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EXPLORING THE COMBINED EXPLANATORY VALUE OF PEDAGOGICAL KNOWLEDGE, ATTITUDE, AND ENGAGEMENT ON THE PROBLEM-SOLVING PROFICIENCY OF LEARNERS IN HINTERLAND SCHOOLS

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ABSTRACT

Mathematical problem-solving proficiency is an important part of mathematics learning, but learners' performance may be influenced by both teacher-related and learner-related factors. This study examined the relationships of Adaptive Pedagogical Content Knowledge, attitude toward mathematical problem-solving, and student engagement with the mathematical problem-solving proficiency of Grade 6 learners in Philippine hinterland schools. A descriptive-correlational design was used. Data were gathered from Grade 6 learners through a researcher-developed Adaptive Pedagogical Content Knowledge questionnaire, adapted questionnaires on attitude and student engagement, and a researcher-made mathematical problem-solving proficiency test covering fractions, decimals, percent, and ratio and proportion. Descriptive statistics, analysis, and multiple linear regression were used to analyze the data. The findings showed that Adaptive Pedagogical Content Knowledge, learners' attitude toward mathematical problem-solving, and student engagement were generally high, while mathematical problem-solving proficiency was at the progressing level. The three variables showed significant but weak relationships with mathematical problem-solving proficiency. Regression analysis also showed that the overall model was significant. None of the variables made a significant contribution when considered in isolation from the other independent variables. The findings suggest that responsive mathematics instruction, positive attitudes, and learner engagement are important in understanding learners' problem-solving proficiency. Future researchers may include Grade 6 learners from other hinterland and non-hinterland schools and examine additional factors, such as prior mathematical achievement, reading comprehension, and parental support at home. They may also use qualitative or mixed-methods approaches to better understand the

difficulties, struggles, and learners experience when solving mathematical problems and applying mathematical concepts to real-life situations. The study was completed in October 2026.

Keywords: *Adaptive Pedagogical Content Knowledge, attitude toward mathematical problem-solving, student engagement, mathematical problem-solving proficiency, Grade 6 learners, hinterland schools*

INTRODUCTION

Mathematical problem-solving requires learners to interpret a situation, identify relevant information, select strategies, carry out procedures, and evaluate whether a solution is reasonable. It therefore extends beyond memorizing facts or applying routine operations. Contemporary mathematics education places problem-solving, reasoning, and the use of mathematics in meaningful situations at the center of mathematical learning (Santos-Trigo, 2024). Research also shows that features of word problems, including linguistic demands and the need for multiple operations, can affect elementary learners' performance (Vessonen et al., 2024).

The development of problem-solving proficiency is particularly important for Grade 6 learners as they prepare to transition to secondary education. For learners in hinterland schools, mathematical understanding can also support practical activities such as measuring, budgeting, buying and selling, and interpreting quantities in everyday settings. Yet the opportunity to solve unfamiliar problems may depend not only on learners' mathematical knowledge but also on how teachers present content and on learners' motivation and engagement.

Pedagogical Content Knowledge describes the specialized knowledge teachers use to represent and explain subject matter in ways learners can understand (Shulman, 1986). In mathematics, this includes selecting examples and representations, anticipating misconceptions, and responding to learners' difficulties. A systematic review by Grigaliūnienė et al. (2025) highlighted instructional strategies, representations, and knowledge of students' difficulties as important aspects of mathematics teachers' pedagogical content knowledge. In a hinterland context, teachers may need to adapt explanations and connect abstract concepts with familiar situations.

Learners' attitudes toward mathematical problem-solving may also be relevant. Expectancy-value perspectives emphasize learners' expectations of success and the value they attach to a task (Eccles & Wigfield, 2002). Learners who regard problem-solving as meaningful and believe they can make progress may be more willing to persist when a problem is difficult. Saadati et al. (2023) documented the importance of upper-primary students' experiences, feelings, and perceived value in understanding their attitudes toward mathematical problem-solving.

Student engagement is another potentially relevant factor. It includes behavioral participation and cognitive investment in learning tasks (Fredricks et al., 2004). During

problem-solving, behavioral engagement may be reflected in participation and sustained effort, while cognitive engagement involves analyzing information, choosing strategies, monitoring reasoning, and reviewing solutions. A meta-analysis by Wong et al. (2024) examined associations between student engagement, academic achievement, and subjective well-being.

Although these areas have been studied, there remains a need for context-specific evidence on how teacher-related and learner-related factors relate to mathematical problem-solving proficiency among Grade 6 learners in Philippine hinterland schools. This study addressed that gap by examining learners' perceptions of teachers' APCK, learners' attitudes toward mathematical problem-solving, and cognitive and behavioral engagement, alongside their performance on a mathematics problem-solving assessment. The findings may inform instructional support and learner-centered approaches in geographically remote school settings.

Research Questions

The study sought to answer the following questions:

1. How do participants assess their teachers' Adaptive Pedagogical Content Knowledge in terms of:
    a. adapting explanations to learners' needs,
    b. choosing strategies for difficult mathematics concepts;
    c. using learners' errors and misconceptions;
    d. and connecting mathematics to learners' experiences?
2. What is the participants' attitude toward mathematical problem-solving in terms of:
    a. enjoyment and interest;
    b. confidence:
    c. persistence when problems are difficult;
    d. and perceived value and usefulness?
3. What is the participants' level of engagement in mathematical problem-solving in terms of:
    a. cognitive and;
    b. behavioral engagement?
4. What is the participants' level of mathematical problem-solving proficiency?
5. Do APCK, attitude toward mathematical problem-solving, and student engagement significantly predict mathematical problem-solving proficiency?

METHODOLOGY

Research design and setting. The study used a quantitative descriptive-correlational design to describe the study variables and examine their relationships without manipulating them. It was conducted among Grade 6 learners in selected hinterland public elementary schools in one of the municipalities in the Division of Agusan del Sur, Philippines, during School Year 2026–2027.

Participants and sampling. The participants were 121 Grade 6 learners selected through purposive sampling. Eligible participants were enrolled in Grade 6 in the participating schools, receiving mathematics instruction, willing to participate, and provided learner assent with written parental or guardian consent.

Instruments. Four instruments were used. The researcher-developed APCK questionnaire contained 32 items across four dimensions: adapting explanations, choosing strategies for difficult concepts, using learners' errors and misconceptions, and connecting mathematics to learners' experiences. Attitude toward mathematical problem-solving was measured using an adapted 32-item questionnaire across enjoyment and interest, confidence, persistence, and perceived value and usefulness. Student engagement was measured using an adapted 16-item scale covering cognitive and behavioral engagement, with eight items per dimension. Mathematical problem-solving proficiency was assessed using a researcher-developed 15-item multiple-choice test aligned with selected Grade 6 mathematics competencies and covering fractions, decimals, percent, and ratio and proportion.

Validity and reliability. The instruments underwent expert review and pilot testing before administration. Internal consistency was evaluated using McDonald's omega. The APCK dimensions had coefficients of .814, .740, .762, and .737, respectively. The attitude dimensions ranged from .775 to .806; cognitive and behavioral engagement had coefficients of .856 and .776, respectively. The mathematics problem-solving test had an omega coefficient of .710 after item review. These values met the study's stated .70 criterion (Hayes & Coutts, 2020).

Data collection and analysis. After ethical clearance and permission from the relevant authorities, data were collected from participating learners. The study reported voluntary participation, confidentiality, and safeguards for learner well-being and privacy. Frequency, percentage, mean, and standard deviation were used to summarize the descriptive findings. Multiple linear regression was planned to examine the combined and individual predictive contributions of the antecedent variables. Regression diagnostics were reviewed, including multicollinearity. Because student engagement and attitude showed potential multicollinearity with the other predictors, student engagement was excluded from the final model, which retained APCK and attitude. The study's findings should be interpreted within the limits of its purposive sample, selected schools, and correlational design.

RESULTS

Participants' assessment of teachers' APCK. The overall APCK rating was High (M = 3.86, SD = 0.73). Connecting mathematics to learners' experiences received the highest dimension mean (M = 3.90, SD = 0.75), followed by adapting explanations to learners' needs (M = 3.88, SD = 0.82), choosing strategies for difficult mathematics concepts (M = 3.85, SD = 0.78), and using learners' errors and misconceptions (M = 3.80, SD = 0.80).

Table 1. Participants' Assessment of Teachers' APCK

Dimension	Mean	SD	Interpretation
Adapting explanations to learners' needs	3.88	0.82	High
Choosing strategies for difficult mathematics concepts	3.85	0.78	High
Using learners' errors and misconceptions	3.80	0.80	High
Connecting mathematics to learners' experiences	3.90	0.75	High
Overall	3.86	0.73	High

Attitude toward mathematical problem-solving. Participants' overall attitude was High (M = 3.85, SD = 0.66). Enjoyment and interest and perceived value and usefulness were the highest-rated dimensions (both M = 3.91). Confidence in solving mathematics problems was the lowest-rated dimension (M = 3.78), although it remained High.

Table 2. Participants' Attitude Toward Mathematical Problem-Solving

Dimension	Mean	Interpretation
Enjoyment and interest	3.91	High
Confidence in solving mathematics problems	3.78	High
Persistence when problems are difficult	3.81	High
Perceived value and usefulness	3.91	High
Overall	3.85	High

Student engagement. Overall engagement was High (M = 3.90, SD = 0.74). Behavioral engagement (M = 3.92, SD = 0.79) was slightly higher than cognitive engagement (M = 3.87, SD = 0.76).

Table 3. Participants' Engagement in Mathematical Problem-Solving

Dimension	Mean	SD	Interpretation
Cognitive engagement	3.87	0.76	High
Behavioral engagement	3.92	0.79	High
Overall	3.90	0.74	High

Mathematical problem-solving proficiency. The participants' mean score was 8.12 (SD = 3.00), interpreted as Progressing. Nearly half of the participants (60 learners, 49.59%) were at the Progressing level. Twenty-two (18.18%) were Proficient, 20 (16.53%) Advanced, 17 (14.05%) Developing, and two (1.65%) Beginning.

Table 4. Participants' Mathematical Problem-Solving Proficiency

Level	Frequency	Percentage
Advanced	20	16.53
Proficient	22	18.18
Progressing	60	49.59
Developing	17	14.05

Beginning	2	1.65
Total	121	100.00

Regression analysis. Preliminary diagnostics indicated potential multicollinearity involving learner-level predictors. Student engagement was therefore excluded from the final regression model, which included APCK and attitude toward mathematical problem-solving. The final model was statistically significant, $F(2, 118) = 7.13$, $p = .001$, with $R = .328$, $R^2 = .108$, and adjusted $R^2 = .093$. The two predictors jointly explained 10.8% of the variance in proficiency.

Table 5. Final Regression Model Predicting Mathematical Problem-Solving Proficiency

Predictor	B	SE	β	t	p
APCK	−0.18	0.56	−.044	−0.321	.749
Attitude toward problem-solving	1.64	0.62	.361	2.659	.009

Note. Model summary: $R = .328$; $R^2 = .108$; adjusted $R^2 = .093$; $F(2, 118) = 7.13$; $p = .001$. The final model excluded student engagement after the multicollinearity diagnostics.

DISCUSSION

The high APCK rating suggests that learners generally perceived their teachers as adapting explanations, selecting strategies, addressing misconceptions, and connecting mathematics with familiar experiences. Connecting mathematics to learners' experiences received the highest rating, which is relevant in hinterland settings where familiar community and household contexts can help make abstract ideas meaningful. This pattern is consistent with the view that teachers' pedagogical content knowledge includes selecting representations and responding to learners' difficulties (Shulman, 1986; Grigaliūnienė et al., 2025). The comparatively lower rating for using learners' errors and misconceptions suggests an area where teachers could further encourage learners to explain their reasoning and treat errors as opportunities for learning.

Learners also reported high attitudes toward mathematical problem-solving, particularly enjoyment, interest, and perceived value. Confidence was the lowest-rated attitude dimension, although it remained high. This distinction matters because a generally positive attitude does not necessarily mean learners feel confident when facing unfamiliar or multistep tasks. Saadati et al. (2023) similarly examined upper-primary learners' attitudes in relation to their problem-solving experiences and perceived value. Teachers may support confidence through guided practice, gradual increases in task difficulty, feedback, and opportunities to compare and explain strategies.

Engagement was high overall, with behavioral engagement slightly higher than cognitive engagement. Learners reported participating and paying attention, while cognitive engagement was comparatively lower. This suggests that classroom participation may need to be complemented by opportunities to ask questions, try alternative strategies, connect prior learning, and reflect on whether answers are reasonable. This interpretation aligns with the multidimensional understanding of engagement described by Fredricks et al. (2004) and the broader evidence synthesized by Wong et al. (2024).

Despite high ratings for APCK, attitude, and engagement, mathematical problem-solving proficiency was at the Progressing level, and 49.59% of learners fell within that category. The difference between self-reported learning conditions and demonstrated test performance suggests that positive perceptions and participation alone may not be sufficient for consistently successful problem-solving. Learners may need more structured opportunities to interpret word problems, select operations, solve multistep tasks, explain their reasoning, and evaluate answers. This is consistent with research emphasizing that problem-solving depends on interpreting problem characteristics and coordinating mathematical knowledge and strategies (Vessonen et al., 2024; Pólya, 1945).

The final regression model was statistically significant and explained 10.8% of the variance in proficiency. Attitude toward mathematical problem-solving was a significant positive predictor, while APCK was not statistically significant after controlling for attitude. The model's significance should not be interpreted as proof of causation, given the correlational design. Likewise, the nonsignificant individual APCK coefficient does not establish that teacher knowledge is unimportant; it means that an independent contribution was not demonstrated in this model. The exclusion of student engagement because of potential multicollinearity also limits conclusions about its unique predictive contribution. The modest R^2 indicates that other unmeasured factors may be relevant, including prior mathematics achievement, reading comprehension, foundational numeracy, and access to learning resources. The results therefore support a balanced response that addresses learner attitudes while continuing to improve adaptive instruction and direct practice in problem-solving.

Conclusions

Grade 6 learners from the selected hinterland schools generally rated their teachers' APCK, their own attitudes toward mathematical problem-solving, and their engagement as High. However, their mathematical problem-solving proficiency was at the Progressing level, with almost half of the participants classified in this category. This indicates a need to strengthen the application of mathematical knowledge to unfamiliar and multistep problems, even when learners report positive attitudes and active participation.

The final regression model containing APCK and attitude toward mathematical problem-solving was statistically significant and explained 10.8% of the variance in proficiency. Attitude was a significant positive predictor; APCK was not significant when attitude was controlled. Student engagement was not included in the final model because of potential multicollinearity, so its independent predictive effect cannot be concluded from that model. Given the design and sample, findings should be interpreted as associations and predictive results rather than causal effects.

Recommendations

1. Mathematics teachers should provide regular, contextualized problem-solving activities using familiar situations such as budgeting, measuring, comparing quantities, and interpreting real-life information.
2. Teachers should strengthen learners' confidence and persistence through guided practice, graduated task difficulty, constructive feedback, and explicit modeling of how to select and revise strategies.
3. Teachers should deepen cognitive engagement by asking learners to explain their reasoning, compare solution methods, ask questions, check answers, and reflect on errors.
4. School leaders may use the findings to guide professional learning on adaptive mathematics instruction, formative assessment, misconception analysis, and contextualized problem-solving.
5. Future studies may use larger and more diverse samples, include additional factors such as reading comprehension and prior achievement, and investigate student engagement using an analytical approach that addresses its overlap with attitude.

Compliance With Ethical Standards

The study reports that ethical clearance and relevant permissions were obtained before data collection. Participation was voluntary, and learner assent and written parental or guardian consent were required. The researcher described measures to protect confidentiality, privacy, and learner well-being, including the use of participant codes and safeguards against public disclosure or labeling based on test performance. The study stated that data were handled in accordance with the Data Privacy Act of 2012. Before submission, the author should verify that this declaration accurately reflects the approved ethics documentation and should add the journal-required explicit statements on conflicts of interest, funding (if applicable), and AI-assisted tools, as appropriate to the actual circumstances.

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