



MASTERING THE MATH MINDSET: NAVIGATING THE GAP BETWEEN WHAT TEACHERS KNOW AND WHAT THEY TEACH

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Abstract:

In Ghana, Senior High School mathematics curriculum standards strongly advocate for inquiry-based and problem-centered pedagogies. However, empirical evidence regarding how teachers' pedagogical knowledge translates into classroom practice remains scarce, particularly in marginalized administrative regions. This study investigated the self-reported knowledge levels, classroom instructional practices, and the theory-practice alignment amongst public SHS mathematics teachers in the Wa Municipality of the Upper West Region, Ghana. Adopting a quantitative descriptive survey design, data were collected from $N = 76$ mathematics teachers using a self-developed structured questionnaire. Descriptive statistics (means and standard deviations) and inferential statistics (paired-samples t-test) were utilized for data analysis. Findings revealed high overall self-reported knowledge ($M = 3.27$, $SD = 0.72$) and implementation levels ($M = 3.23$, $SD = 0.70$). Teachers reported highest competence in assessing learner reasoning processes ($M = 3.49$) and selecting real-world problems ($M = 3.34$) but demonstrated lower scores in theoretical underpinnings ($M = 3.11$) and providing extension activities ($M = 3.17$). The paired-samples t-test indicated no statistically significant difference between teachers' perceived knowledge and instructional practices, $t(70) = 0.34$, $p = .738$, $d = 0.06$, revealing strong self-efficacy alignment. Continuous professional development should focus on strengthening foundational theoretical frameworks and diagnostic formative assessment strategies.

Keywords: math mindset, pedagogical content knowledge, problem-solving, problem-solving pedagogy, theory-practice gap

1. Introduction

Promoting effective problem-solving skills is undeniably crucial to achieving mathematical proficiency and improving critical thinking skills of learners, which is recognized internationally and nationally by mathematics educators (Gbegini *et al.*, 2026; Xenofontos & Andrews, 2023). The current Senior High School (SHS) mathematics curriculum strongly advocates for inquiry-based and problem-centered pedagogies to enhance learners' conceptual understanding and applicability of mathematics in real-life contexts (NaCCA, cited in Opong, 2025), supported by emerging digital and AI-driven pedagogical strategies (Boateng *et al.*, 2026). However, the discrepancy between the national curriculum's focus on problem-solving and the actual instructional practices demonstrated in classrooms is a concern for mathematics educators in Ghana (Atta & Aseidu-Addo, 2021).

Problem-solving is an act of tackling routine and non-routine duties that necessitate the solver to employ forecasting, deep thinking and analytical techniques to determine solutions (Polya, 1945; Zimmermann, 2016). Repeatedly redefining a task until it becomes manageable, bridging the gap between an initial state and a desired outcome,

is demonstrated by Schoenfeld and Sloane (2016) as problem-solving. The complex nature of effective problem-solving instruction requires educators to be subject-matter experts, understand theoretical frameworks, and use dynamic instructional strategies. Social Constructivists share the view that learning can best be achieved when learners actively design mathematical knowledge through social interaction, collaborative discourse, and inquiry within the classroom environment (Johnson & Johnson, 2014; Vygotsky, 1978).

Effective problem-solving in this framework affords learners the opportunity to scrutinize multiple representations, engage in meaningful mathematical dialogues, and justify their reasoning (Pehkonen *et al.*, 2016; Xenofontos & Andrews, 2023). These problem-oriented activities promote shared cognitive engagement where teachers actively participate alongside learners as facilitators (Heilporn *et al.*, 2021). To consolidate the constructivist principles is Polya's (1945) four-stage heuristic framework, consisting of (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back. Incorporating heuristic strategies, such as decomposing complex problems into manageable components, equips learners with the ability to visualize real-life activities as tools that foster resilience, critical thinking, and a growth mindset (Boaler, 2015).

Mathematics teachers must be grounded in Pedagogical Content Knowledge (PCK), a concept introduced by Shulman (1986), to enable them to translate these theoretical models into effective classroom activities. Shulman (1986) opined that PCK allows teachers to transform abstract mathematical concepts into accessible, inquiry-based learning experiences through the synthesis of subject-matter expertise and pedagogical skill. Teachers' PCK in recent mathematics education directly influences their instructional decision-making, task selection, and classroom atmosphere. However, empirical studies into teachers' PCK present mixed results globally and nationally. For instance, Siswono *et al.* (2019) observed that though mathematics teachers often exhibit strong pedagogical knowledge, their grasp of specific topic-related problem-solving methods remains limited.

In Ghana, Asoma *et al.* (2022) investigated basic school mathematics teachers and observed that they used formal problem-solving methodologies to a limited extent, frequently relying on basic manipulatives rather than structured heuristic strategies despite possessing self-reported expertise. Recent research in Senior High Schools reveals that teachers' ability to diagnose conceptual misconceptions and model rigorous problem-solving steps greatly influenced learner performance in complex domains such as Euclidean geometry and algebraic proof (Davor *et al.*, 2026; Ntori *et al.*, 2026).

Furthermore, recent empirical studies by Gbegini *et al.* (2026) highlighted that teachers perceive problem-solving as a crucial tool that fosters resilience, critical thinking and active learning, whilst incorporating innovative, technology-supported teaching methods significantly mediates learner engagement and problem-solving success (Boadu & Boateng, 2024; Osei-Owusu *et al.*, 2026). Schmid *et al.* (2021) in their structural modeling

studies also added that teachers' digital pedagogical content knowledge directly predicts learners' conceptual understanding and problem-solving ability in secondary school mathematics.

Consequently, examining teachers' self-reported knowledge level regarding problem-solving pedagogy remains vital for targeting professional development interventions. The pragmatic implementation of problem-solving pedagogy in the classroom environment is anchored on key instructional behaviours. Teachers often use scaffolding to initiate instruction using accessible tasks, progressively introducing complex, multi-layered problems to provide temporary support that is systematically withdrawn as learners develop autonomy (Van de Pol *et al.*, 2015). Formative assessment practices and timely instructional feedback are shown to be crucial tools for developing autonomous mathematical problem-solving skills in high school learners (Moyo, 2022). Taley (2022) opined that learner motivation and conceptual understanding are improved by linking mathematical problems to real-world contexts. Hence, SHS teachers frequently draw on real-world word problems and interdisciplinary scenarios from science and economics to illustrate mathematical utility.

Also, recent empirical studies highlighted that learners' lived realities and cultural backgrounds are linked to culturally responsive and ethnomathematical task design to connect classroom problem-solving (Atta & Bonyah, 2023; Nolan & Xenofontos, 2023). Collaborative problem-solving environments enable learners to articulate thought processes and build upon peers' ideas through structured peer inquiry (Boye *et al.*, 2023; Johnson & Johnson, 2014), while incorporating educational software, graphing utilities, and dynamic visual resources facilitates exploratory learning (Bandoh *et al.*, 2024; Roschelle *et al.*, 2016).

Though the Senior High School mathematics curriculum strongly advocates for inquiry-based and problem-centered instruction, empirical evidence systematically connecting SHS teachers' internal knowledge base to their observed classroom practices remains scarce, particularly in marginalized administrative regions such as the Wa Municipality of the Upper West Region. It is therefore crucial to address this empirical gap to determine whether teachers' perceived pedagogical knowledge of problem-solving translates directly into classroom practice.

2. Objectives of the Study

The study sought to:

- 1) evaluate the self-reported knowledge level of Senior High School mathematics teachers regarding problem-solving as a pedagogical tool in the Wa Municipality.
- 2) examine the instructional practices employed by Senior High School mathematics teachers when teaching through problem-solving in the classroom.

- 3) determine whether a statistically significant difference exists between Senior High School mathematics teachers' perceived knowledge level and their actual classroom instructional practices.

2.1 Research Questions

The research aimed to provide some answers to the questions that follow:

- 1) What is the self-reported knowledge level of Senior High School mathematics teachers regarding problem-solving as a pedagogical tool?
- 2) What instructional practices do Senior High School mathematics teachers use when teaching through problem-solving?
- 3) Is there a statistically significant difference between Senior High School mathematics teachers' perceived knowledge level and their actual classroom instructional practices?

3. Method

3.1 Design

A quantitative descriptive survey design anchored on the positivist's paradigm was adopted for this study. Bryman (2016) demonstrated that Positivism assumes a single reality exists independently of human perception. A descriptive survey aims to highlight a snapshot of this objective reality, such as measuring population attitudes and behaviours without manipulating it. To facilitate single-wave data collection across a large target population, researchers Creswell and Creswell (2018) and Saunders *et al.* (2019) highlighted that descriptive surveys are cost-effective. Also, Babbie (2020) added that descriptive survey design yields multi-layered datasets capable of descriptive, inferential, and explanatory analysis, thereby enhancing the generalizability of findings across larger groups. The researchers collected data from a wide range of mathematics teachers from within the Wa municipality. Hence, the researchers selected survey methods for the study.

3.2 Participants and Setting

The target population for this study comprised all $N = 79$ public Senior High School mathematics teachers in the Wa Municipality of the Upper West Region, Ghana. The rationale for choosing mathematics teachers from public SHSs as the target population is due to a diverse student population, including students from disadvantaged socio-economic backgrounds. The total population was less than 100. Hence, a census sampling technique was employed to include all 79 mathematics teachers (Portier, 1982). A total of 76 respondents completed and returned the survey, yielding a 96.20% response rate. The remaining three teachers were unavailable during the data collection period.

3.3 Survey Instruments

A self-developed structured questionnaire was designed and employed as the instrument for data collection. The instrument was divided into three structured sections: Section A indicated the demographic characteristics of the respondents (7 items). Section B demonstrated Teachers' Knowledge Level About Problem-Solving as a Pedagogical Tool Questionnaire (TKPSQ; 14 items), whilst Section C highlighted Teachers' Instructional Practices Through Problem-Solving Questionnaire (TIPPSQ; 19 items). Sections B and C utilized a 4-point Likert scale (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree). To establish the content and face validity of the items, expert views of senior mathematics educators were incorporated. Consistency of the items was verified using Cronbach's alpha (α), yielding reliability coefficients of $\alpha = .84$ for the TKPSQ subscale and $\alpha = .78$ for the TIPPSQ subscale, which indicated a highly reliable scale.

3.4 Data Analysis

Data were analyzed using SPSS Statistics (version 27.0). Frequencies and percentages were computed for demographic data. Descriptive statistics- specifically means (M) and Standard Deviations (SD) were calculated to address Research Question 1 and Research Question 2. To determine whether a statistically significant mean difference existed between teachers' overall perceived knowledge score and their classroom instructional practices score Research Question 3, an inferential paired-samples t -test was conducted at a significance level of 5% (two-tailed). The effect size of the mean difference was measured using Cohen's d .

3.5 Ethical Considerations

Permission was sought from the headmasters and mathematics teachers at participating public Senior High Schools in the Wa Municipality. Informed consent was obtained from all participating mathematics teachers prior to survey administration. Voluntary participation, anonymity, and confidentiality were strictly preserved by excluding personal identifiers from the questionnaire.

4. Results

4.1 Research Question 1: What is the self-reported knowledge level of Senior High School mathematics teachers regarding problem-solving as a pedagogical tool?

This question sought to determine the knowledge level of Senior High School mathematics teachers regarding problem-solving as a pedagogical tool. Table 1 indicates the descriptive statistics for Question 1.

Table 1: Means and Standard Deviations of Teachers' Perceived Knowledge About Problem-Solving Pedagogy

S/N	Statement	M	SD
1	I understand how to assess not only the correctness of solutions but also the reasoning processes and problem-solving strategies employed by learners.	3.49	0.65
2	I possess the knowledge and adaptability to modify problem-solving approaches based on the needs and dynamics of their specific classroom.	3.39	0.62
3	I possess knowledge about learners' cognitive development and how problem-solving contributes to their intellectual growth.	3.32	0.81
4	I recognize the importance of linking problem-solving tasks to real-world applications.	3.32	0.67
5	I possess strategies for supporting diverse learners in problem-solving activities.	3.30	0.74
6	I am equipped with a repertoire of teaching strategies that facilitate effective problem-solving instruction.	3.30	0.73
7	I understand the importance of allowing learners to explore, inquire, and construct their understanding through active engagement with mathematical problems.	3.28	0.70
8	I recognize the importance of both covering essential content and providing opportunities for in-depth exploration through problem-solving.	3.25	0.63
9	I am aware of the cultural diversity within their classrooms and incorporate culturally relevant problem-solving tasks.	3.24	0.78
10	I understand how to integrate problem-solving activities into the mathematics curriculum.	3.24	0.75
11	I have skills in designing effective and engaging problem-solving tasks.	3.21	0.75
12	I am aware of various strategies to adapt problems to different levels of difficulty, ensuring that all learners can engage in meaningful problem-solving experiences.	3.18	0.80
13	I often align my educational philosophy with the principles of problem-solving.	3.13	0.72
14	I understand the theoretical underpinnings of problem-solving as a pedagogical approach, which includes recognizing problem-solving as a method that goes beyond rote memorization, emphasizing conceptual understanding, and promoting critical thinking.	3.11	0.77
Overall	Average of Means	3.27	0.72

Note: N = 76; Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree.

The results in Table 1 revealed that teachers reported a high overall perceived knowledge level ($M = 3.27$, $SD = 0.72$). The highest-rated knowledge dimension pertained to assessing reasoning processes rather than mere solution correctness ($M = 3.49$, $SD = 0.65$). Lower-rated items included aligning educational philosophy ($M = 3.13$, $SD = 0.72$) and understanding the theoretical underpinnings of problem-solving pedagogy ($M = 3.11$, $SD = 0.77$).

Research Question 2: What instructional practices do Senior High School mathematics teachers use when teaching through problem-solving?

Research Question 2 explored the classroom instructional practices employed by SHS mathematics teachers. Table 2 presents the descriptive statistics.

Table 2: Means and Standard Deviations of Teachers' Instructional Practices When Using Problem-Solving

S/N	Statement	M	SD
1	I select or create problems that have real-world relevance and applicability.	3.34	0.61
2	I use varied assessment methods to evaluate learners' problem-solving skills.	3.32	0.67
3	I adopt inquiry-based methods that encourage learners to explore mathematical concepts independently.	3.32	0.63
4	I differentiate instructions to accommodate diverse learning styles and abilities when using problem-solving as a pedagogical tool.	3.32	0.63
5	I offer scaffolding support to learners, providing guidance and assistance as needed.	3.28	0.68
6	I connect new problem-solving tasks to learners' prior knowledge.	3.27	0.70
7	I integrate technology, such as interactive simulations, educational software, or online resources, to enhance learners' problem-solving experiences.	3.25	0.67
8	I facilitate classroom discourse, which helps learners articulate their thought processes, fostering a deeper understanding of mathematical concepts.	3.24	0.73
9	I promote collaborative learning by encouraging learners to work together on problem-solving tasks.	3.23	0.81
10	I facilitate discussions about problem-solving strategies, alternative approaches, and solutions.	3.23	0.74
11	I offer timely and constructive feedback on learners' problem-solving efforts.	3.23	0.64
12	I cultivate a positive classroom culture that values effort, risk-taking, and perseverance in problem-solving.	3.21	0.70
13	I present well-defined problem statements that are clear and accessible to learners.	3.21	0.67
14	I align problem-solving activities with the types of questions learners may encounter in standardized tests.	3.20	0.73
15	I encourage a growth mindset by praising effort, emphasizing the learning process, and framing challenges as opportunities for development.	3.18	0.78
16	I use modelling as a guide for my learners as they develop their problem-solving skills.	3.18	0.72
17	I foster a reflective learning environment, prompting learners to think about their problem-solving processes and outcomes.	3.18	0.70
18	I offer extension activities for learners who demonstrate a strong aptitude for problem-solving.	3.17	0.76
19	I use formative assessment techniques during the problem-solving process to gauge learners' understanding, identify misconceptions, and adjust instruction accordingly.	3.10	0.74
Overall	Average of Means	3.23	0.70

Note: N = 76. Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree.

The results in Table 2 demonstrate an overall mean score of $M = 3.23$ ($SD = 0.70$), indicating regular implementation of problem-solving instructional strategies. Selecting real-world problems ($M = 3.34$, $SD = 0.61$) and using varied assessments ($M = 3.32$, $SD = 0.67$) were the most frequent practices. Conversely, providing extension activities for advanced learners ($M = 3.17$, $SD = 0.76$) and conducting formative assessments *during* problem-solving ($M = 3.10$, $SD = 0.74$) were reported least frequently.

Research Question 3: Is there a statistically significant difference between Senior High School mathematics teachers' perceived knowledge level and their actual classroom instructional practices?

This question examined whether a statistically significant difference existed between teachers' perceived knowledge level and their reported instructional practices. The results of the paired-samples *t*-test are presented in Table 3.

Table 3: Paired-Samples *t*-Test Comparing Teachers' Pedagogical Knowledge and Instructional Practices

Variable	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	Cohen's <i>d</i>
Perceived Knowledge	3.27	0.72	0.34	70	.738	0.06
Instructional Practices	3.23	0.70				

Note: N = 76. M=Mean; SD= Standard Deviation.

Table 3 shows that the paired-samples *t*-test revealed that the mean difference between teachers' perceived pedagogical knowledge and classroom implementation was not statistically significant, $t(70) = 0.34$, $p = .738$, $d = 0.06$. The effect size ($d = 0.06$) indicates a negligible practical difference, demonstrating that teachers perceive their classroom implementation to closely match their overall pedagogical knowledge level.

5. Discussion

Senior High School mathematics teachers in the Wa Municipality indicated a high overall self-reported knowledge level ($M = 3.27$, $SD = 0.72$), feeling most competent in assessing reasoning processes ($M = 3.49$) and adapting to classroom dynamics ($M = 3.39$). These findings align with current empirical evidence emphasizing researchers' recognition of problem-solving as a tool for critical thinking (Gbegini *et al.*, 2026; Ntori *et al.*, 2026). However, lower scores in philosophical orientation ($M = 3.13$) and theoretical groundings ($M = 3.11$) expose a gap in foundational Pedagogical Content Knowledge (PCK) (Shulman, 1986), highlighting findings that teachers often lack deep theoretical understanding (Schmid *et al.*, 2021; Siswono *et al.*, 2019) due to training models that focus on procedural delivery.

Furthermore, Teachers revealed regular implementation of problem-solving instruction ($M = 3.23$, $SD = 0.70$), prioritizing real-world task selection ($M = 3.34$), inquiry-based activities ($M = 3.32$), and differentiated assessments ($M = 3.32$). Underpinning problems in pragmatic contexts reflects Polya's (1945) heuristics and culturally responsive pedagogy (Atta & Bonyah, 2023; Nolan & Xenofontos, 2023; Taley, 2022), whilst the integration of technology ($M = 3.25$) resonates with evidence that technology promotes learners' active participation (Boadu & Boateng, 2024; Osei-Owusu *et al.*, 2026). However, lower scores for extension tasks ($M = 3.17$) and real-time formative assessment ($M = 3.10$) indicate vital operational lapses, which can obstruct learners' growth and

success in multifaceted topics like Euclidean geometry and algebra (Davor *et al.*, 2026; Ntori *et al.*, 2026).

Also, the paired-samples t-test highlighted no statistically significant difference between perceived knowledge and reported practice, $t(70) = 0.34$, $p = .738$, $d = 0.06$; suggesting great self-efficacy alignment (Geist, 2015). Although self-reported survey data may reflect social desirability bias, as noted by Willingham (2021), the high teacher efficacy profile strongly supports the constructivist goals of the national curriculum (Opong, 2025).

6. Conclusion

This study evaluated the pedagogical knowledge, instructional practices, and theory-practice alignment of SHS mathematics teachers in the Wa Municipality, Ghana. The findings demonstrate high overall self-reported knowledge and active integration of real-world, inquiry-based problem-solving practices in classrooms. Inferential analysis confirmed no statistically significant gap between teachers' perceived knowledge and implementation, revealing high perceived alignment. However, structural gaps persist in teachers' theoretical grounding, in-process formative assessment, and provision of extension activities for high-achieving learners.

6.1 Recommendations

The study recommended the following:

- 1) Policy makers should restructure professional development workshops in the Upper West Region to emphasize the theoretical and philosophical foundations of problem-solving pedagogy.
- 2) Professional training should focus on equipping teachers with real-time diagnostic techniques to identify learner misconceptions during problem-solving tasks.
- 3) Curriculum planners should provide pre-designed, contextually relevant problem-solving task repositories that include extension activities for diverse learning tiers, reducing individual task-creation burdens on teachers.

Statements and Declarations

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Data Availability

The data that support the findings of this study are available from the corresponding author, DOK, upon reasonable request.

Ethics Approval

Not applicable.

Informed Consent

Informed consent was obtained from all subjects involved in the study.

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Conflicts of Interest

The authors declare no conflicts of interest.

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