Using Problem-Solving Strategies to Improve Students' Performance in Mathematics in Senior High Schools in the North Tongu District, Ghana

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This study aimed to investigate how problem-solving strategies can be used to improve students' performance in mathematics in Senior High Schools in the North Tongu District. The study used the descriptive survey design underpinned by positivist philosophical thought. The data were collected using a four-point Likert-type scale questionnaire. The sample size for the study was 170 respondents purposefully selected. A questionnaire was administered to teachers and students. The data were analysed using regression, one-way analysis of variance (ANOVA), frequency, percentages, mean and standard deviation. It emerged from the study that teaching students in smaller groups effectively shows teachers conscious thinking about problem-solving strategies. The study pointed out that cooperative work among teachers in a set of algorithms and rules that cover all possibilities is a good sign of teacher knowledge in problem-solving strategies. The findings further revealed that teachers' high level of teaching experience in mathematics significantly impacts their application of problem-solving strategies in their classrooms and helps improve students' mathematics performance. It was recommended that the curriculum division of the GES should improve and transform the country's secondary mathematics curricula and instructional tools to include a problem-solving approach/strategy in teaching mathematics. It was also established that periodic visits to schools to supervise whether the implementation is ongoing and to support teachers with challenging issues is highly recommended.

Keywords: Problem-solving Strategies, Senior High School, North Tongu District, Teachers, Students, Mathematics

Introduction and Background: Mathematics is crucial for success in school, being an informed citizen, being productive in one's chosen career, and personal fulfilment. In today's technology-driven society, greater demands have been placed on individuals to interpret and use mathematics to make sense of information and complex situations. Raising students' achievement in mathematics has become a matter of concern in recent years. Improving the quality of learning and teaching mathematics may likely increase students' achievement in mathematics. A study by Rivkin et al. (2005) revealed that learners who receive high-quality instruction in mathematics experience greater and more persistent achievement gains than their peers who receive lower-quality instruction in mathematics. Current technology and scientific advancement being experienced worldwide require that Ghanaian students be taught to go beyond low-level comprehension and mere memorisation of facts and formulae if they are to become problem solvers of the future. Trainee teachers, therefore, should be adequately equipped during initial teacher training to develop their students' higher-level thinking skills, especially in mathematics.

In mathematics, success exists not only by what we know but also by how we apply our understanding of the idea and inside information (Schoenfeld, 2014).

The most significant part of teaching mathematics subjects, especially in Senior High Schools, is instructional methods. Unfortunately, mathematics education in Ghanaian schools is in poor shape regarding concepts and teaching techniques, and students' enthusiasm for the subject is waning (Adediwu & Tayo, 2007).

Ghanaian schools are in poor shape regarding concepts and teaching techniques, and students' enthusiasm for the subject wanes (Adediwu & Tayo, 2007). According to various studies conducted in Ghana, students perform poorly in mathematics problem-solving due to pressure in mathematics classes (Agbi, 2006). Several gauges for judgment used have been acknowledged as the goals of arithmetic command. Still, the most common aspect of writing exists in mathematics teachers who teach using useless and uninspiring education methods (Ezeoba, 2010). Teachers prevent students from asking for discovery, resolving, idea plans, and other approaches that are famous for being advantageous to students in mathematics problem-solving, according to Ezeoba (2010). Instead, they depend on educational methods that are natural to execute in the classroom but are incompetent and inappropriate, following what was indicated by Ezeoba (2010).

Educators focused their consideration on logical plans as a component of arithmetic teaching and education. The problem-solving technique has long existed and is widely recognised as a skill that helps humans learn mathematical subject matter better. It has the potential and is expected to be an excellent instrument for advanced education (Danjuma & Arshatu, 2010). According to Oneshakepokaiye (2011), favourable teaching requires fruitful, purposeful, result-familiarised, qualitative, significant, and sensible teaching, as Kolawole and Oluwatayo (2005) delimited.

The essence of being a good educator is knowing how to encourage students to learn or accomplish their learning goals actively. As a result of manipulating numbers, Mathematics teachers should use a teaching plan or action that allows students to actively learn to grasp whatever idea, law, or animate objects are taught. Mathematics may be instructed in various habits, including lead discovery, question answer, discussion, and descriptive distinguish techniques.

Problem-solving is a method that determines educational abilities to understand and be part of the construction of critical and imaginative thinking. These characteristics are ultimately crucial visible features of thinking and learning. This study wanted to check thoroughly the effects of a logical plan of action used in difficult-to-instil knowledge matter; given that arithmetic is a means of sharpening the mind's reasoning ability and cultivating personality, it is necessary for offering general and elementary development of knowledge in many nations. Life without arithmetic is impossible, in accordance with Owan (2012) Cockcroft (as explained in a speech by Githua & Mwangi, 2003), and it would be troublesome to live a regular growth in many parts of the world outside it. Mathematics is influential not only for favourable academic outcomes but also for animate objects, such as a conversant citizen, existence productive in an individual's chosen declaration, and judgment of personal accomplishment.

Ghana's weak performance in fashionable arithmetic, as revealed varied Ghana was placed lowest in Africa and the sphere in the Trends in International Mathematics and Science Study (TIMSS) results from our eighth-grade individual actively learning (JHS2) in 2019. Ghanaian primary school students' attainment in mathematics nationally and globally has been weak (Asante & Mereku, 2012).

Statement of the Problem

Poor student performance in mathematics in Ghana has been a concern over the years. Different teaching approaches in mathematics to assist students are abundant in the education curriculum. Still, every teacher has their own views of how mathematics should be taught in schools to assist learners in mathematics problem-solving (Tachie et al., 2021). It is urgently relevant that SHS students learn mathematics in a way that improves their problem-solving strategies. However, students cannot maximise their performance in mathematics due to teachers limited knowledge of mathematics teaching, inexperience and or poor method of teaching mathematics in schools (Chikiwa et al., 2019; Tachie et al., 2021). In the North Tongu District, there has been a recurring decrease in performance in mathematics among SHS students from 2010 to 2019 due to some of the issues outlined above. The constant decline in grades by SHS students could be due to the teaching approaches used by teachers in the North Tongu District. Many mathematics teachers prefer using traditional approaches to teaching mathematics and ignore any other approach that enhances students' enjoyment and understanding of mathematics; hence, there is a need to encourage problem-solving strategies to improve student's performance in mathematics.

Research Questions

To address the objectives of the study, the following research questions have been formulated to guide the study:

1. What knowledge do mathematics teachers have of teaching mathematics with problem-solving strategies in the North Tongu District?
2. What knowledge do SHS students have on teaching and learning mathematics with problem-solving strategies in the North Tongu District?
3. What problem-solving strategies are used by mathematics teachers to teach SHS students in the North Tongu District?

Theoretical Framework

Grant and Osanloo (2015) state that a theoretical review is a systematic observation or explanation of the phenomenon of the study. However, DeVos et al. (2011) indicate that the theory reviewed in studies determines how research questions should be answered and how empirical procedures should be used. The selected theories used for this study are "Radical constructivism" and "Social constructivism theory".

Radical Constructivist Theory

Radical constructivism is a theory of knowledge (epistemology) that argues that humans generate knowledge and meaning from the interaction between their experiences and ideas. The basic idea in this theory is that learning is an active and constructive process, with the learner viewed as an information constructor. In the constructivist classroom, the teacher guides the learner, providing bridging or scaffolding and helping to extend the learner's zone of proximal development. The student is encouraged to develop meta-cognitive skills such as reflective thinking and problem-solving techniques. Social constructivism focuses on an individual's learning that occurs as a result of discussions and interactions in and among groups. Many studies argue that discussion plays a vital role in increasing students' ability to test their ideas, synthesise the ideas of others, and build a deeper understanding of what they are learning (Reznitskaya et al., 2007; Weber et al., 2008). Hence the use of this theory.

Conceptual Framework

The study was modelled by a conceptual framework representing dependent and independent variables and their relationships, as shown by the arrows in Figure 1.

Independent Variable ⟷ Intervention Variable ⟹ Dependent Variable

Figure 2.1: Conceptual Framework (Source: Researcher Contract, 2021)

The central thesis of the study was that first, a teaching approach (problem-solving approach or a conventional approach) would affect SHS students' levels of cognitive domains, resulting in either high or low performance in the lower cognitive level domains (knowledge and comprehension), and higher level cognitive domains (application, analyses, synthesis and evaluation). Second, a teaching approach (a problem-solving approach or a conventional approach) will affect teachers' and students' views about the nature of teaching and learning mathematics, resulting in a change in their opinions about teaching and learning.

The expected outcome of these changes in achievement levels in cognitive domain knowledge and views about teaching and learning mathematics will change students' mathematical achievement. The extraneous variables, the variables that are likely to negatively or positively affect the outcome (performance) of the independent variable (a problem-solving approach) but are unknown to the study and therefore cannot be controlled by the study, are teachers' and students attitudes towards teaching and learning of mathematics, respectively.

Empirical Review

Teachers' Knowledge of Mathematics Teaching

Teachers' content knowledge of mathematics is a complex conceptual structure characterised by several factors, including its extent and depth, structure and unifying concepts, knowledge of procedures and strategies, and knowledge about mathematics as a whole and its history (Ernest, 1989). Ernest (1989) correctly argues that this knowledge provides an essential foundation for teaching mathematics and that the primary goal of teaching mathematics is to facilitate the reconstruction of some portion of the teachers' knowledge by the learner. For Ernest (1989), whatever means of instruction are adopted, the teacher needs a substantial knowledge base of the subject to be taught to plan for instruction and understand and guide learners' responses.

Furthermore, he argues that the teacher's knowledge of mathematics will underpin the teachers' explanations, demonstrations, diagnosis of misconceptions, acceptance of children's own methods, curriculum decisions (such as emphasising central concepts), and so on. In effect, Ernest seems to suggest that the knowledge of mathematics provides a foundation for the teacher's pedagogy since substantial knowledge of the subject matter of mathematics is requisite to teachers' confidence and competence in teaching mathematics. The goal of education is for learners to be independent adults ready for any occupation. According to Joynes et al. (2019:31), solving problems, presenting, making choices or connections, and thinking critically, analysing, or evaluating every situation is crucial in a working environment., therefore teaching and learning approaches used by teachers should embrace problem-solving skills or strategies that equip learners for challenges they face in a mathematics classroom in the country (Ferguson, 2010). Some skills needed in the 21st century are discussion, collaboration, and cognitive skills like evaluating, analysing, and problem-solving, which are essential in mathematics problem-solving (Joynes et al., 2019). Teachers teaching mathematics can help develop these skills in students by incorporating the right teaching approach, keeping in mind that we are in a new, developing technology era.

Many prospective elementary school teachers often assume that their own schooling mathematics knowledge will supply the subject matter needed to teach young children (Feiman-Nemser & Buchmann, 1986). Unfortunately, mathematics teacher educators take prospective teachers' subject knowledge for granted, focusing on pedagogical knowledge skills (Ball & Feiman-Nemser, 1988). Yet researchers have highlighted the critical influence of teachers' knowledge of the ideas about mathematics on pedagogical orientation and decisions (Thompson, 1984). Since limited subject matter knowledge will influence teachers' pedagogical orientation, equal attention has to be given to prospective mathematics teachers' subject matter knowledge by mathematics educators so that they will graduate as effective mathematics teachers.

Also, Ball (1990) argues that mathematics methods courses, in particular, can influence pre-service teachers' knowledge, assumptions, and beliefs about mathematics. This issue on mathematics teaching and learning reforms requires effective teaching methods such as a problem-solving approach.

Problem-solving Strategies for Teaching and Learning of Mathematics

A problem-solving approach used in mathematics textbooks is based on the work of Polya (1945). Polya's problem-solving model involves four stages: understand the problem, devise a plan for solving the problem, carry out your plan, and look back. In this teaching approach, learners must learn to apply and adapt appropriate strategies to solve problems. These strategies include using diagrams, looking for patterns, listing all possibilities, trying special values or cases, working backwards, guessing and checking, creating an equivalent problem, and creating a more straightforward problem.

Problem-solving is crucial in mathematics education because it transcends mathematics. By developing problem-solving skills, we learn how to tackle mathematics problems and logically work our way through problems we may face. The memoriser can only solve problems they have encountered already, but the problem solver can solve problems they have never encountered before. According to Rav (1999), the essence of mathematics resides in "inventing methods, tools, strategies, and concepts for problem-solving".

Group Work

Sajedi (2014) mentioned that when learners are involved with responsibility, their credence level rises, and they become more responsible for their learning. This method promotes togetherness since learners interact meaningfully in the target language and get helpful peer responses. Group work is a classroom activity where students work in teams to construct knowledge and accomplish tasks through collaborative interaction" (Reid, 2010).

Simulation

This learning strategy enhances student's ability to utilise learned knowledge to find solutions to problems (Zhu et al., 2011). This also endows students with opportunities to try out procedures and make mistakes without causing actual patient harm (Jude et al.; McLaughlin et al.).

Demonstration Method

Kimweri (2004) highlights the demonstration method as a showcase of a process and services to display the rudimentary principles or actions involved. Demonstration, an effective tool, is convenient and essential in teaching skills. However, for a demonstration to be successful, it should immediately be followed by hands-on activities to strengthen procedures (Klmweri, 2010). According to Ameh et al. (2017), demonstration helps the teacher do whatever the learners are expected to do at the end of the lesson by explaining the step-by-step process.

Discussion Method

Ndirangu (2007) asserted that this method helps teaching and learning by allowing students to share concepts. This method can start a topic to ascertain learners' prejudiced ideas of the subject matter by introducing to students a situation and demanding an explanation of what learners have learnt.

Brainstorming Method

MIE (2004) defines brainstorming as a technique used to elicit responses from learners in which the learner's feedback regarding the given topic is acceptable.

Drill and Practice

Pooja (2017) explained drill and practice as a repetition of memorialising information. Lim et al. (2012) explained that this instructional method featured systematic repetition of concepts, examples and practice problems. This method helps learners acquire knowledge and skill through training through multiple repetitions, rehearse, practice and engage in a rehearsal to learn or become proficient.

METHODOLOGY

Research Paradigm

The philosophical foundation of the study was based on the assumption of the pragmatist paradigm of how knowledge is gained and the methodology choices that guided the study. A paradigm is "a basic set of beliefs that guide action, also referred to as worldview, epistemologies and ontologies" (Creswell, 2014).

Pragmatism favours mixed methods and ensures that the contextual realities of the people being studied are considered (Davies, 2018) in ways that allow contexts to be compared and contrasted (Cartwright & Montuschi, 2014).

It combines positivist and interpretivism paradigms to seek generalisation and help construct the meaning the research participants give on the field during data collection. The choice of the pragmatist paradigm was influenced by the issue being studied and the research setting where the study was conducted.

Research Approach

The research approach can be divided into three forms (Creswell, 2014; Johnson & Johnson, 2014; Ngulube & Ngulube, 2015). These are quantitative, qualitative and mixed-method research approaches.

In this study, the quantitative phase represents the positivist philosophical worldview underpinning the entire research process since the study aims to use problem-solving strategies to improve student's performance in mathematics in SHS, which would be measured through numerical data and analyses. Data analysis would be done numerically to reflect the reality found on the ground. However, the quantitative data provides the initial outlook of the research problem. The purpose of the quantitative phase was to give a numeric description that may be used to generalise the findings to the particular population.

Moreover, quantitative data is essential because it would help generalise the current state of problem-solving strategies to improve students' performance in mathematics in SHSs. Using only quantitative results would not be appropriate for the study because of the nature of the study and what the researcher wants to achieve.

Research Design

In this study, a cross-sectional survey is defined as a quantitative method for collecting data where researchers collect data from a representative cross-section of the population of interest to understand the situation (Creswell & Creswell, 2018).

Population

Table 3 shows the targeted population for the study.

Table 1: Population for the Study

No of SHSs	Estimated Population	
	Mathematics Teacher	Students
St. Kizito SHS	98	664
Dofor SHS	91	611
Aveyime SHS	88	595
Volo Community SHS	82	582
Battor SHS	79	561

(Source: District SHSs Mapping Report, 2020)

The population of the study was comprised of SHSs teachers and students in the North Tongu District. The estimated number of teachers in the North Tongu District was 438, and the number of students was 3,013. Table 4 shows the population accessible from the study area. Table 4 shows the population that is accessible for the study.

Table 2: Distribution of Accessible Population for the Study

Variables	Estimated Accessible Population	
	Mathematics Teachers	Form Two (2) Students
St. Kizito SHS	7	204
Aveyime SHS	6	160
Volo Community SHS	5	128

Dofor SHS	5	112
Battor SHS	5	106

(Source: Annual School Census 2020 for Senior High Schools, GES, 2020)

The accessible population for the study covered all mathematics teachers and two (2) students in the North Tongu District of Ghana. The researcher chose the form of two students because they have existed for two years. The mathematics teachers were selected because their services in the teaching and learning process were paramount in schools. The accessible population was heterogeneous cause it involved teachers who teach in different schools with different academic qualifications and experience. The following section explains the sample and sampling procedures used for the study.

Sample and Sampling Techniques

The sample size is the proportion of the population of interest selected for a research study (Patten & Newhart, 2017). However, for rigour, it was essential to ensure that the characteristics of the population that determined the sample selection were adequately reflected in the entire population. Table 5 shows the quantitative sample used for the study.

Table 3: Distribution of Quantitative Sample

Variables	Estimated Accessible Population	
	Mathematics Teachers	Form Two (2) Students
St. Kizito SHS	7	41
Aveyime SHS	6	32
Volo Community SHS	5	26
Dofor SHS	5	22
Battor SHS	5	21
Total	28	142

(Source: Field data, 2021)

The sample consists of five (5) SHSs, twenty-eight (28) teachers and 142 students selected from the North Tongu District. However, the total sample size for the study was one hundred and seventy (170) respondents.
The sampling technique denotes the processes utilised in selecting research participants from a larger population group so that conclusions can be drawn to represent how the larger group of people act or what they believe (Plonsky, 2017). Sampling represents the collection of smaller individuals from the population (Maree, 2012). The sampling procedure ensured that research questions and hypotheses were adequately answered (Collins, 2015).

Table 4 Distribution of Sampling Procedures

Variables	Procedure
Schools	Census
Teachers	Purposive
Students	Gay and Diehl's (1992) procedure for determining the sample was adopted, and simple random sampling.

(Source: Field data, 2020)

Table 6 represents the sampling procedure used for the study. The procedures used for the quantitative phase were census, proportionate and simple random sampling. In the first phase, a census sampling procedure was used to select all five (5) SHSs in North Tongu District. This was done because the researcher was interested in using all the SHSs in the North Tongu District. Again, with the census sampling, the views representing respondents from various SHSs would be adhered to.
In the second phase, the researcher used a purposive sampling technique to select mathematics teachers, whereas proportionate and simple random sampling techniques were used in the third phase. In this phase, the researcher obtains a sample of students by adopting the Gay and Diehl (1992) procedure for determining sample size. They stated that when the accessible population was less than 200 units, then selecting 20% may be appropriate for generalisation. This procedure allows the researcher to draw externally valid conclusions about the entire population and provides a fair representation of respondents. From this approach, (20%) of the respondents were selected from the five (5) SHSs in the North Tongu District.

In the second quantitative phase, the researcher used a simple random technique to select the proportionate 20% of the respondents from the SHSs in the North Tongu District. By performing the simple random sampling, YES or NO was written on a piece of paper and put into a box. The respondents were asked to pick one paper from the box and replace it to guarantee fairness in the selection process. This process was done until the researcher could sample 20% from two (2) students from each school. The researcher employed the simple random sampling technique to remove the biased selection of individuals/elements so that if a large number of samples were drawn, the average sample would accurately represent the population (Creswell, 2014).

Instrumentation

The researcher chose a structured questionnaire for this study. However, the type of structured questionnaire was a Likert scale where a register statement was given to respondents to agree or disagree (Kusi, 2012). The Likert-type scale was grouped into four (4), which were scored as follows: "Strongly Agree" =4 "Agree" =3, "Disagree" =2, and "Strongly Disagree".

Data Collection Procedure

After the researcher had observed all ethical considerations, the quantitative data collection procedure proceeded with the help of field assistants. The researcher visited the study area, where permission was sought from the authorities in the study area. An introductory letter collected from the District Directors of Education was sent and shown to the heads of the selected SHSs in the study area before they allowed the researcher to proceed with data collection. When the researcher visited the SHSs, informed consent, privacy, anonymity and confidentiality were discussed with the selected respondents before data collection.

At the next stage, the researcher administered the questionnaire to conveniently selected teachers and students with the help of the field assistants to speed up the data collection procedure. After carefully administering the questionnaire, the researcher gave the respondents time to fill it out and return it to them the following day. All the questionnaires were administered to 170 respondents and collected back after they finished answering them.

Reliability and Validity

To ensure that the instruments are reliable, they were pre-tested to determine their reliability with the Cronbach Alpha measure of internal consistency. The Statistical Product for Service Solution (Version 25.0) was used for the computations. A reliability value of .791 was obtained.

However, content validity is established by assessing the extent to which a research instrument accurately measures all aspects of a construct. Criterion validity refers to the extent to which a research instrument is related to other instruments that measure the same variables (Heale & Twycross, 2015; Kusi, 2012). To enhance the study's validity, the instrument was given to my supervisor for expert assessment and scrutiny. The instrument was also submitted to the ethical review committee; their advice was taken, and all the recommended corrections were effected.

Data Analysis and Processing

The data was analysed using descriptive and inferential statistics. The Statistical Package for Social Sciences (SPSS) version 25.0 software assisted the researcher in the analysis. The background section from the questionnaire was analysed using frequency percentages and was presented in tables. Mean and standard deviation were used in analysing research questions 1, 2, 3 and 4.

Hypothesis one was analysed using regression. For hypothesis two, the researcher was interested in comparing the mean scores for more than two different groups, so one-way analysis of variance (ANOVA) was the appropriate method for analysing such data. The researcher used ANOVA to analyse the hypotheses because the data was collected from more than three (3) independent groups to predict one dependent variable. Again, ANOVA was a suitable analytical tool because it helped compare results between the three (3) groups.

RESULTS

Knowledge mathematics teachers have on teaching mathematics

This section examines how teachers' knowledge has an impact on teaching mathematics. Table 1 displays the respondents' (teachers) findings on their knowledge of mathematics.

Table 5: Knowledge mathematics teachers' have on teaching mathematics

Statement	M	SD	MR
It is best to teach learners mathematics in small groups.	3.87	0.64	1st

A mathematics teacher should consciously facilitate problem-solving in the mathematics class.	3.79	0.63	2nd
Cooperative group work and presentation in mathematics are suitable for efficient learning.	3.65	0.52	3rd
Teaching mathematics by allowing learners to discover rules for themselves will lead to the incompletion of the syllabus.	3.42	0.42	4th
Learners should be encouraged to discuss their solutions with their peers during mathematics lessons.	3.21	0.54	5th
Conventional approach (teacher-centered) is the best way to teach learners to solve mathematics problems.	2.65	0.32	6th
Whole class teaching by a teacher is more effective than a teacher facilitating learning.	2.54	0.13	7th
Teaching mathematics means confronting learners with problems to solve on their own.	2.42	1.11	8th
The mathematics teacher should encourage learners to deduce general principles from practical experiences.	2.13	0.14	9th
In teaching mathematics learners should be encouraged learners to ask more questions.	2.08	0.23	10th
Teaching mathematics means consciously creating an environment to stimulate learners to construct their own conceptual knowledge.	1.93	0.65	11th
Teaching must focus on understanding as much as possible so that the learners can explain methods and connections.	1.78	0.16	12th
Mean of Means	**2.79**	**0.46**	

(Source: Field data, 2020)

The overall mean scores for Table 12 were (M=2.79 and SD=0.46), proving that teachers know about teaching mathematics in SHS. The responses on the item "It is best to teach learners mathematics in small groups" recorded a mean of 3.87 (SD=0.64), which was within the highest score range. The result affirms the teacher's educational level and experience in teaching mathematics on the issue of whether "A mathematics teacher should consciously facilitate problem-solving in the mathematics class". A mean of 3.79 (SD=0.63) was recorded, showing that teachers know about teaching mathematics in the North Tongu District.

The analysis in Table 12 shows that cooperative group work and presentation in mathematics are suitable for efficient learning, with a mean score of 3.65 and a standard deviation value of 0.52. However, teachers' fourth most frequent mathematical knowledge was that "teaching mathematics by allowing learners to discover rules for themselves will lead to incompletion of syllabus". This theme was recorded (M=3.42, SD=0.42).

Five scales recorded a medium response rate. These include "Conventional approach (teacher-centred) is the best way to teach learners to solve mathematics problems", "Whole class teaching by a teacher is more effective than teacher facilitating learning", "Teaching mathematics means confronting learners with problems to solve on their own", "The mathematics teacher should encourage learners to deduce general principles from practical experiences" and "In teaching mathematics learners should be encouraged learners to ask more questions". These scales recorded mean and standard deviation values between (M=2.65-2.08 and SD= 1.11-0.13).

However, "Teaching mathematics means consciously creating an environment to stimulate learners to construct their own conceptual knowledge" recorded the most negligible value for the mean and standard deviation with the score (M=1.93, SD=0.65) and "Teaching must focus on understanding as much as possible so that the learners can explain methods and connections" also recorded (M=1.78, SD=0.16). Finally, the results from Table 12 show that a test value of more than 2.50 means that teachers found in North Tongu District have medium knowledge in teaching mathematics.

Students' Knowledge in Studying Mathematics

This section examines the knowledge students have on studying mathematics. Table 13 displays the respondents' (students) findings on their mathematics knowledge.

Table 7: Students Knowledge in studying Mathematics

Statement	M	SD	MR

Cooperative work in groups is suitable for efficient learning of mathematics.	3.65	0.55	1st
Mathematics should be learned as a set of algorithms and rules that cover all possibilities.	3.62	0.34	2nd
Learners should learn mathematics by working with other learners using worksheets.	3.41	0.31	3rd
Learners should learn mathematics in groups.	3.39	0.45	4th
Learners should ask questions during mathematics lessons.	3.22	0.29	5th
Learners should often be confronted with novel problems to solve.	3.11	0.26	6th
Learning rules and methods by rote are essential in mathematics.	3.06	0.21	7th
Learning mathematics means finding correct answers to a Problem.	2.76	0.19	8th
The best way to learn mathematics is to see an example of the correct method for a solution, either on the blackboard or in the textbook, and then to try to do the same yourself.	2.72	0.16	9th
Those who get the correct answer in mathematics have understood what they have learnt in mathematics.	2.69	0.27	10th
Learners should discover for themselves the desired conceptual knowledge in the learning process during the learning of mathematics.	2.54	0.21	11th
A conventional approach (teacher-centred) is the best way to teach learners to solve mathematics problems.	2.48	0.24	12th
A problem-solving method (student-centred) is effective to actively involve learners in the mathematics learning process.	2.41	1.05	13th
The most important aspect of learning mathematics is to know the rules and to be able to follow them.	1.98	1.35	14th
Mean of Means	**2.93**	**0.42**	

(Source: Field data, 2021)

The results from Table 2 show that students have moderate knowledge and understanding of mathematics in SHSs. The overall mean and means score were (M=2.93, SD=0.42). This indicates that students in SHSs in the North Tongu District understand the rudimentary knowledge in mathematics. Respondents' comments stated, "Cooperative work in groups is good for efficient learning of mathematics" (M=3.65, SD=0.55), which shows the highest response rate among the scales on knowledge students have in mathematics.

Further, Table 13 reported that "Mathematics should be learned as a set of algorithms and rules that cover all possibilities" was recorded as (M=3.62, SD=0.34), the second most frequent scale on students' knowledge in mathematics. Concerning high response, respondents suggested that "Learners should learn mathematics by working with other learners using worksheets", "Learners should learn mathematics in groups", "Learners should ask questions during mathematics lessons," "Learners should often be confronted with novel problems to solve" and "Learning rules and methods by rote are important in mathematics" recorded a mean above 3.00.

There were six (6) moderate response rates recorded in Table 13. For instance, respondent's comments on "Learning mathematics means finding correct answers to a Problem" recorded (M=2.76, SD=0.19). At the same time, respondents suggested that the best way to learn mathematics is to see an example of the correct method for a solution, either on the blackboard or in the textbook, and then to try to do the same yourself, which is recorded (M=2.72, SD=0.16). One issue, namely, getting the correct answer in mathematics, is that they have understood what they learned (M=2.69, SD=0.27).

Table 3 further shows that respondents were Learners who should discover for themselves the desired conceptual knowledge in the learning process while learning mathematics, with a mean score of (M=2.54) and (SD=0.21). Another scale showed that the "conventional approach (teacher-centred) is the best way to teach learners to solve mathematics problems" A problem-solving method (student-centred) is effective in involving learners in the

mathematics learning process actively" recorded mean and standard deviation value (M=2.48, SD=0.24) and (M=2.41, SD=1.05) respectively.
Finally, Table 3 recorded a low response that "The most important aspect of learning mathematics is to know the rules and to be able to follow them" and therefore only recorded a mean value of (M=1.98) and a standard deviation of (SD=1.35). The analysis of scales from Table 13 shows that students had moderate knowledge of mathematics in the North Tongu District.

Problem-Solving Strategies Used in the Classroom
This section assesses problem-solving strategies SHS teachers in North Tongue District use in classrooms.

Table 8: Problem-Solving Strategies Used in Classroom

Statement	M	SD	MR
Group Work	3.98	0.46	1st
Discussion	3.87	0.39	2nd
Demonstration	3.71	0.34	3rd
Drill and Practice	3.47	0.21	4th
Brainstorming	2.98	0.19	5th
Stimulation	2.91	0.21	6th
Mean of Means	**3.49**	**0.30**	

(Source: Field data, 2020)

From Table 3, respondents asserted that "group work was the appropriate problem-solving strategy" recorded (M=3.98, SD=0.46). The second statement that respondents identified as the most frequent problem-solving strategy was on "Discussion" recorded (M=3.87, SD=0.39), while the third most frequent problem-solving strategy was on "Demonstration" recorded (M=3.71, SD=0.34). However, Table 14 further showed that "Drill and Practice" also recorded a mean score of 3.47 and a standard deviation value of 0.21.
Again, it was reported that "Brainstorming" was also a problem-solving strategy, recording a mean score of 2.98 (SD=0.19). However, teachers' use of "Stimulation" as a problem-solving strategy yielded a mean score of 2.91 and a standard deviation value of 0.21.

DISCUSSION OF FINDINGS
Teachers' Knowledge of Mathematics and Problem-solving Strategies
The first research question highlights information about teachers' knowledge of problem-solving strategies used by mathematics teachers in SHS. By way of discussing this theme, the literature on the knowledge within the context of SHS teachers' use of problem-solving strategies was critically used to support the findings.
The general response rate of the themes shows that SHS teachers know about using problem-solving strategies. The response to "It is best to teach learners mathematics in small groups" recorded a mean of 3.87 (SD=0.64), within the highest score range. The result affirms the teacher's educational level and experience in teaching mathematics. Again, the study reported that "mathematics teachers should consciously facilitate problem-solving in the mathematics class". A mean of 3.79 (SD=0.63) was recorded, showing that teachers know about teaching mathematics.
The analysis found in this section shows that cooperative group work and presentation in mathematics are suitable for efficient learning, with a mean score of 3.65 and a standard deviation value of 0.52. whereas "teaching mathematics by allowing learners to discover rules for themselves will lead to incompletion of syllabus" was also recorded (M=3.42, SD=0.42). On the contrary, according to Stein (2007), mathematics learning is not about copying notes; mathematics ought to be taught to encourage students to use mathematical discourse to make conjectures, talk, question, and agree or disagree about problems to discover critical mathematical concepts.
It was revealed that teachers' knowledge of conventional problem-solving strategies was regarded as more effective than teacher-facilitating learning. However, other respondents suggested that teachers confront learners with problems to solve their mathematical challenges. In contrast, some respondents revealed that encouraging learners to deduce general principles from practical experiences shows that teachers know problem-solving strategies. The findings also show that encouraging learners to solve more mathematics questions shows teachers in-depth knowledge of problem-solving methods. Problem-solving, as used in mathematics education literature, refers to the process wherein students encounter a problem – a question for which they have no apparent resolution nor an algorithm they can directly apply to get an answer (Schoenfeld, 1992).

Again, the findings show that teachers creating an enabling environment to help learners think consciously to construct their own conceptual knowledge shows teachers' knowledge of problem-solving strategies. Teachers' understanding of concepts shows how learners can connect or explain subject matter in mathematics.

Students' Knowledge of Mathematics and Problem-solving Strategies

The results show that students moderately understand mathematics in SHSs North Tongu District. The finding revealed that students understand the rudimentary knowledge in mathematics. This is so because they believe cooperative work in groups is suitable for learning mathematics efficiently. Respondents suggested that their mathematics should be taught using algorithms and rules that cover all possibilities.

Researchers worldwide are looking for ways to use problem-solving as a teaching tool. The Principles and Standards for School Mathematics (NCTM, 2000) describes problem-solving-based teaching as using interesting and well-selected problems to launch mathematical lessons and engage students. In this way, new ideas, techniques and mathematical relationships emerge and become the focus of discussion. Good problems, as indicated by NCTM (2000), can inspire the exploration of important mathematical ideas, nurture persistence, and reinforce the need to understand and use various strategies, mathematical properties, and relationships.

The findings show working on mathematics using worksheets and in groups provides learners with the knowledge to understand mathematics. Other respondents posit that asking questions in the classroom during mathematics lessons and solving novel challenges help students have in-depth knowledge of problem-solving strategies. Some findings show a moderate response rate. For instance, respondents commented, "The best way to learn mathematics is to see an example of the correct method for a solution, either on the blackboard or in the textbook, and then try to do the same yourself. Some respondents suggested that an effective way to understand problem-solving mathematical knowledge. Respondents indicated that the conventional approach is the best way to teach learners to solve mathematics problems.

Problem-solving Strategies Used in Teaching Mathematics

The analysis of this research question was on problem-solving strategies used in teaching mathematics. The analysis reflects Table 14 in chapter four, where the researcher compares the statement made by respondents and supports it with the literature of the study. The analysis shows that "group work was the appropriate problem-solving strategy" recorded the highest mean and standard deviation value in Table 14. Respondents also suggested that discussing mathematics in the classroom was an essential problem-solving strategy to help students understand mathematics in SHSs. This theme also recorded a mean and standard deviation value of (M=3.87, SD=0.39).

In the same vein, a study by Alkan (2016), Matey and Fickell (2014) and Morris (2019) confirm that past students were also found to have used experiential learning strategies here; students are involved. Active participants are exposed to novel experiences involving risk, knowledge is situated in place and time, and learning demands inquiry into specific real-world problems and critical reflection. The independent style of learning was also found in this study. The use of this learning style could be due to the fact that when learning in groups there could be some distractions from other colleagues or students which affects the success of the group work learning style. Thus, learning independently helps students stay focused, confirming the self-regulated learning style where students personally engage in studies and regulate the learning process themselves without external influence (Bhagat et al., 2015).

However, the results also show that demonstration, drill, and practice were effective strategies used by SHS teachers to assist students with mathematical challenges. The theme recorded mean and standard values of (M=3.71, SD=0.34; M=3.47, SD=0.21) respectively. In support, the problem-solving approaches of demonstration, drill, and practice were established to influence students' performance in the WASSCE examination positively. These practical techniques make it easy for students to engage in practical and repetitious learning of concepts. This makes it easy for students to reminisce about all the information or knowledge taught, improving their performance. This is in tandem with that of Zhao et al. (2014), who revealed that a problem-solving approach could result in positive student performance.

These themes (Brainstorming and Stimulation) recorded a moderate mean and standard deviation with the values of 2.98 (SD=0.19) and 2.91 (0.21), respectively. This means that SHS teachers believed brainstorming and stimulation were the key concepts when using problem-solving procedures to assist students in learning mathematics. Furthermore, it was found from the results of the study that student-centred approaches, which included discussion and simulation, translated into significant and superior performance among past students, which affirmed the results that student-centred methods had a positive influence on the performance of students in Science (Kang & Keinonen, 2018). The results further contradict the findings of Dong et al. (2019), who found that student-centred learning insignificantly impacted students' performance in reading subjects.

Conclusions

1. The study revealed that teaching students in smaller groups effectively shows teachers conscious thinking about problem-solving strategies.
2. They concluded that cooperative work in a set of algorithms and rules that cover all possibilities is an excellent sign of teacher knowledge in problem-solving strategies.
3. The study concluded that teachers' years of teaching mathematics impact their application of problem-solving strategies in the classroom.
4. The study concluded that brainstorming, group work and discussion were more effective problem-solving strategies than demonstration, drill and practices.

Recommendations

The study's recommendation for each sub-section was based on improving practice and policy.

1. The curriculum division of the GES should improve and transform the country's secondary mathematics curricula and instructional tools to include a problem-solving approach in teaching mathematics, as enshrined in the policy statement.
2. The curriculum division of Ghana's TED needs to overhaul Ghana's mathematics course outlines to train mathematics teacher trainees in universities and teacher education colleges to incorporate problem-solving tasks in content and pedagogy.
3. It is clear from this study that a focus is needed on teachers' practice and awareness of issues and factors that impact the implementation of a problem-solving approach in the teaching and learning of mathematics. Periodic visits to schools to supervise whether the implementation is ongoing and support teachers with challenging issues are highly recommended.

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