think word problem solving is all about?

R: Emm, word problems are means of translating complex or complicated mathematical concepts in to everyday language which is easily understood or easily understandable and workable mathematically. I think also that it is accepting to solve a challenging mathematics puzzle or word problem by thinking critically through

several ways. And translating it to work it is a way of solving it. That is basically what word problem solving is about.

Q: How do you practice teaching word problem solving in the mathematics classroom?

R: Yes, em in teaching word problems in fact Ghana Education Service (GES) has a concept, a policy to encourage teachers, mathematics teachers to teach word problems because there seems to be em a deficiency and there is that gap between students being able to stand on their feet to solve problems. And this is just one means through which that gap or deficiency can be dealt with. Word problem solving can be used to boost students" confidence and thinking ability to deal with everyday issues in life. **So we are encouraged to teach and set a lot of pre-test questions and those things on word problems. In terms of class exercises and even the questions that we pose we should as much as possible pose them in a form of word problems so that it will cause** (1) students to stand on their feet and think on their own. (2) to like I said earlier on be able to translate mathematical concepts in to everyday language so they can better understand and deal with.

Q: What problem solving strategies do you use in teaching?

R: Okay the strategies vary, strategies vary based on the understanding of the students. And I think in terms of strategies more often than not at the lower levels we are encouraged to use animate objects or inanimate objects, whatever one is appropriate for the topic that is being taught. I do use manipulative materials such as paper folding depending on the problem. Sometimes, I make and draw a diagram to simplify the problem aha I sometimes draw tables so the pupils can understand the concept and work. **Heuristics**

Q: What are some of the challenges of teaching of word problem solving in the JHS mathematics classroom?

R: Now the problems are many and varied. You know we are supposed to teach word problems from primary school. Unfortunately, come to the JHS, the junior high school, they don‟t seem to grasp word problems at the primary level, that is the word problem concept is not grasped by pupils at the lower level and this can be attributed to teachers too, that is per the way they present lessons on word problems in particular and other topics in mathematics. Teacher‟s content and knowledge of pedagogy need attention. (1), (2) may be following from that when you start introducing word problems, it sounds **new** to them and appears to be very **strange** to them.

(3) most of them lack the thinking ability, the mental faculties of the children have not been well developed through teaching and learning and the **demand on them cognitively is very high** on word problem solving.

(4) Apart from this they lack understanding of the language of the problems posed to translate because even how to read the text is a big challenge. Reading, reading is a big issue that needs attention. Also topics that involve word problems are not enough in the JHS mathematics textbooks.

(5) word problem solving teaching needs a lot of time, it wastes a lot of time for teachers in preparation and lesson delivery.

Q: How do students practice word problem solving in the JHS mathematics classroom?

R: You see because that was not inculcated in them from the word go, practice is very limited and no wonder it transcends from basic to the senior secondary. Do they do class exercises and so on? Oh yah, we give class exercises, assignments and home

works where students do practice solving. Sometimes they in groups pose word problems and try to write and solve. These they at times do in a way to practice.

Q: What difficulties do students encounter when solving word problems?

R: Oh because of the problems of the language that they already have. They are not able to read problems put to them well. They lack vocabulary because of lack of reading and hence lack comprehension and understanding. So the changing (transformation) of question into equation to solve is a big problem.

When teacher‟s view was asked about what can be done to deal with the difficulties? The views were that policy makers have to do something about the issue of NALAB seriously. The use of local language at the lower primary should be looked at so that the English language is introduced right from the lower classes. Since word problems are in the English and not the local language.

Mathematics teachers at the lower level should be encouraged to use more word problems in the teaching of mathematics. Word problems should not be restricted to a topic or two. It should run through most topics in the primary and JHS mathematics textbooks. There should be provision of teaching and learning materials in the schools by the Ministry of Education to make lessons on word problems practical to learners. In-service training and organizing refresher courses for teachers will help equip teachers with strategies for teaching word problem solving to alleviate students‟ problems.

Transcription of Interviewee # 3(T3)

Date: Wednesday, 28-03-2012

Q: In your own opinion what do you think word problem solving is all about?

R: Word problems, my opinion well I see it as the normal mathematics that we do or solve that it has been posed in a sentence form or case study form for pupils to, to help children to at least think, yah enable them to think to get concepts. **Problems in a sentence form**.

Q: How do you practice teaching word problem solving in the mathematics classroom?

R: Yah, in teaching word problem or word problem solving emm you have to relate it to child"s immediate environment or surroundings (contextualize it), yeh. You can"t teach it abstract because at the basic level, the children most of them the understanding first of the language is not there. They are not able to understand what they strive to read. So you have to relate it to the environment so they can have a feel of it. If they understand then they can go about it and can do it and so on.

Q: What problem solving strategies do you use in teaching?

R: Well as I said normally in teaching word problem solving in linear equation for instance, you have to start with something that the child can see, concrete things in the environment. Like in teaching fractions in word problem you use real objects example manila cards. You can also make tables or use diagrams make trial and improvement to teach as strategies. The students should be made to understand the problem, take a way or method or plan to solve the problem and we must find out for the right answer.

Transcription of Interviewee #3 (S3)

Date: Friday, 14-05-2012

Q: What do you think are word problems in mathematics?

R: Ok, it is when mathematics being treated or set in a form of sentence which is to be understand before it can be worked. That is they are in words.

Q: How often do you solve word problems in the classroom or in the house?

R: I use to solve some from textbooks, in class works and exercises given to us. When we have free time we practice solving word problem questions and we do some in the houses.

Q: What difficulties do you face when you solve word problems as students?

R: The questions are tricky and are not practical in numbers. The questions are not easy to understand and sometimes take our time. Our teacher‟s way of presenting the topic to us should be checked. Our school like this we are many in class so the exercises given to us are not many, one or two.

Q: What do you think can be done to remove the difficulties in our schools on word problems?

R: Constant practice, making lesson practical to students. There must be use of teaching and learning aids to make topic practical to us. Yes if they can increase the time for math. Students must be interested in learning and teachers must do their best to teach very well.