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Pedagogical Competence as the Key Driver: Analyzing the Relative Impact on Mathematics Achievement in Primary School

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Abstract
While teacher competence is widely acknowledged as crucial for student success, the relative importance of its specific dimensions—pedagogical versus professional competence—remains less clear, particularly in specific local contexts of primary mathematics education. This correlational study investigated the distinct impacts of these two competencies on the mathematics achievement of 45 sixth-grade students at SD Negeri 7 Buntok, Indonesia. Data were collected through a validated teacher competency questionnaire (completed by 3 class teachers) and a curriculum-based mathematics test. Multiple linear regression analysis revealed that both competencies significantly predicted student achievement, jointly explaining 54.1% of the variance in scores. Notably, pedagogical competence (β = 0.59, p = 0.001) emerged as a stronger unique predictor than professional competence (β = 0.38, p = 0.010). These findings underscore that while deep content knowledge is necessary, the ability to design, deliver, and manage effective instruction is paramount for enhancing student learning outcomes. The study provides empirical evidence for prioritizing pedagogical skill development in teacher training and professional development programs to improve primary mathematics education.
Keywords: Pedagogical competence; professional competence; mathematics achievement; teacher effectiveness; elementary education

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INTRODUCTION

Primary education plays a crucial role in establishing the foundation of students' academic abilities, particularly in mathematics, which requires logical thinking, analytical skills, and problem-solving (Copur-Gencturk & Tolar, 2022). Low mathematics achievement has become a global issue in primary education due to its direct impact on students' readiness for higher levels of learning (Yang & Kaiser, 2022). Numerous studies indicate that the quality of instruction is significantly influenced by teacher competence, especially pedagogical and professional competencies possessed by classroom teachers.

Teachers' pedagogical competence includes the ability to design and implement learning processes that are appropriate to students' needs and characteristics, as well as to evaluate learning effectively (Prasetyono et al., 2021). It also encompasses classroom management strategies that contribute to instructional quality and student engagement. Meanwhile,

professional competence refers to deep mastery of subject content and strategic capability in delivering material so that students can understand it optimally (Blömeke et al., 2015). In the context of mathematics instruction, both competencies are frequently associated with improved student learning outcomes (Sundqvist, 2019).

Empirical evidence demonstrates that teacher competence has a significant effect on students' academic achievement. Lestari and Nugraheni (2022) says that Mathematics teachers' professional competence significantly influences instructional quality and students' mathematics achievement, as it affects teachers' ability to deliver content and adapt teaching strategies (Yunanti & Amaliyah, 2025). In addition, a meta-analytic study confirmed that professional development (PD) programs targeting pedagogical and content competence greatly contribute to students' mathematics achievement, although the outcomes vary across studies (Gjoneska et al., 2022).

Other relevant studies also affirm that pedagogical and professional competencies significantly influence student achievement in mathematics, both at the primary and secondary levels (Sudargini & Purwanto, 2020). Their empirical study found that both types of teacher competence are crucial in improving students' mathematics learning outcomes.

Further comprehensive studies have revealed a positive relationship between teachers' pedagogical competence and student achievement through improved instructional quality, particularly in mathematics, although the influence of each competency dimension may vary depending on classroom context and student characteristics (Van Es & Sherin, 2021). Theoretical literature emphasizes that teacher competence involves not only mastery of content but also the ability to apply various pedagogical strategies to enhance students' understanding of complex material (Shi et al., 2022). This is especially important in mathematics education, where deep conceptual understanding is a prerequisite for achieving higher-order competencies.

Nevertheless, some studies suggest that the relationship between teacher competence and student achievement is not always consistent and may be influenced by other factors, such as instructional strategies, teaching experience, ongoing professional support, and school conditions (Stussi & Pool, 2022). However, in general, the influence of pedagogical and professional competence on constructive learning has been widely evidenced in international and comparative contexts, indicating that investing in the development of teacher competence is a vital step toward improving student learning quality (Blömeke et al., 2015).

In the Indonesian context, SD Negeri 7 Buntok Barito Selatan a representative public elementary school faces similar challenges, with a number of Grade VI students still failing to meet the minimum standard of learning in mathematics. This variation in student achievement highlights the need to evaluate the impact of teachers' pedagogical and professional competencies on learning outcomes. Local studies, such as (Yunanti & Amaliyah, 2025). Support the relevance of this inquiry in the context of primary mathematics education.

Therefore, this study aims to empirically investigate how teachers' pedagogical and professional competencies affect the mathematics achievement of sixth-grade students at SD Negeri 7 Buntok Barito Selatan. The findings are expected to provide a strategic foundation for teacher professional development and improvements in mathematics instruction at the primary level, as well as contribute empirical evidence to the mathematics education literature.

METHODS

Research Design

This study employed a quantitative approach with an explanatory correlational design to examine the influence of teachers' pedagogical and professional competencies on the mathematics achievement of sixth-grade students at SD Negeri 7 Buntok, Barito Selatan. This design allows testing of the hypothesized relationships between teacher competence variables and student outcomes through statistical analysis and hypothesis testing.

Participants

The participants of this study were all sixth-grade teachers and students at SD Negeri 7 Buntok. Using total population sampling, the study included 3 class teachers and 45 sixth-grade students (all students in the grade). This complete sampling was chosen due to the small and accessible population size.

Instruments

Two main research instruments were used to gather data on teacher competencies and student achievement:

Teacher Competency Questionnaire

This instrument measured teachers' pedagogical and professional competencies. The questionnaire was developed based on indicators from the Indonesian National Education Minister Regulation No. 16 of 2007, using a 5-point Likert scale for responses. It comprised 30 items in total, divided into two subscales: 15 items on pedagogical competence and 15 items on professional competence. Table 1 shows examples of the questionnaire items for each competency. The instrument was content-validated by two education experts and pilot-tested, yielding a high internal consistency (Cronbach's Alpha = 0.89).

Table 1. Sample teacher competency questionnaire items

No	Statement	Score
1	The teacher designs learning based on student characteristics.	1–5
8	The teacher demonstrates deep mastery of subject matter.	1–5
14	The teacher uses learning media to enhance conceptual understanding.	1–5
27	The teacher evaluates learning based on authentic assessment principles.	1–5

Mathematics Achievement Test

This was a curriculum-based test designed to assess student learning outcomes in mathematics. The test was constructed with reference to the Grade VI School Operational Curriculum. It included 30 multiple-choice questions covering cognitive domains from C1 (knowledge) to C3 (application) of Bloom's Taxonomy, on topics such as integers, fractions, measurement, and basic geometry. For example, one item asked students to perform an addition of fractions, and other items involved solving practical measurement problems. The test instrument was validated by an experienced mathematics teacher and was analyzed for item discrimination and difficulty level to ensure its quality.

Sample question

Question 5: What is the result of $\frac{3}{4} + \frac{2}{3}$?

A. $\frac{5}{7}$

B. $\frac{17}{12}$

C. $\frac{6}{7}$

D. $\frac{13}{12}$

Procedure

The research procedure was carried out through a structured sequence of activities, beginning with the preparation stage and continuing through to data analysis. Initially, the researcher established coordination with the school principal and the sixth-grade teachers to explain the objectives, scope, and procedures of the study, as well as to obtain formal permission and institutional support for the data collection process. This initial coordination

ensured that all parties involved clearly understood their roles and the overall implementation of the research.

Following this stage, teacher competency questionnaires were distributed to the three participating teachers. The questionnaires were completed independently by each teacher, and a two-day period was provided for returning the completed forms. This approach was intended to allow the teachers sufficient time to respond carefully and objectively to all items.

Subsequently, the mathematics achievement test was administered to the students in a classroom setting. A total of 45 sixth-grade students took the test simultaneously under standardized conditions. The administration process was supervised jointly by the classroom teachers and the researcher to ensure consistency, fairness, and adherence to the established testing procedures.

After all questionnaires and test instruments had been completed, the collected data were compiled for further processing. The responses were coded systematically and entered into a spreadsheet and statistical software to facilitate accurate tabulation, verification, and subsequent statistical analysis.

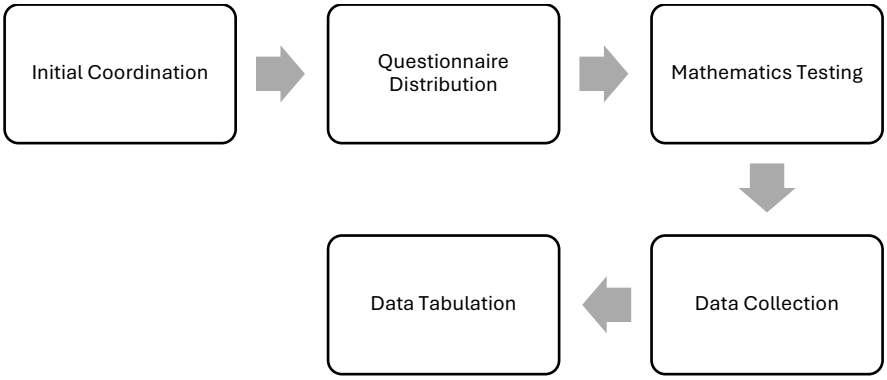

Figure 1. Research Procedure

Data Analysis

The quantitative data in this study were analyzed using IBM SPSS Statistics version 26. The analysis began with descriptive statistics to obtain an overview of the data characteristics by calculating the mean and standard deviation of each main variable, namely teachers' pedagogical competence, teachers' professional competence, and students' mathematics achievement. This stage aimed to describe the central tendency and the dispersion of the data for each variable examined.

Prior to conducting inferential analysis, several statistical assumptions were tested. The normality of the data distribution was examined using the Kolmogorov–Smirnov test to ensure that the scores of each variable did not significantly deviate from a normal distribution. In addition, a linearity test was performed to confirm the existence of linear relationships between the independent variables (pedagogical and professional competencies) and the dependent variable (students' mathematics achievement).

Subsequently, inferential statistical analyses were conducted to examine the relationships and effects among variables. Pearson product–moment correlation was employed to analyze the bivariate relationships between each teacher competence variable and students' mathematics achievement, providing information regarding the direction, strength, and significance of the linear associations. Furthermore, multiple linear regression analysis was applied to determine the combined effect of pedagogical and professional competencies on students' mathematics achievement and to identify the unique contribution of each independent variable while controlling for the other. This analysis produced the coefficient of determination (R^2), regression coefficients (B), and the significance levels of each predictor.

All statistical tests were conducted using a significance level of $p < 0.05$, with $p < 0.01$

indicating highly significant correlations. Statistical decisions were made based on standard decision rules, and the results are reported using relevant statistics such as correlation coefficients, regression coefficients, and p-values.

Ethical Considerations

This study was conducted in accordance with ethical standards for educational research. Formal permission was obtained from the local education authorities and the school principal prior to data collection. Participation was voluntary: the teachers and students (with parental consent for minors) were informed about the purpose of the study and their role in it. Confidentiality of all respondents was maintained by anonymizing teacher and student data. The researchers ensured that the study did not disrupt regular teaching and learning activities, and feedback on overall findings was offered to the school without disclosing any individual's responses.

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RESULTS AND DISCUSSION

Results

Descriptive Statistics

Table 2 presents the descriptive statistics for the main variables of the study: teachers' pedagogical competence (X_1), teachers' professional competence (X_2), and students' mathematics achievement (Y). For the teacher competency scores, N = 3 teachers (each teacher's competency score was derived from the questionnaire), and for student achievement N = 45 students.

Table 2. Descriptive statistics

Variable	N	Min	Max	Mean	Std. Deviation
Pedagogical Competence (X_1)	3	62	75	69.00	6.50
Professional Competence (X_2)	3	60	78	69.33	9.00
Mathematics Achievement (Y)	45	48	92	73.56	10.43

On average, the teachers' pedagogical and professional competence scores were in the high range (mean $X_1 \approx 69.0$; mean $X_2 \approx 69.3$ out of a maximum possible score of 75), indicating that the teachers self-reported relatively strong competencies. The students' mathematics achievement had a mean of about 73.56 (on a test scored from 0 to 100), which can be considered fairly good, although the scores ranged widely from 48 to 92, as reflected by a standard deviation of 10.43. This suggests considerable variability in individual student performance.

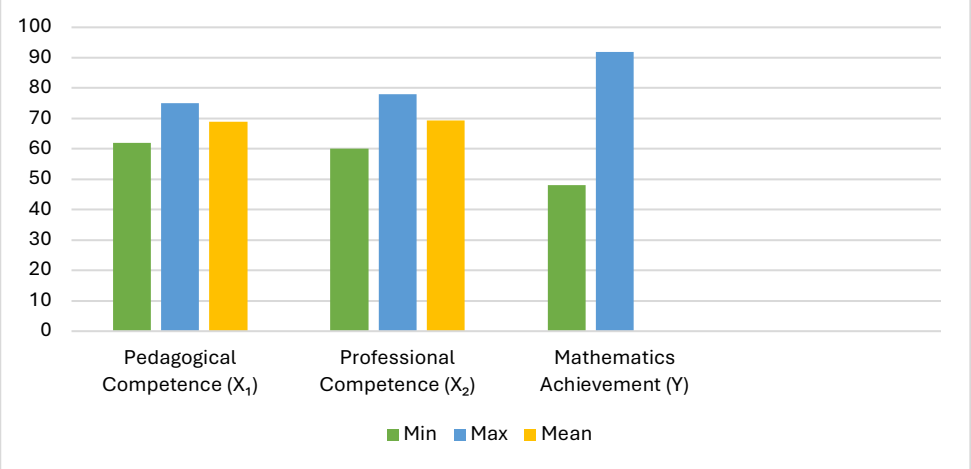

Figure 2. Descriptive Statistics

This bar chart illustrates the mean scores (with standard deviation error bars) for teachers' pedagogical competence, teachers' professional competence, and students' mathematics achievement. As shown, the average student achievement (Y) is somewhat higher

than the teachers' average competency scores, and the variability in student achievement is larger (longer error bar) compared to the variability in the three teachers' competency scores.

Assumption Test

Before conducting correlation and regression analyses, a Kolmogorov–Smirnov test was performed to assess the normality of each distribution. Table 3 shows the results of the normality test for each variable.

Table 3. Normality Test

Variable	Statistic	df	Sig. (p)
X_1 (Pedagogical)	0.167	3	0.200*
X_2 (Professional)	0.185	3	0.200*
Y (Achievement)	0.089	45	0.200*

As seen in Table 3, the significance values (*p*) for the Kolmogorov–Smirnov tests are all above 0.05 (marked with *), indicating that the score distributions for teachers' pedagogical competence, teachers' professional competence, and students' mathematics achievement do not significantly differ from a normal distribution. Thus, the assumption of normality is satisfied for all variables, supporting the use of parametric statistical analyses.

Correlation Analysis

A Pearson product-moment correlation analysis was conducted to examine the relationships between the teacher competency variables (X_1 and X_2) and students' mathematics achievement (Y). Table 4 summarizes the bivariate correlations and their significance levels.

Table 4. Pearson correlation analysis

Pairs	r	p (2-tailed)
$X_1 \leftrightarrow Y$	0.651	0.000*
$X_2 \leftrightarrow Y$	0.582	0.000*
$X_1 \leftrightarrow X_2$	0.803	0.000*

Significance: $p < 0.01$ (two-tailed).

The results in Table 4 show that both pedagogical competence and professional competence are positively and significantly correlated with students' mathematics achievement. Specifically, the correlation between pedagogical competence (X_1) and achievement (Y) is $r = 0.651$ ($p < 0.01$), and between professional competence (X_2) and achievement (Y) is $r = 0.582$ ($p < 0.01$). This indicates that higher teacher competence in either domain is associated with higher student test scores. In addition, the two competencies are strongly correlated with each other ($r = 0.803$, $p < 0.01$), suggesting that teachers who score high in pedagogical skills also tend to score high in professional knowledge. Notably, the pedagogical competence shows a somewhat stronger correlation with student achievement than professional competence does, hinting that pedagogical skills might play a particularly crucial role in this context.

Regression Analysis

To further investigate the predictive effect of the two teacher competencies on student mathematics achievement, a multiple linear regression analysis was performed. In this regression model, the students' mathematics achievement score (Y) was the dependent variable, and the two teacher competency scores (X_1 and X_2) were entered simultaneously as independent variables. The regression results are presented in Tables 5, 6, and 7.

Table 5. Model summary

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.736	0.541	0.524	7.13

Table 5 indicates an R value of 0.736 for the model, and an R^2 of 0.541. This R^2 value means that approximately 54.1% of the variance in sixth-grade students' mathematics achievement can be explained by the combined influence of the teachers' pedagogical and professional competencies. The adjusted R^2 (0.524) is close to the R^2, suggesting a good fit without overfitting for the number of predictors and sample size. In other words, over half of the variation in student performance is associated with differences in teacher competence levels,

which is a substantial proportion in educational research.

Table 6. ANOVA

Model	F	Sig.
1	25.72	0.000*

**$p < 0.001$ (overall model significance).

The ANOVA in Table 6 shows that the regression model is statistically significant (F = 25.72, $p < 0.001$). This confirms that considering pedagogical and professional competencies together provides a significantly better prediction of mathematics achievement than using the mean alone. In practical terms, there is a real linear relationship between the set of teacher competence variables and student achievement scores.

Table 7. Regression Coefficients

Predictor	B	Std. Error	t	Sig.
(Constant)	12.97	8.422	1.541	0.131
X_1 (Pedagogical)	0.59	0.155	3.806	0.001*
X_2 (Professional)	0.38	0.142	2.676	0.010*

Significance: $p < 0.05$; $p < 0.01$.

Table 7 provides the regression coefficients (unstandardized B) for each predictor along with their significance levels. The constant (intercept) is 12.97 (this is the expected student score when both X_1 and X_2 are zero, which is not directly meaningful in this context beyond being part of the equation). Importantly, both teacher competencies have positive B coefficients and are statistically significant predictors of student achievement: Pedagogical competence (X_1): B = 0.59, t = 3.806, p = 0.001. This indicates that for each one-unit increase in the pedagogical competence score (on the questionnaire scale), the students' mathematics score is predicted to increase by an average of 0.59 points, holding professional competence constant. This effect is highly significant ($p < 0.01$). Professional competence (X_2): B = 0.38, t = 2.676, p = 0.010. This suggests that each one-unit increase in the professional competence score corresponds to a 0.38 point increase in student mathematics achievement on average, controlling for pedagogical competence. This effect is also statistically significant ($p < 0.05$).

Comparing the magnitude of these coefficients, pedagogical competence appears to have a larger impact on student achievement than professional competence in this model. The standardized beta coefficients (not shown in the table) would similarly reflect a stronger contribution from pedagogical competence. The regression results thus support the hypothesis that while both forms of teacher competence are important, pedagogical skills might be the more influential factor in driving student success in mathematics.

In summary, the quantitative results indicate that teachers' competency levels were relatively high and student mathematics performance was good, on average. Pearson correlations confirmed significant positive relationships between each teacher competency and student achievement. Moreover, the multiple regression analysis demonstrated that together, pedagogical and professional competencies account for a majority of the variance in mathematics scores, with pedagogical competence showing a notably stronger unique effect. These findings provide robust evidence in support of the study's hypotheses.

Discussion

The results of this study provide clear evidence that teachers' pedagogical and professional competencies have a positive and significant impact on the mathematics achievement of sixth-grade students at SD Negeri 7 Buntok. Taken together, these two dimensions of teacher competence explained over half of the variance in student mathematics performance ($R^2 = 0.541$) in our sample. In line with expectations, pedagogical competence emerged as a particularly strong predictor (B = 0.59, p = 0.001) compared to professional competence (B = 0.38, p = 0.010). Descriptively, while the teachers in this study demonstrated moderately high levels of both competencies, there was still room for growth. The students' mathematics outcomes were generally good, yet variable, suggesting that improvements in teaching practices could further elevate and equalize learning outcomes.

Teachers' Pedagogical Competence and Students' Learning Outcomes

The finding that pedagogical competence has a strong influence on mathematics achievement is consistent with previous research by(König et al. (2021) who reported that teachers' ability to manage differentiated instruction and design learning activities that stimulate students' thinking is positively associated with mathematics achievement. Similarly, Park et al. (2025) found that teachers' depth in applying innovative and adaptive learning approaches contributes significantly to students' conceptual understanding of mathematics.

These findings also reinforce the results of Park et al. (2025), which emphasized that pedagogical content knowledge the ability to integrate subject matter knowledge with appropriate pedagogical strategies is strongly correlated with instructional quality and students' academic achievement in mathematics. The study highlighted that teachers who not only master content but also know how to deliver it effectively can meaningfully enhance students' understanding (Sumual & Ali, 2017).

Teachers' Professional Competence and Students' Learning Outcomes

This study also reveals that teachers' professional competence significantly contributes to students' mathematics achievement, although its contribution is relatively smaller than that of pedagogical competence. This finding aligns with the study conducted by Franklin and Chang (2025), which demonstrated that teachers' mastery of content and technical skills in delivering mathematical topics are positively associated with students' achievement. This suggests that when teachers possess strong professional competence encompassing deep understanding of mathematical concepts and curriculum students tend to achieve better learning outcomes.

Furthermore, this result is consistent with the findings of Depaepe et al. (2020), who reported that the combination of pedagogical and professional competencies simultaneously has a significant effect on elementary school students' mathematics achievement. Their study emphasized that effective instruction requires teachers not only to understand theoretical concepts but also to apply them in classroom practice (Yanti, 2024).

Relationships among Variables and Theoretical Implications

Pearson correlation analysis in this study demonstrates significant positive relationships between pedagogical competence and mathematics achievement ($r = 0.651$) and between professional competence and achievement ($r = 0.582$). These results indicate that higher levels of teacher competence are associated with higher student achievement in mathematics. The strong correlation between pedagogical and professional competencies ($r = 0.803$) further supports the notion that these two dimensions of competence are closely interconnected in instructional practice.

These findings are consistent with the study by Lindström et al. (2025) which emphasized that instructional quality formed through the integration of content knowledge and pedagogical skills has a significant impact on students' academic achievement. The integration of teacher competencies serves as the foundation for effective teaching and learning processes.

In addition, an international study by Lindström et al. (2025) found that teachers' formal competence is positively associated with students' mathematics achievement, even after controlling for other variables such as socioeconomic background. This supports the understanding that teacher competence functions as a critical determinant of student achievement beyond contextual factors (Schoenfeld, 2020).

Practical Context at SD Negeri 7 Buntok

Descriptive results indicating a relatively large standard deviation in students' mathematics achievement scores ($SD = 10.43$) suggest variations in students' mathematical abilities. These differences may be influenced by variations in teachers' competencies in implementing effective instructional strategies. According to Murkatik et al. (2020), teacher competence directly affects students' learning motivation, which in turn impacts academic

achievement.

This context highlights that although teachers' competency levels are generally moderate, further improvement in pedagogical and professional understanding is still necessary to maximize students' mathematics learning outcomes. Therefore, continuous enhancement of teacher competence can help reduce disparities in student achievement (Amaliyah & Rahmat, 2021).

Overall, the findings of this study demonstrate that sustained improvement in teachers' pedagogical and professional competencies can contribute to addressing gaps in students' mathematics achievement. This reinforces recommendations for evidence-based curriculum practices, emphasizing teacher training and professional development as key strategies in educational reform (Sulfasyah et al., 2015).

Limitations and Future Research

While this study provides valuable insights, several limitations must be acknowledged. First, the sample size was small (only three teachers and 45 students from a single school), which may limit the generalizability of the findings. The context of one elementary school in Barito Selatan may not represent other regions or educational settings. Future research should include a larger and more diverse sample encompassing multiple schools or districts to enhance external validity. Second, the study's correlational design means causation cannot be definitively established. Although the findings are consistent with a causal influence of teacher competence on achievement, we cannot rule out the effect of unmeasured variables (such as student socio-economic factors or prior ability). Longitudinal or experimental studies (e.g., tracking improvements pre- and post-teacher training interventions) would be useful to strengthen causal inferences. Third, teacher competencies were measured via self-report questionnaire, which could introduce bias (teachers might overrate their skills). Employing additional assessment methods, such as classroom observations or student feedback, could provide a more nuanced evaluation of teacher competence.

Future research directions include exploring the qualitative aspects of how pedagogical competence translates into classroom practice. For instance, observational studies could identify which specific pedagogical strategies (problem-based learning, use of manipulatives, etc.) are most effective in boosting math understanding. Additionally, examining potential mediating factors such as student motivation or self-efficacy could deepen our understanding of how teacher competence impacts student achievement. Finally, since our study suggests pedagogical competence has a particularly strong effect, further investigation is warranted into professional development programs that effectively enhance pedagogical skills, and how those improvements in teaching practice quantitatively affect student outcomes over time.

CONCLUSION

This study has empirically demonstrated that teachers' pedagogical and professional competencies have a significant positive influence on the mathematics achievement of sixth-grade students at SD Negeri 7 Buntok. Together, these competencies accounted for 54.1% of the variance in students' test scores, indicating that the quality of instruction as shaped by teachers' ability to manage the learning process and master the subject matter is a dominant factor in student performance. Importantly, the analysis revealed that pedagogical competence exerts a greater influence than professional competence on student achievement in mathematics. This suggests that a teacher's skill in designing, delivering, and evaluating instruction effectively is a key driver of students' academic success, even as content expertise remains necessary.

These findings reinforce the notion that efforts to improve student learning outcomes cannot be separated from the continuous enhancement of teacher competence. In practical terms, the results contribute evidence to the policy and practice of elementary education: they support prioritizing structured teacher professional development programs that focus on both pedagogical and professional skill areas. Strengthening teachers' instructional strategies (e.g.,

through training workshops, peer mentoring, and reflective teaching practices) and deepening their content knowledge should be central goals for educational stakeholders aiming to raise mathematics achievement. By investing in teacher quality, schools will likely see corresponding improvements in student learning.

In conclusion, the present study contributes to the growing body of literature affirming teacher competence as a cornerstone of educational quality. It highlights that in the context of primary mathematics education, what teachers know and how they teach jointly determine a large part of student success. Stakeholders in education school leaders, teacher educators, and policymakers are thus encouraged to use these insights to inform initiatives that build stronger pedagogical and professional capacities in teachers. Ultimately, enhancing these competencies holds promise for better learning outcomes not only in the studied school but in similar educational contexts. Future studies with broader scopes and experimental designs are recommended to further validate and expand upon these findings, guiding the way toward effective strategies for teacher development and student achievement gains.

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