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A Case Study on Algebra difficulties in Tema Education Metropolis in Ghana

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Abstract

Due to the way mathematics is perceived, teachers in modern mathematics education took a different strategy while addressing word problems in Algebra. The teacher can guide students to build problem-solving abilities to create mathematical concepts that can be applied in practical settings. This study is a case study with Junior High School students at Tema Metropolis in Ghana. Data collection and analysis for the study were done using a qualitative methodology. Using a purposive sampling technique, data were gathered from 12 participants, including 6 Junior High School mathematics teachers and 6 students. Data were gathered using observation, interviews, and document analysis (student workbooks). The research revealed three distinct approaches taken by teachers when it comes to Algebra word problems: embracing a challenging mathematical problem and putting much effort into solving it; solving challenging mathematics story problems that involve real-world scenarios and coming up with solutions for any mathematics problem that contains a significant amount of background information but is not immediately amenable to a solution. Due to the way Junior High School mathematics teachers in Ghana handle the issue, students find it challenging to grasp the problem and also the inability to pose their own word problem.

Keywords: *Students' difficulty, mathematics teachers, Algebraic word problem-solving.*

Introduction

Any advanced country's economic, scientific, and technological advancement is built on mathematics and Algebra is the bedrock of mathematics. This is why the study of mathematics is highly valued in the educational systems of nations that are concerned about their progress (MOE, 2010). A problem-solving mathematics curriculum encourages the use of mathematics in unusual or challenging settings. Additionally, it places a focus on presenting mathematical concepts to students through methods they will use in the actual world. The use and application of mathematics in practical tasks, in real-world issues, and within mathematics itself are all part of the problem-solving mathematics curriculum. Any arithmetic exercise where important background information is supplied as text rather than in mathematical notation is referred to as a "word problem" in mathematics education(Boonen et al., 2013; Martinez, 2001). Word issues can vary in the quantity of language used and typically incorporate some form of narrative. For this reason, they are sometimes also called story problems.

A dimension that should be the primary focus of teaching and learning in schools is "Knowledge," "Application," etc., according to the "Definition of Profile Dimension" section of the Ghanaian Junior High School mathematics curriculum. Unfortunately, it has been discovered that schools continue to emphasise teaching information and understanding, which are low ability thinking skills while ignoring higher ability thinking skills.

The current pre-university problem-solving mathematics curriculum in Ghana mandates the application of mathematics to real-world situations (Baah-Duodu et al., 2019). It specifically advised the use of suitable mathematical critical thinking and problem-solving techniques in mathematics teaching and learning (NaCCA, 2020). Thus, one of the primary goals of teaching mathematics at Ghana's pre-university institutions is to assist students in developing their problem-solving skills (Baah-Duodo et al. 2019).

The theoretical foundation of this study is based on Shulman's (1986) knowledge domains in instruction. Shulman advocated three topic domains for teaching, including pedagogical content knowledge (PCK), curricular knowledge (CK), and subject matter content knowledge (SMCK). The term "pedagogical content knowledge" was coined by Schulman in 1986 and was later defined by Kirschner, Hendrick, and Jim (2022) to refer to the knowledge teachers acquire about how to teach specific subjects to specific students. As Coe (2013) notes, simply because a teacher has engaged the students in a lesson does not imply that they are learning. Engagement is frequently a subpar substitute for learning, and the idea that one can enter a classroom and magically detect learning is mistaken. Without any requirement for an independent assessment of what, if anything, has been learned, teachers may persist in the fallacy that what they have taught becomes a surrogate for what the students have learned (Coe, 2013). Teaching is therefore not just counterintuitive but also deceptive, and what appears to be effective on the surface can actually ng.

Teaching entails bringing out the accumulated knowledge and experiences that students bring to class and working on those ideas and experiences with the students by refining, reorganising, co-constructing, and repairing these ideas and experiences into meaningful and comprehensible forms for students to assimilate (Atteh & Andam, 2019; Shulman, 2000). This serves as the foundation upon which problem-solving in mathematics should be taught. It follows that to effectively teach mathematics word problem solving, teachers must have a thorough understanding of the mathematical substance of word problem solving, problem-solving pedagogy, and the curriculum materials that define the scope and direction of word problem-solving (Baah-Duodu, Ennin, Borbye & Amoaddai, 2019). More critically, teachers need to be well-versed in all of these subject areas. Teaching entails making both internal and external connections, and this can only be done, claims Shulman (2000), if teachers involve their students in the discussion in the classroom. Only in an interactive learning environment do students reveal to the teacher their ideas, concepts, preconceptions, and experiences (Atteh & Andam, 2019). The knowledge domains proposed by

Shulman (1986) provide a clear framework for instructing mathematics problem-solving and are very relevant for teachers today.

Subject matter content knowledge

Subject matter content knowledge is the amount and organisation of all knowledge in a teacher's mind (Shulman, 1986; Atteh & Andam, 2019). They contend that a thorough understanding of facts, concepts, and procedures is not sufficient to assess a teacher's subject-matter expertise. It necessitates an awareness of the subject's structural elements as defined by Schwab. Schwab (1978) asserts that a subject's structural components encompass both its substantive and syntactic components. With the use of syntactic and substantive structures, teachers will be able to carefully examine, justify, compare, and contrast students' approaches to solving word problems in order to identify and correct any flaws or misunderstandings. In addition, teachers' ability to employ instructional resources, assess students' progress and decide on representations, emphasis, and sequencing all depend on their understanding of the mathematical content they are teaching (Ball, Hill & Bass, 2005; Atteh & Andam, 2019).

Pedagogical content knowledge

In terms of subject knowledge, pedagogical expertise comes in second. Shulman (1986) asserts that pedagogical content knowledge transcends the realm of subject matter content knowledge to encompass the dimension of subject matter knowledge for teaching. It combines the most frequently taught topics, the most helpful ways of representing those ideas, the most potent analogies, and examples, illustrations, explanations, and demonstrations in the art of teaching (Atteh & Andam, 2019).

Additionally, pedagogical content knowledge provides strategies for presenting and structuring the subject matter in a way that makes it understandable to students with a range of perspectives and understandings (Nilsson & Lund, 2022). They must be knowledgeable about the pedagogical techniques most suited for restructuring the comprehension of students who could initially seem to them to be in the dark (Shulman, 2000). Additionally, pedagogical content knowledge entails a comprehension of what makes learning about particular topics challenging, as well as the assumptions and prejudices that students of all ages and backgrounds frequently bring to the learning environment (Shulman, 1986; Atteh & Andam, 2019). The pedagogical content knowledge aids teachers in foreseeing their students' learning challenges and offering alternate models or explanations to mitigate such challenges. Although teaching is uncertain, this does not exclude teachers from being ready for it in the classroom. The teaching of Algebra word problems in the curriculum is likely to improve when teachers are ready to harness all available pedagogical strategies of teaching and learning and employ them in the classroom (Atteh & Andam, 2019).

Curricular knowledge

The whole range of programs created for the teaching of mathematics topics at a specific grade level constitutes the mathematics curriculum. It covers a broad range of educational resources available in connection to the subject matter to be covered as well as the features that direct the utilization of specific curriculum resources under specific conditions (Shulman, 1986). Wardlaw (2008) highlighted the importance of curriculum, pedagogy, and assessment congruence in his presentation at a forum hosted by the National Curriculum Board. This means that teachers must maintain the correct interplay of this alignment to promote effective teaching and learning of word problem-solving in the mathematics classroom. It is crucial to emphasize that for effective teaching and learning of word problem-solving in the mathematics classroom, teachers must be fully aware of the alignment for student learning at the fundamental level of education (Yee, 2009). Teachers should carefully consider students' mathematical concepts, consider textbook explanations, and weigh the relative merits of two different representations when dealing with a

specific mathematical problem (Ball & Bass, 2000). The professional teacher is required to be knowledgeable about the curricular elements being studied by his or her students concurrently in other disciplines. Therefore, teachers must possess a thorough understanding of the teaching curriculum in order to teach word problems or word problem-solving.

Conceptions of problem and problem-solving

According to studies, there are many different conceptions of problems and problem-solving, and these conceptions have an impact on how teachers instruct their students in the classroom.

The definition of a problem according to Cooney, Davis, and Henderson (1975) is "A question which provides a difficulty which cannot be resolved by any conventional technique known to the students" (p. 242). They said that difficulty might also be thought of as a roadblock that stands in the way of a goal. Until the student is driven to get beyond the obstacle and reach the goal, the barrier does not represent a problem. 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 (Lipton & Zalcstein, 1977). 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 Amina. In five years, time, he will be half her age. What is John's age now? (MAG, 2005).

Three criteria are provided by Krulik and Rudnick (1996) to determine if a situation qualifies as a problem. The first prerequisite is that the person can resolve the problem by achieving a certain goal. Second, there must be barriers in the way of reaching the goal; third, the previous two requirements will push the person to look into ways to get around the barriers. It doesn't matter if the task at hand is challenging or not, as long as the student views it as such. Here, accepting a challenge entails the student's willingness to identify effective strategies for resolving the issue. However, the process invariably requires a problem solver who is engaged in a mathematical task to organise and deal with domain-specific and domain-general pieces of knowledge (Nortvedt, 2011).

Problem-solving as context

Mathematics instruction has been justified by the use of problem-solving. The subject is connected to practical problem-solving situations to convince pupils of the importance of mathematics. Another technique for inspiring students is problem-solving by giving them a contextual (real-world) example of the use of a mathematical concept or procedure. A teacher may use the setting of problem-solving to introduce the idea of fractions, for instance, giving groups of students the task of dividing two pieces of licorice such that each receives an equal share. The teacher aims to accomplish several things by presenting this problem-solving context, including motivating students to learn about fraction concepts through the use of a comfortable and appealing medium, helping to make the concepts more concrete through practice, and providing a justification for learning about fractions.

Problem-solving as a skill

Instead of teaching problem-solving techniques across the curriculum as a way to enhance conceptual knowledge and fundamental abilities, proponents of this viewpoint believe that problem-solving techniques should be taught as a separate topic (Lester Jr & Cai, 2016). They provide students with practice utilising these general methods to tackle everyday issues, such as sketching a picture, working backward, or constructing a list. However, when problem-solving is considered as a set of talents, the skills are frequently organized in a hierarchy, with pupils being

expected to first acquire the capacity to solve routine problems before attempting non-routine problems. (Bukari, 2019) claims that the Polya (1945) model of problem-solving skills is still advised for use in today's mathematics classrooms for both teaching and evaluating problem-solving abilities. They are:

1. recognising and unpacking the problem
2. Coming up with a strategy to deal with the problem
3. Carrying out the strategy and
4. Considering the situation critically.

He asserts that although the four steps of problem-solving are presented in a progressional order, it may not be possible to simply follow them to arrive at solving problems.

Problem-solving as art

George Polya (1945) proposed the notion that problem-solving may be taught as a practical art, similar to playing the piano or swimming, in his classic book How to Solve It. Polya defined "modern heuristics" (the art of inquiry and discovery) to refer to the skills required to successfully research new challenges since he considered problem-solving as an act of discovery. He promoted presenting mathematics as an experimental and inductive discipline rather than as a complete body of facts and rules. Teaching children problem-solving as an art is intended to help them become skilled and enthusiastic problem solvers as well as autonomous thinkers who can handle vague, open-ended issues.

Problem-solving approaches

Three problem-solving methods are identified in the study literature on problem-solving: teaching *for* problem-solving, teaching *about* problem-solving and teaching *through* problem-solving (Siemon & Booker, 1990; Lester, 2013; Li & Lappan, 2014). Each of these strategies has an impact on the kinds of exercises and teaching methods that might be used with pupils during math lessons. All three methods rely on heuristics and problem-solving techniques. While issue solving is emphasized as an object of inquiry in both teaching for and about it, teaching through problem-solving emphasizes problem-solving as a process of inquiry (Hino, 2007). Though problem-solving-based instruction is thought to be the most effective strategy, it has been claimed that all three approaches have a place in the teaching of mathematics especially in Algebra. The fact that problem-solving can be taught can result in it being treated as another subject in the curriculum. Finally, teaching through problem-solving-based instruction is the most likely to advance knowledge.

Rationale and research questions

The rationale of the study is to determine Ghanaian JHS students' and teachers' difficulties in solving Algebra word problems and how they practice problem-solving across the content domains described by the mathematics curriculum.

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 the problem-solving skills to be functional in real-life situations, especially in Algebra word problems. The following research questions guided the study:

1. What are teachers' conceptions of Algebra word problem-solving in the mathematics curriculum at Tema Education Metropolis in Ghana?

2. How is the teaching of Algebra word problem solving practiced by teachers in the mathematics classroom at Tema Education Metropolis in Ghana?
3. What problems militate against the teaching of Algebra word problem-solving in the mathematics classroom at Tema Education Metropolis in Ghana?
4. What difficulties do JHS students encounter when solving Algebra word problems in the mathematics classroom at Tema Education Metropolis in Ghana?

Method

This study is a case study in the Tema Education Metropolis of the Greater Accra Region of Ghana, this design was utilized to examine the word problem-solving strategies employed by Junior High School mathematics teachers and the challenges that students face while attempting to solve Algebra word problems.

The multimethod focus of qualitative research includes an interpretive, naturalistic approach to its subject (Aspers & Corte, 2019). In order to make sense of or interpret occurrences in terms of the meaning's scholars assign to them, qualitative researchers examine phenomena in natural environments.

A case study is an investigation that uses a variety of empirical resources to evaluate a current occurrence or event in its actual context (Silverman, 2013). Case study research is employed to carry out a thorough analysis of a problem in a particular situation and setting. It entails compiling comprehensive data in a constrained space. As a result, the study included both instructors and students from the three sub-metros of the Tema Education Metropolis. By including participants in data gathering, this strategy aims to establish trust and rapport with the study's participants (Kornbluh, 2015; Patton, 2015).

Since the study's design mostly relied on a qualitative technique for data collecting and analysis, it was important to poll teachers and students to select for interviews, observations, and workbook analyses that would help us understand the phenomena better.

Research setting

This study was carried out in the Greater Accra region of Ghana's Tema Education Metropolis (TEM), which is made up of the three sub-metros Kpone-Katamanso, Tema East, and Tema West. Schools can be found in both rural and urban areas in these sub-metropolises. However, there are not enough infrastructure facilities, particularly in rural areas, to fulfill the demand of the growing number of school-age children. Examples include classrooms, furniture, and curriculum materials. The teacher-to-student ratio is extremely high, particularly in rural areas. A small number of graduate professional and non-professional teachers, as well as 3-year post-secondary teaching certificate holders, teach mathematics at the Junior High Schools. The majority of the locals in these sub-metros are fishermen and small-scale traders. Most students' parents immigrated to the area as employees of the government or entrepreneurs, students in urban communities come from a variety of socioeconomic backgrounds. This brings diversity to the classroom and makes it difficult for teachers to meet the needs of each student.

Participants

The participants for the study consisted of Junior High School mathematics teachers and students in the Tema Education Metropolis of the Greater Accra Region of Ghana.

Research tools

A sample is a carefully chosen subset of the population's units. The data collection process employed a purposeful sampling technique. The purposive sampling technique helps the researcher to instantly connect with the

participants and employ those participants to gather valuable information for a deeper understanding (Creswell, 2009; Baah-Duodo et al., 2019). To put it another way, purposeful sampling enables the researchers to choose people who have the necessary knowledge and experiences that are crucial to the topic being studied. Due to the sample demographic make-up and geographic location in Ghana's Greater Accra Region, Tema Education Metropolis was the sole choice for the study and was therefore chosen using the purposive sample technique.

There are no guidelines for choosing the sample size for a qualitative study, according to Patton (2015). In a qualitative study, the sample size "depends on what the researcher wants to know, what is at stake, the research's aim, what would be beneficial, what will have credibility, and what can be done with the resources available" (p.244). The three sub-metros of Kpone-Katamanso, Tema East, and Tema West were taken into consideration for the study after Patton's remarks. The sub-metros were selected based on three factors: (1) familiarity with the area's geography; (2) diversity, as the sub-metros have both underprivileged and wealthy JHS; and (3) ease of access to the schools. Due to the use of interview, observation, and document analysis (students' exercise books) as study tools, the researcher purposefully recruited 12 participants from the three (3) sub-metros, including 6 teachers and 6 students.

Data sources and analysis

It is necessary to gather a range of data using three study instruments in order to have a thorough understanding of the word problem-solving strategies used by Junior High School mathematics teachers and the challenges that students face while attempting to solve word problems in Algebra. In particular, the study made use of interviews, observations, and document analysis. These instruments were employed to make-up for one instrument's shortcomings.

Trustworthiness of instruments

In qualitative research, credibility is used to demonstrate that the findings are "worth paying attention to" (Lincoln & Guba, 1994). Any qualitative research endeavour must address four challenges of reliability. Credibility, transferability, dependability, and confirmability are some of these problems. Transcripts of the interviews were handed back to the interviewees so they could confirm that what was written down accurately reflected their answers, establishing the legitimacy of the research findings. They might remark on whether they thought the data were used in a way that was consistent with their own experiences. Getting participant comment on results improves credibility. To prove transferability and support claims made by specific participants, researchers employed detailed explanations to shed light on the circumstances. We went into great detail on the protocols we followed before, during, and after data collecting for our research. Researchers in mathematics education with competence in qualitative research examined the study's data analysis and research procedures documentation (Lincoln & Guba, 1994). Lincoln and Guba, who are quoted in (Shenton, 2004), emphasize the connections between dependability and credibility, contending that in practice, proving the former helps to guarantee the latter. Their recommendations were taken into consideration, and the dependability of the research techniques and data analysis procedures was established based on prior qualitative research.

Ethical considerations

The Metropolitan Director of Education was consulted for approval before using Junior High Schools mathematics teachers and students as research subjects. Official letters were written by the researchers to get in touch with the headmasters and mistresses of the schools taking part in the study and request their consent. Prior to completing the interviews, observations, and document analysis, participant consent was obtained. we were quite open about the

study's objectives and made it apparent that it was simply academic research. Additionally, we provided participants with guarantees of anonymity and confidentiality regarding the data we obtained.

Results and Discussions

Interview results

Six Junior High School mathematics teachers from Tema Education Metropolis' three sub-metros were interviewed. In each sub-metro, two teachers were interviewed from each of two schools. Each of the two schools had one teacher who was interviewed. The purpose of the interview was to provide the researcher with a thorough grasp of the study. The six teachers were chosen based on their attendance records at the school and their expressed concern when the researcher approached them about the inclusion of Algebra word problems or word problem solutions in the mathematics curriculum. The abbreviation T followed by a number in the presentation is the code for the teacher interviewee; for example, T1 and T3 mean first and third teacher interviewees, respectively, as labelled in the transcription report. The abbreviation S is the code for the student interviewee; for example, S1 and S2 mean first and second student interviewees, respectively.

How Junior High School mathematics teachers view word problem solving

The mathematics curriculum is implemented by teachers. The teacher's understanding of Algebra word problem solving will determine whether it is practiced or included in the mathematics curriculum. Six Junior High School mathematics teachers were questioned about word problems and word problem-solving to have a deeper knowledge of the research. A sample of the response is shown below.

Q: In your own opinion what do you think Algebra word problem solving is all about?
In responding to the question *T3* said:

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

The problem-solving techniques used by mathematics teachers in Junior High School

The researchers questioned the mathematics teachers about the instructional methods they frequently employed when teaching word problem solutions in the classroom.

Q: Mention some of the strategies you often use in teaching your Algebra word problem-solving lessons? A sample of the response common to them was what T1 said.
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, and backwards. Sometimes I use equation or a formula, use guess and check.*

Researchers 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:

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

Teachers adopt different strategies 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 Junior High School mathematics teachers use problem-solving strategies such as recognising and unpacking the problem, coming up with a strategy to deal with the problem, carrying out the strategy, and considering the situation critically. Based on the teachers' responses, one can conclude that there is no definite word problem-solving strategies that teachers ought to use to achieve mathematics curriculum objectives (Rosales et al., 2012).

Obstacles to teaching students how to solve algebra word problems in mathematics

The following question was posed by the researchers to uncover the issues that work against teaching Algebra word problem-solving classes.

Q: What do you think are some of the challenges of teaching Algebra 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 (Matthews, 1997). They indicated the causes of these difficulties to include: students' lack understanding of the language of text and not willing to be actively involved in class, students' beliefs about the difficulty of Algebra 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 Algebra word problem solving is very difficult and this belief has influenced their attitude and interest toward word problem-solving, for example, *T1* stated:

Students believe that mathematics is very difficult much more to talk about Algebra word problem solving, so whenever you say something concerning word problem solving, students get scared. To be better informed, researchers asked *T1* if there is something particular that often puts students away from mathematics, especially in Algebra. In responding to this question, *T1* states:

> *Maybe 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 primary school that mathematics is very difficult and it is formula work, so teaching and learning mathematics Algebra word problem solving with reading, reasoning, understanding of sentences and series of inquiries become a problem to students.*

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 Algebra word problem solving quite uninteresting. This was clearly expressed by *T2* who said:

> *...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.*

Researchers were eager to know why students will fail to participate in Algebra 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 can 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 incompetence of Mathematics Teachers in Teaching Algebra Word Problem-Solving

The interviewees acknowledged that many teachers lack the requisite knowledge and expertise in teaching mathematics word problem solving as captured in the interview response agrees with the results (Baah-Duodo et al., 2019) according to the response of T4 and T6

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

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

JHS Students' Difficulties When Solving Word Problems in Mathematics

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

Q: What are the difficulties students' encounter when solving Algebra 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 choose suitable mathematical operations, is among the factors that prevent them from solving word problems correctly.

T5 in responding to the question said:

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

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

Results of Observations

This study required observation since it was important to see and comprehend how math teachers instruct Algebra word problem-solving in a genuine classroom setting. The six JHS mathematics teachers who were interviewed also had their Algebra lessons monitored. Two teachers had post-observation interviews conducted as well. The goal of the observation was to observe how JHS teachers used Algebra word problems in their lessons on

mathematics. The purpose of the post-observation interview was to ascertain why teachers did not put specific instructional strategies into effect during their word problem-solving lessons. Every teacher had 70 minutes of observation time.

An observation checklist with 15 classroom teaching methods served as the basis for the observation. The researchers watched and checked off any problem-solving techniques used by the teacher during the delivery of the lesson. Table 1 displays the matrix of instructional strategies that teachers employ.

Table 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 that allow students to practice the skills they have just learned	√	√	√	√	√	√
Provide concrete materials for students	×	×	√	×	√	×
Discuss useful problem-solving strategies	√	√	√	√	√	√
Encourage students to use variety approaches to solve problems	√	×	×	√	√	×
Pose open-ended problems that require open Investigations	×	×	×	×	×	×
Give opportunities for students to explore solutions by their 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 that 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.

In word problem-solving lessons, all six teachers provided detailed explanations of what students must do to solve issues, as seen in (Table 1). They talk about techniques for solving issues like comprehending them, formulating a plan of action, putting it into action, and assessing the results. It was noted that all six teachers (Table 1) provide opportunities for students to explore solutions in their own ways prior to being shown by the teacher. Problem-solving heuristics that were frequently observed include making a table, drawing diagrams, guessing and checking, trial and improvement, etc. Additionally, they emphasized student-centred instruction and clarified crucial components of difficulties for students (Table 1).

Only two teachers were seen employing issues that come from the school setting or that relate to students' prior experiences, while all six teachers presented application problems that allowed students to apply skills and concepts they had just learned (Table 1).

During lesson observation, three crucial instructional strategies were completely overlooked. Posing open-ended questions that demand in-depth research, letting students build their own knowledge during word problem-solving courses while teachers act as facilitators and mentors, and encouraging students to come up with their own challenges were some of these techniques (Table 1). The researchers then asked two of the teachers they had witnessed why these instructional strategies were not being used, and they responded as follows:

> *T5: It is a fact, yes that open-ended problems lead to open investigations and multiple solutions which are not that easy to find the right answers to. This makes it takes a lot of time and difficult to prepare lessons since you have to make provisions for most of the possible solutions that students may produce consistent with (Baah-Duodo et al 2019)*
>
> *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 in consonance (Baah-Duodo et al., 2019).*

According to the answers given, some of the reasons why the teachers observed did not engage in those techniques included teachers' weak pedagogical subject knowledge of Algebra word problem solving, students' poor aptitude, and a lack of curricular materials.

Table 1 shows that five of the teachers were helping their pupils model Algebra word problems into equations or diagrams, particularly challenges like the "choose a number" game in algebraic expressions and word problems involving ages in linear equations. Four of the teachers were observed using concrete materials that students could manipulate during sessions, so this practice was not neglected (Table 1). Three teachers were observed urging students to share their methods for answering with their peers in small groups and to write their responses or solutions on the chalkboard for a discussion with the class as a whole. The six teachers observed in this study practiced such problem-solving approaches as teaching *for* problem-solving and teaching *about* problem-solving (Siemon & Booker, 1990; Xenofontos & Andrews, 2012). 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.

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

The analysis of the students' class notes and exercise books was done to help the researchers determine whether or not Junior High School (JHS) students practice Algebra word problem-solving in the mathematics classroom and how frequently they do so in the schools, as recommended by the mathematics curriculum. We looked at the classwork and activity books of six students, two from each of the two Tema Education Metropolis sub-metros (including the three interviewed students). Students will be able to accomplish the curriculum's intended goals with the help of word problem solving practice. They will acquire the abilities, principles, and knowledge required to deal with problems, issues, and circumstances encountered in daily life. Thus, information was gathered based on pre-established criteria to classify class projects and exercises on word problem solving for the three terms in each of the six schools under investigation. Table 2 displays the outcomes from the textbooks used for classwork and exercises.

Table 2: Summary of class works/exercises on word problem solving

Serial Number	No. of Class Work/Exercises	No. of Class Work/Exercises on Word Problem Solving (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

Table 2 shows that no class work or exercises were completed on WPS out of the 21 class activities that were examined. In a similar vein, 1 class work/exercise out of 43 that were reviewed was completed using Word Problem Solving (WPS). This further suggests from Table 2 that just 1 class work/exercise was completed on WPS out of a total of 64 class work/exercises checked in the TK sub-metro (TKE x BkI & TKE x BkII). Table 2 showed once more that 1 of the 33 class assignments/exercises verified was on the done WPS list. In a similar vein, 3 of the 44 class assignments and exercises that were reviewed were completed using WPS. This indicates that just 4 of the 77 class assignments and exercises checked in the TE sub-metro (TEE x BkIII and TEE x BkIV) were completed using the WPS (Table 2). Table 2 further revealed that out of 63 class works/exercises that were analyzed, 4 were done on WPS, and out of 62 class works that were analyzed, 3 were done on WPS. Table 2 showed that only 7 of the 125 class assignments and exercises checked in the TW sub-metro (TWE x BkV and TWE x BkVI) were completed using the WPS (Table 2).

Table 2's findings show that just 12 of the 266 class assignments/exercises that were checked or 4.5% were on the WPS.

Table 2 further showed that just 1 of the 15 corrections made on exercises and classwork in the TK sub-metro were on WPS. Similar to this, only 2 of the 12 changes made on exercises or classwork in the TE sub-metro were on WPS. Table 2 further shows that only 3 modifications were made to WPS out of the 41 corrections made to assignments and exercises in the TW sub-metro. Table 2's findings show that just 6 of the 68 corrections made to exercises and classwork or 8.8% of all corrections were made to WPS.

For JHS students to successfully complete their coursework, they must engage in mathematics WPS practices. To achieve the objectives of the mathematics curriculum, teachers must possess problem-solving and, by extension, word problem-solving skills. The school schedule should allot specific time for mathematics teachers to teach the WPS and provide practice activities to students. Additionally, a lot of emphasis should be placed on WPS in public exams and standardized assessments in order to motivate teachers to teach WPS and its principles. This will assist in avoiding the circumstance shown in Table 2 so that pupils will meet the anticipated mathematics levels.

Discussions

The findings revealed that teachers' conceptions of word problem solving especially in Algebra were seen from three different perspectives, including embracing a challenging mathematical problem and putting much effort into solving it; solving challenging mathematics story problems that involve real-world scenarios and coming up with solutions for any mathematics problem where significant background information is presented as text rather than in mathematical notation and does not have an immediate method of solving it.

In the classroom, teachers' choices are implicitly influenced by their conceptions. How teachers conceptualize a subject in the curriculum has a significant impact on what they teach in class, how they teach it using specific teaching resource materials, and why they use a particular technique and this finding is in consonance with (Atteh & Andam, 2019). In this study, teachers responded that on word problem solving one has to figure out a solution to any mathematics activity when significant background material is supplied as text rather than in mathematical notation and there isn't an obvious way to solve it. This result agrees with (Martinez, 2001; Boonen et al.2013) theory of word problem solution. Also, teachers use various problem-solving heuristics such as drawing a diagram, producing a model and looking for a pattern which was in consonance (Li & Lapan, 2014). With this idea in mind, teachers hold the opinion that there is no direct algorithm for solving Algebra word problems that may be used also consistent with (Rosale et al., 2012)

Several difficulties with teaching mathematics word problem-solving in JHS were noted by teachers in this survey. For the purposes of this discussion, these difficulties were divided into three main categories. They include the teachers' poor subject-matter expertise in problem-solving, their poor pedagogical expertise in teaching mathematics WPS, and their poor understanding of the course contents. These results were consistent with the knowledge domains for effective instruction proposed by Shulman (1986). According to Shulman (1986), teachers must have a comprehensive understanding of subject, pedagogy, and course materials in order to impart information to students. Insufficient problem-solving exercises in mathematics textbooks have been mentioned by (Ali et al., 2010; Anderson et al., 2004) as obstacles to teaching mathematics word problem- solving.

In this study, it was shown that one difficulty in teaching mathematics Algebra word problems to students was their language incapacity. This was consistent with earlier research (Adesoji, 2008; Fletcher, Mike; Santoli, 2003). For students to learn how to solve Algebra word problems, they must be able to read and comprehend language. Students are less able to investigate the process of solving a problem when they lack the terminology to interpret a mathematical problem.

Conclusion

Teachers' conceptions either direct or impact the way they teach in the classroom. Teachers approached Algebra word problem solving differently because of how they conceptualize the task. The ability to accept a challenging mathematical problem and putting much effort into solving it; solving difficult mathematics story problems that involve real-world scenarios and coming up with solutions for any mathematics problem that contains enough background information but no clear path way of tackling the problem are the ideal stages outlined in this study. The major finding is the inability of students at Junior High Schools at Tema Education Metropolis to pose their own problems as evidence of conceptual understanding Algebra word problems.

Recommendations

The study identified in a broader perspective the challenges of teaching mathematics WPS including teachers' 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 teach mathematics word problem-solving.
- The pupils at Junior High Schools should be given opportunities to practice more investigative problems in mathematics using appropriate models to solve them.
- Colleges of Education now train mathematics majors to teach in Junior High schools instead of generalist teachers who sometimes may lack content and pedagogical content knowledge for teaching mathematics.
- Ghana Education Service through heads of Junior High schools in Tema Metropolis should enforce this policy of using trained mathematics professionals and avoid the use of non-specialist professionals to teach mathematics at Junior High Schools.

Suggestions for Further Research

Future studies, according to the researchers, should look at how JHS mathematics teachers' attitudes and beliefs on Algebra word problem solving and their instructional strategies relate to one another.

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