Teachers' Pedagogical Content Knowledge, Learners' Engagement, and Mathematics Performance: Bases for Action Plan

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ABSTRACT

In this research, the researcher examined how learner engagement mediates the connection between teacher Pedagogical Content Knowledge (PCK) and the math performance of Key Stage 2 students in the Municipality of Buenavista using a descriptive correlational research design. A validated survey questionnaire was utilized to collect data from 60 math teachers and 1,977 learners included an academic record of students' performance. The results showed that the math teachers had a "Highly Competent" level of PCK (M=3.85) and the students had an average level of "Engagement" (M=3.09) with the lowest emotional engagement. Though teachers were competent in teaching, mediation analysis via Path Analysis indicated that learner engagement had no significant mediational effect (p=0.974) on the relationship between teachers' PCK and learner performance. The results suggest that although teacher competence and learner engagement are critical factors in influencing students' math achievement, other systemic or external variables may play a larger role influencing mathematical outcomes. Based on these findings, an action plan has been developed to increase emotional engagement and address the performance gap between instructional quality and academic achievement.

Keywords: Academic Performance, Behavioral Engagement, Cognitive Engagement, Emotional Engagement, Level of Learners' Engagement, Level of Pedagogical Content Knowledge, Pedagogical Content Knowledge (PCK).

INTRODUCTION

Issues facing the quality of mathematics education in the Philippines are particularly relevant in rural villages like Buenavista where little research exists. Although many qualitative and quantitative investigations exist (international and national) documenting the importance of teachers understand their pedagogical content knowledge (PCK) (the combination of a teacher's familiarity with the subject area and their ability to teach the material ideally) are conducive to presenting math concepts that all students understand. Most currently published studies document urban, wealthy, high-performing schools, leaving out under-researched demographics such as rural teachers, teachers from underdeveloped regions, and teachers at public elementary schools serving disadvantaged populations. In those areas teachers frequently modify their methods because of their communities and limitations. This leads to potential PCK's context specific characteristics that have not been recognized in published reports, which necessitate an exploration of how PCKs could look in the rural community of Buenavista and compare to the national standards based on teacher access to support systems and available teacher training/ resources.

Recent research has emphasized the importance of student engagement as a key contributor to academic achievement. Student engagement is generally examined along three dimensions; behavioral engagement (participation and effort), emotional engagement (interest and connection) and cognitive engagement (mental effort and strategy use). Researchers have shown that in structured learning environments, students are generally more behaviorally engaged than emotionally and/or cognitively engaged; particularly in the subject of math where many students experience anxiety and a lack of confidence. Given these findings, it begs the question of whether implementing effective instructional strategies that include PCK can improve student learning by enhancing the degree to which students engage with the content.

There have been numerous studies done that show an association exists between the PCK of teachers and the performance of learners, but little research has been conducted to understand what actually causes the association. The DSALE data from the Division Summative Assessment in Learning Evaluation shows that Key Stage 2 learners in the Municipality of Buenavista continue to score below the national average in mathematics. This highlights the need to explore factors that may be mediating the relationship between teaching and performance, such as learner engagement, and the impact of the capacity of the teacher and the motivation of the learner towards increasing mathematics performance. Therefore, the purpose of this study was to investigate the intervening role of the level of engagement of learners on the relationship between teachers' PCK and Key Stage 2 mathematics performance in the Municipality of Buenavista during SY 2025-2026, so that localized, evidence-based recommendations can be developed for improving the mathematical instruction and outcomes of learners from marginalized educational settings.

Objectives

This study determined the intervening effect of the learners' level of engagement between the teachers' Pedagogical Content Knowledge (PCK) and mathematics performance of Key Stage 2 learners in the Municipality of Buenavista for the Academic Year 2025-2026.

Specifically, the study sought to answer the following questions:

1. What is the teachers' level of pedagogical content knowledge (PCK) in teaching Mathematics?

2. What is the learners' level of engagement in learning Mathematics in terms of behavioral engagement, emotional engagement, and cognitive engagement?

3. What are the learners' academic performance of the learners in Mathematics?

4. To what extent does the learners' level of engagement intervene between the teachers' Pedagogical Content Knowledge (PCK) and learners' mathematics performance?

5. What action plan could be proposed from the findings of the study?

METHODOLOGY

The study employed a descriptive-correlational research design to examine the relationships among teachers' Pedagogical Content Knowledge (PCK), learners' engagement, and mathematics performance. This design was deemed appropriate as it allows for the identification of relationships among variables without manipulating them.

The research was conducted in the Municipality of Buenavista, Bohol, which comprises two districts: Buenavista I (15 elementary schools) and Buenavista II (13 elementary schools), for a total of 28 public elementary schools during the first semester of School Year 2025–2026.The respondents included 60 mathematics teachers and 1,977 Key Stage 2 learners. A complete enumeration technique was utilized for teachers to ensure full representation, while stratified random sampling was applied to learners to achieve proportional representation across schools and minimize sampling bias. This combination strengthened the study's methodological rigor and generalizability within the research context.

Data were collected using a three-part structured questionnaire adapted from validated instruments. The first part assessed teachers' PCK based on the Philippine Professional Standards for Teachers (PPST) using a 4-point Likert scale (4 = Highly Competent to 1 = Not Competent). The second part measured learners' engagement across behavioral, emotional, and cognitive dimensions using a 4-point scale (4 = Fully Engaged to 1 = Not Engaged). The third part consisted of learners' final mathematics grades obtained from school records. The instrument underwent expert validation, pilot testing, and reliability analysis, yielding a Cronbach's alpha coefficient that met the acceptable threshold of 0.70, indicating internal consistency.

For data analysis, weighted mean and standard deviation were used to determine levels of PCK and engagement. Percentage analysis described learners' academic performance. To examine relationships among variables, multiple regression analysis was employed. Furthermore, mediation analysis using path analysis was conducted to assess the direct, indirect, and total effects of PCK on performance through learner engagement. Statistical significance was set at $\alpha = 0.05$, ensuring a clear basis for interpreting results.

RESULTS AND DISCUSSION

Table 1 Teachers' Level of Pedagogical Content Knowledge (PCK) in Teaching Mathematics n = 60

Statements	Mean	SD	Descriptive Value
1. I apply knowledge of content ...	3.93	0.08	Strongly Agree
2. I establishes safe and secure …	3.93	0.08	Strongly Agree
3. I plan, manage, and implement …	3.93	0.08	Strongly Agree
4. I set achievable and appropriate…	3.93	0.08	Strongly Agree
5. I use a range of teaching strategies...	3.92	0.07	Strongly Agree
6. I maintain learning environments …	3.90	0.05	Strongly Agree
7. I manage learner behavior …	3.90	0.05	Strongly Agree
8. I use effective verbal and non-verbal…	3.89	0.04	Strongly Agree
9. I establish safe and secure …	3.89	0.04	Strongly Agree
10. I maintain supportive learning …	3.87	0.02	Strongly Agree
11. I establish a learner-centered ….	3.85	0.00	Strongly Agree
12. I ensure the positive use of ICT...	3.84	0.01	Strongly Agree
13. I apply a range of successful …	3.84	0.01	Strongly Agree
14. I design, adapt, and implement...	3.84	0.01	Strongly Agree
15. I use research-based knowledge ...	3.79	0.06	Strongly Agree
16. I adapt and implement learning …	3.79	0.06	Strongly Agree
17. I apply a range of teaching strategi...	3.77	0.08	Strongly Agree
18. I adapt and use culturally ...	3.77	0.08	Strongly Agree
19. I use differentiated, …	3.74	0.11	Strongly Agree
20. I plan and deliver teaching ...	3.72	0.13	Strongly Agree
Composite Mean	3.85	0.06	Highly Competent

Note: 3.26-4.00 Highly Competent

2.51-3.25 Competent

1.76-2.50 Slightly Competent

1.00-1.75 Not Competent

The Table 1 shows the Teachers' Level of Pedagogical Content Knowledge (PCK) in Teaching Mathematics using the weighted mean and standard deviation. This shows that statement 1 ''I apply knowledge of content within and across curriculum teaching areas''; statement 2 ''I establish safe and secure learning environments by consistently implementing policies, guidelines and procedures''; statement 3 ''I plan, manage, and implement developmentally sequenced teaching and learning processes to meet curriculum requirements and varied teaching contexts''; and statement 4 ''I set achievable and appropriate learning outcomes that are aligned with learning competencies'', got the highest weighted mean of 3.93, (SD=0.08), interpreted as highly competent. While in statement 20 I plan and deliver teaching strategies got the lowest weighted mean of 3.72, (SD=0.13) interpreted as highly competent. The overall composite mean is 3.85, (SD=0.06), and interpreted as highly competent. This implies that teachers show strong skills in teaching math as evidenced by high scores and consistent responses. Therefore, they are good at explaining math clearly which contributes positively to learners' learning.

This is aligned in the study of Habiyaremye et al. (2023) that teachers demonstrated a highly positive attitude towards integrating Pedagogical Content Knowledge (PCK) into their mathematics teaching. This positive attitude is inferred to be a result of the pedagogical training offered through the implementation of a competency-based curriculum.

Table 2 Learners' Level of Engagement in Learning Mathematics in terms of Behavioral Engagement, Emotional Engagement, and Cognitive Engagement n = 1,977

Indicators	Composite Mean	SD	Descriptive Value
Cognitive Engagement	3.16	0.85	Engaged
Behavioral Engagement	3.13	0.85	Engaged
Emotional Engagement	2.99	0.91	Engaged
Overall Composite Mean	3.09	0.87	Engaged

Table 2 shows the Learners' Level of Engagement in Learning Mathematics in terms of Behavioral Engagement, Emotional Engagement, and Cognitive Engagement using the weighted and standard deviation. In the first indicator which is the Cognitive Engagement got the highest weighted mean of 3.16, (SD=0.85), interpreted as Engaged while Emotional Engagement got the lowest weighted mean of 2.99, (SD=0.91), interpreted as Engaged. The overall composite mean of the three indicators is 3.09, (SD= 0.87), which is interpreted as Engaged.

The data shows a clear gap as an encouraging sign, as it proves the learners' natural interest in math. It implies that learners display positive feelings, interest, and motivation toward learning Mathematics. Therefore, it implies that learners exert effort in understanding mathematical concepts and apply thinking strategies to solve problems.

Consistent to the study of Joshi et al. (2022), cognitive engagement was found to have the most significant impact on social, behavioral, and emotional engagement. This highlights the importance of strategies that foster deep learning and higher-order thinking skills.

In line with the study of Reinhold et al. (2021), emotional engagement uniquely predicted cognitive learning outcomes, with a 32% higher probability of a correct answer in the posttest for each standard deviation increase

in emotional engagement. This indicates that intrinsic motivation, perceived competence and autonomy support, and situational interest are relevant for achieving learning goals, even when controlling for prior knowledge.

Overall, the findings show that the learners' level of engagement in learning Mathematics in terms of behavioral, emotional, and cognitive engagement is interpreted as engaged. This indicates that learners actively participate in class activities, show positive attitudes toward the subject, and exert effort in understanding mathematical concepts.

Aligned with the study of Joshi et al. (2022), the findings suggest that the four types of engagement social, behavioral, cognitive, and emotional are interconnected and mutually influential. This powerful interaction impacts learners' creativity, critical thinking, and collaboration.

Table 3 Learners' Academic Performance in Mathematics Subject n = 60

Grading Scale	**Frequency (f)**	**Percentage (%)**
Outstanding (90-100)	18	30
Very Satisfactory (85-89)	37	62
Satisfactory (80-84)	5	8

Table 3 shows that the learners' academic performance in Mathematics based on their grading scale, analyzed using the Percentage Formula. The data reveal that the majority of the learners fall within the grading scale of 85–89, with a frequency of 37 learners, representing 62% of the total respondents. This level of performance is described as Very Satisfactory, indicating that most learners demonstrate a commendable level of understanding and achievement in Mathematics.

On the other hand, the lowest number of learners falls within the grading scale of 80–84, with a frequency of 5 learners, or 8%, which is interpreted as Satisfactory. This suggests that only a small portion of the learners achieved the minimum satisfactory level of performance in the subject. The data show that the respondents obtained a mean score of 88.08 with a standard deviation of 4.05, indicating relatively consistent performance among the learners.

Overall, the results imply that the majority of learners are performing well in Mathematics, as reflected by the high percentage of learners within the very satisfactory range as seen in the table 3. This distribution indicates a generally positive academic performance among the learners, while also highlighting the need to provide additional academic support for those who fall within the lower performance bracket to further enhance their learning outcomes in Mathematics.

These findings align with the research of Meyer and Turner (2022), who emphasize that achievement gap is largely explained by the shift from passive compliance to active cognitive persistence; motivated learners are significantly more likely to engage in "productive struggle," viewing complex multi-step problems as surmountable challenges rather than sources of anxiety.

Table 4 Extent of the Learners' Level of Engagement Intervene to the Teachers' Pedagogical Content Knowledge (PCK) and Learners' Mathematics Performance

Mediation Estimates				
Effect		**SE**	**Z**	**p**
Indirect		0.659	-0.0323	0.974

Direct		2.067	-0.8373	0.402
Total		2.170	-0.8076	0.419
Variable	α	p-value	Interpretation	Decision
Mediation Analysis Summary	0.05	0.419	Not Significant	Do not reject

The findings reveal that learner engagement does not significantly mediate the relationship between teachers' Pedagogical Content Knowledge (PCK) and learners' mathematics performance. Although both PCK and engagement are theoretically established determinants of learning, the absence of a significant indirect effect suggests that engagement does not operate as the mechanism through which PCK influences academic outcomes in this context.

Several explanations may account for this result. First, contextual and extraneous variables may exert a stronger influence on mathematics performance than engagement. Factors such as socio-economic status, access to instructional resources, parental involvement, and classroom environment may attenuate the mediating role of engagement. Second, the restricted variability in the data—evidenced by uniformly high levels of teacher competence and generally engaged learners—may have limited the statistical power to detect mediation effects. Third, learner engagement may function as an independent (parallel) predictor of achievement rather than as an intervening variable linking PCK to performance.

Taken together, these findings underscore the multidimensional and complex nature of mathematics achievement, wherein no single factor sufficiently explains learning outcomes. Consistent with prior research (e.g., Keller et al., 2017), the results suggest that teachers' pedagogical knowledge alone may be insufficient to significantly enhance learner performance without accounting for broader contextual and learner-related influences.

SUMMARY OF FINDINGS

This section provides the summary of findings in this study.

1. Teachers demonstrated a high level of Pedagogical Content Knowledge in mathematics, with a composite mean score of 3.85, (SD=0.06).

2. The overall composite mean level of learner engagement was 3.09, (SD=0.87 interpreted as "Engaged".

3. The data showed that the respondents obtained a mean score of 88.08 with a standard deviation of 4.05, indicating relatively consistent performance among the learners.

4. There was no significant effect of the Learners' Level of Engagement Intervene to the Teachers' Pedagogical Content Knowledge (PCK) and Learners' Mathematics Performance.

CONCLUSION

Based on the findings of the study, these conclusions were drawn:

The findings revealed that the study's results showed that mathematics teachers have a strong grasp of pedagogical content knowledge (PCK) and use effective strategies to aid learner understanding. Learners generally display engagement across behavioral, emotional, and cognitive dimensions, but this engagement declines with more challenging tasks, underscoring the importance of fostering persistence and problem-solving skills. Learner performance in mathematics was largely very satisfactory, with grades typically ranging from 85 to 89. However, mediation analysis indicated that learner engagement does not significantly mediate the relationship between teacher PCK and mathematics performance, implying that other variables besides engagement may influence the link between teaching expertise and learner achievement. Thus, future researchers

may explore other factors affecting mathematics performance, such as motivation, learning strategies, or classroom environment, using larger or more diverse samples to better understand the links between teacher knowledge, learner engagement, and achievement.

RECOMMENDATIONS

Based on the findings and conclusions, the researcher recommends the following:

1. Teachers may continue to strengthen their Pedagogical Content Knowledge (PCK) while incorporating strategies that enhance learners' persistence and independent problem-solving skills in mathematics.

2. Schools may implement professional development programs and workshops focused on innovative, learner-centered teaching approaches to improve both learner engagement and academic performance.

3. Educators may encourage to integrate enrichment activities, collaborative problem-solving tasks, and formative assessments to monitor and support learners' progress in mathematics.

4. Future studies may investigate other factors that may influence mathematics performance, such as learners' motivation, study habits, and classroom environment, to provide a more comprehensive understanding of teaching and learning outcomes.

5. The researcher may assist in the implementation of the proposed action plan by coordinating with school administrators and teachers in disseminating its key components, monitoring its initial application in classroom settings, and evaluating its effectiveness in improving learners' engagement and mathematics performance.

Implication

The findings of the study suggest that although teachers demonstrate a high level of pedagogical content knowledge and learners exhibit a generally engaged disposition, these factors alone are insufficient to significantly influence mathematics performance. This indicates that academic achievement is shaped by a more complex interplay of variables beyond teacher competence and learner engagement. From a practical standpoint, the results underscore the need for multifaceted educational interventions. Schools should not only focus on enhancing instructional quality but also address learner-related and contextual factors such as motivation, study habits, emotional support, and access to learning resources.

Moreover, the non-significant mediation effect highlights the importance of exploring alternative explanatory variables. Factors such as mathematics anxiety, self-efficacy, parental involvement, and classroom climate may provide a more comprehensive understanding of performance outcomes. For policymakers and educators, the study suggests that improving mathematics achievement requires a holistic approach, integrating teacher development, learner support systems, and resource allocation. Finally, for future research, the findings point to the need for expanded models of analysis, incorporating additional mediators or moderators and utilizing more diverse samples to better capture the complexity of teaching and learning processes

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