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The Influence of Basic Mathematical Ability on Science Performance among Pre-service *Madrasah Ibtidaiyah* Teachers

Anita Ekantini [a*], Efi Tri Astuti [b], Ruqoyyah Amilia Andania [c], Faisal Ashar Naim [d]

[a,b,d] Universitas Islam Negeri Sunan Kalijaga Yogyakarta, INDONESIA
[c] National Dong Hwa University, TAIWAN

**Corresponding author:* Anita Ekantini. *E-mail address:* 19921009201903201 8@uin-suka.ac.id

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a b s t r a c t

Background: Many pre-service *madrasah ibtidaiyah* teachers experience difficulties in solving physics-related science problems despite understanding the underlying scientific concepts. These difficulties are frequently associated with inadequate mastery of basic mathematical skills. Although previous studies have reported a relationship between mathematics and physics learning, empirical evidence examining basic mathematical ability as a predictor of science performance among pre-service elementary Islamic teachers remains limited.
Aims: This study aimed to examine the influence of basic mathematical ability on the science performance of pre-service *madrasah ibtidaiyah* teachers enrolled in the Advanced Science course and to determine the extent to which basic mathematical ability predicts students' science performance.
Methods: A quantitative correlational design was employed involving 63 fourth-semester of pre-service *madrasah ibtidaiyah* teachers selected through total sampling. Data were collected using a basic mathematics test covering number operations, fractions, decimals, and exponents, and a science performance test covering temperature and heat, Newton's laws, work and energy, impulse and momentum, quantities and units, and the solar system. After satisfying the assumptions of normality and linearity, the data were analyzed using simple linear regression.
Results: The findings revealed that basic mathematical ability significantly predicted science performance ($p < .001$). The regression analysis yielded a coefficient of determination (R^2) of 0.578, indicating that basic mathematical ability explained 57.8% of the variance in students' science performance. The positive regression coefficient further demonstrated that higher levels of basic mathematical ability were associated with better science performance.
Conclusions: Basic mathematical ability serves as a foundational cognitive prerequisite and a strong predictor of science performance among pre-service *madrasah ibtidaiyah* teachers. These findings extend the evidence on the central role of mathematical competence in science learning by demonstrating its substantial predictive contribution within the context of Islamic elementary teacher education.

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1. Introduction

Science education plays a fundamental role in developing scientific literacy, critical thinking, problem-solving skills, and evidence-based decision-making, all of which are essential competencies for prospective elementary school teachers. A solid understanding of science enables future teachers to explain natural phenomena systematically and to facilitate meaningful learning experiences for their students (Santos et al., 2025). The Advanced Science course is one of the compulsory courses for pre-service *madrasah ibtidaiyah* teachers at UIN Sunan Kalijaga Yogyakarta. The main content of this course is closely related to physics topics, such as temperature and heat, Newton's laws, quantities and units, work and energy, impulse and momentum, as well as the solar system. These topics require mathematical skills in problem solving (Azizah et al., 2015; Nurlailiyah & Deta, 2015). Physics materials demand calculations to solve problems as a consequence of applying physical formulas (Sukarjita et al., 2023).

Conceptual understanding refers to the ability to comprehend mathematical ideas in a comprehensive and functional manner (Fahrudhin et al., 2018). Conceptual understanding includes understanding mathematical concepts, explaining the relationships among concepts, and applying concepts to solve problems(Radiusman, 2020). In this study, the concepts referred to are related to number operations, namely addition, subtraction, multiplication, and division. Mathematics is a key component of many natural and technical sciences (Kolar-Begović et al., 2017). Mastery of basic mathematical concepts is a prerequisite for learning physics in science education (Tulende et al., 2021).

Basic mathematical concepts such as comparing, classifying, and measuring constitute fundamental science process skills. Mastery of basic mathematics is an essential part of developing scientific concepts (Fidia et al., 2020). These basic mathematical concepts are used in solving science problems (Gallenstein, 2005). Therefore, basic mathematical ability is required as a prerequisite for learning physics (Hastuti et al., 2020). Good mastery of mathematics supports the understanding of science concepts, especially those involving calculations and problem solving (Nurmaulida et al., 2018). There is almost no field of science that does not use mathematical concepts to explain its own concepts, theories, or models (Ndungo & Mugizi, 2019).

Mathematics and science are inherently interconnected because many scientific concepts rely on mathematical reasoning for their representation and explanation (Meredith et al., 2007). Mathematics enables students to recognize patterns in empirical data, quantify scientific relationships, and construct models that explain natural phenomena. For example, mathematical equations describe the relationship between mass and volume in determining density, while graphs facilitate the interpretation of changes in rainfall over time. Beyond serving as a computational tool, mathematics contributes to science learning by supporting several cognitive processes. Students with stronger mathematical ability are generally better able to interpret quantitative information, translate verbal scientific problems into mathematical representations, analyze relationships among variables, and apply logical reasoning to solve scientific problems. These cognitive processes reduce extraneous cognitive load and enable learners to construct more coherent scientific understanding (Mcbride & Silverman, 1991). Consequently, mathematics ability is conceptualized as an antecedent factor that enhances science performance through cognitive mechanisms such as quantitative reasoning, problem

representation, logical reasoning, and scientific problem-solving. This conceptual relationship provides the theoretical basis for examining mathematics ability as a significant predictor of achievement in advanced science learning.

Various studies show that students still experience difficulties in solving science problems that involve mathematical concepts (Nurlailiyah & Deta, 2015). Mathematical abilities, especially in basic arithmetic operations and quantitative reasoning, are important prerequisites for understanding various scientific concepts, especially in physics materials that require numerical analysis and the application of equations (Asshagab et al., 2023). Therefore, weak mastery of basic mathematics has the potential to hinder students' ability to understand science concepts and solve context-based problems.

These findings are also supported by various previous studies which show a positive relationship between mathematics ability and science learning outcomes. Students who have good numeracy skills and mastery of mathematical operations tend to be more successful in solving science problems (Ningsih et al., 2024), which require analytical skills, interpreting data, and using mathematical equations (Andris et al., 2025). On the other hand, low mathematical abilities cause students to experience difficulties in understanding the relationship between variables, choosing the right formula, or carrying out calculations accurately, which has an impact on low scientific problem-solving abilities (Astutik et al., 2026; Ade et al., 2021).

A similar phenomenon was also found in pre-service *madrasah ibtidaiyah* teachers. The evaluation results of science courses show that many students scored below 50. Further analysis indicates that the low learning outcomes are caused by students' limitations in understanding problem solving questions that require the application of mathematical formulas. This difficulty was apparent when students were asked to explain the problem-solving process in front of the class. Most still experience doubts in determining the solution steps, choosing the appropriate formula, and explaining the reasons for using certain procedures. Further investigation showed that some pre-service *madrasah ibtidaiyah* teachers had not mastered basic mathematical concepts and operations, such as fractions, exponents and decimal numbers. Apart from that, some students also still experience difficulties in carrying out multiplication and division operations with relatively large numbers. These limited basic mathematical abilities have an impact on students' low ability to solve science problems, especially physics materials that require mathematical calculations.

Previous research by Tulende et al. (2021) shows that providing basic mathematical concepts improves students' understanding in solving physics problems. Research by Riwanto et al. (2019) indicates that students are still unable to understand mathematical equations when solving physics problems (Riwanto et al., 2019). Conceptual understanding of mathematics plays an important role in solving physics problem-solving tasks (Yopi et al., 2021). In addition, (Slamat et al., 2021) states that science learning outcomes are influenced by reasoning ability and basic mathematical ability. This study focuses on science performance as influenced by students' mastery of basic mathematical concepts. Although various studies have identified a relationship between mathematics ability and success in science learning, most studies have focused on elementary and secondary school students or only examined the correlation between the two variables. Research specifically investigating the conditions of prospective elementary school or Islamic elementary school teacher students, particularly regarding how weaknesses

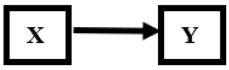
in basic mathematics skills affect the science problem-solving process, is relatively limited. Pre-service *madrasah ibtidaiyah* teachers are prepared as future teachers who will be responsible for teaching integrated mathematics and science concepts to elementary school students. Poor mastery of basic mathematics among pre-service *madrasah ibtidaiyah* teachers has the potential not only to impact their success in college but also to impact the quality of their future teaching.

Based on this description, there is a research gap that needs to be filled. There is a lack of research that has in-depth examined the relationship between basic mathematics ability and science problem-solving skills in pre-service *madrasah ibtidaiyah* teachers as prospective elementary school teachers. Furthermore, there is limited research developing or implementing learning strategies to address low basic mathematics ability as a foundation for science learning. Therefore, this research is important to provide empirical evidence regarding the characteristics of difficulties experienced by pre-service *madrasah ibtidaiyah* teachers and to produce learning recommendations that can improve science problem-solving abilities by strengthening basic mathematical competencies.

2. Methods

2.1 Research design

This study used a quantitative approach, characterized as a structured research design with predefined variables, hypotheses, and research procedures (Abdullah et al., 2022; Johnson & Christensen, 2014). The research method used was correlational (Khidhir, 2021; Putri et al., 2025), aiming to examine the relationship between variable X and variable Y, namely the mastery of basic mathematical concepts and science performance. The relationship between variable X and variable Y is illustrated in Figure 1.



Notes:
X: Basic Mathematics Ability
Y: Science Performance

Figure 1. Relationship between Variable X and Variable Y

2.2 Participants

The participants in this study were pre-service *madrasah ibtidaiyah* teachers at UIN Sunan Kalijaga Yogyakarta. They were active fourth-semester students aged between 19 and 21 years. The fourth-semester were divided into two classes, namely Class A and Class B. The sampling technique used was total sampling, in which all members of the population were included as research participants.

Table 1. Participant Profile

Class	Gender	
	Male	Female
A	7	21
B	11	24
Total	18	45

Table 1 shows that the number of female students in both Class A and Class B was higher than that of male students. There is a relationship between gender and academic achievement (Sri & Yonanda, 2020), with female students generally demonstrating better academic performance than male students. Several studies indicate that one reason female students tend to achieve higher academic performance and have a lower risk of dropping out is their higher learning motivation compared to male students, as well as their greater variety of learning strategies adapted to the characteristics of the learning material (Bowman et al., 2022). Learning motivation and learning strategies are two key determinants of educational success.

2.3 Data collection

The instruments used in this study were test instruments (Parwati et al., 2021; Sukmawati et al., 2023; Vargas et al., 2024), consisting of a basic mathematics concept mastery test and a science performance test. The basic mathematics test covered addition, subtraction, multiplication, and division, while the science performance test included topics such as temperature and heat, Newton's laws, quantities and units, work and energy, impulse and momentum, and the solar system. The test blueprint for basic mathematics ability is presented in Table 2, and the science performance test blueprint is shown in Table 3.

Table 2. Blueprint of the Basic Mathematics Ability Test

Component	Content	Item Numbers
Addition	Fractions, Decimals	1–5
Subtraction	Fractions, Decimals	6–10
Multiplication	Fractions, Decimals, Exponents, Squares	11–15
Division	Fractions, Decimals, Exponents, Squares	16–20

Table 3. Blueprint of the Science Performance Test

Topic	Number of Items
Temperature and Heat	10
Newton's Laws	10
Quantities and Units	10
Work and Energy	10
Impulse and Momentum	10
Solar System	10

This study was conducted in the Primary Teacher Education for Islamic Schools (PGMI) Study Program at UIN Sunan Kalijaga Yogyakarta during the even semester of the 2024/2025 academic year. The research was carried out by administering a basic mathematics concept understanding test and a science performance test to all students in Class A and Class B, totaling 63 students.

2.4 Data analysis

Validity and reliability tests were conducted for all research instruments (Azhar et al., 2018; Lianawati et al., 2025; Sürücü, 2020). Instrument validity included both content validity and empirical validity. Content validity was established through expert judgment by three

lecturers with expertise in educational evaluation, mathematics, and science education. The experts evaluated the relevance, clarity, and representativeness of each item, resulting in an average Aiken's V coefficient of 0.89, indicating high content validity. Empirical validity was assessed through a pilot test involving pre-service *madrasah ibtidaiyah* teachers who were not included in the research sample. Item analysis using Pearson's product-moment correlation showed that all items met the validity criterion, with corrected item–total correlation coefficients ranging from 0.41 to 0.78 ($p < 0.05$). Reliability analysis using Cronbach's alpha demonstrated satisfactory internal consistency, with coefficients of 0.87 for the mathematics ability test, 0.91 for the Advanced Science achievement test, and 0.89 for the learning motivation questionnaire. These findings indicate that all research instruments were valid and reliable for data collection. Empirical validity and reliability analyses were performed using SPSS version 25.

The assumption tests included the normality test and the linearity test. The normality test was conducted to determine whether the data distribution was normal. Data were considered normally distributed if the significance value was greater than 0.05. The linearity test was performed to examine whether the two research variables had a significant linear relationship. A significant linear relationship between variable X and variable Y was indicated if the significance value was greater than 0.05. After meeting the assumption requirements, hypothesis testing was conducted.

Hypothesis testing was conducted using linear regression analysis with the assistance of SPSS software. The hypotheses formulated in this study were as follows:

H_0 : There is no effect of basic mathematics ability on students' science performance.

H_a : There is a significant effect of basic mathematics ability on students' science performance.

The null hypothesis (H_0) was rejected if the Sig. (2-tailed) value at a 5% significance level was less than 0.05.

3. Results

This study aims to: (1) Determine whether basic mathematics ability affects the science performance of pre-service *madrasah ibtidaiyah* teachers, and (2) Examine the magnitude of the effect of basic mathematics ability on the science performance of pre-service *madrasah ibtidaiyah* teachers. This study involved two variables: basic mathematics ability as the independent variable and science performance as the dependent variable. The research data were collected from 63 students. Data on students' basic mathematics ability are presented in Table 4.

Table 4. Students' Basic Mathematics Ability Data

Aspect	Score
Minimum Score	15
Maximum Score	100
Mean	68.6
Standard Deviation	19.1

Table 4 shows that the lowest mathematics score was 15 and the highest score was 100, with an average score of 68.6. There is a wide gap between the minimum and maximum scores. The mean score of 68.6 is also considered low, as it is below the minimum mastery criterion (KKM) of 75.

Data on students' science performance are presented in Table 5.

Table 5. Students' Science Performance Data

Aspect	Score
Minimum Score	21
Maximum Score	67
Mean	47.3
Standard Deviation	10.4

Table 5 shows that the lowest science performance score was 21 and the highest was 67, with an average score of 47.3. Based on these results, students' science performance can be categorized as very low. Even the highest score obtained by students remains relatively low. This study seeks to reveal whether the low level of science performance is influenced by students' basic mathematics ability. Based on the scores obtained for basic mathematics ability and science performance, statistical analysis was subsequently conducted. The statistical analysis employed regression analysis.

Before hypothesis testing was conducted, prerequisite tests were carried out, namely the normality test and the linearity test. The results of the linearity test using SPSS showed a significance value of 0.233 > 0.05, indicating that the independent variable (basic mathematics ability) and the dependent variable (science performance) have a linear relationship. The results of the normality test, calculated using SPSS version 22, are presented in Table 6.

Table 6. Tests of Normality

Variable	Sig. (2-tailed)
Basic Mathematics Ability	0.962
Science Performance	0.255

Table 6 shows that the significance value for basic mathematics ability was 0.962 and for science performance was 0.255, both greater than 0.05. This indicates that the data were normally distributed.

3.1 Correlation Coefficient and Coefficient of Determination Analysis

The correlation coefficient (R) aims to measure the strength of the linear relationship between variables, indicating how closely the data points follow a straight line. Table 6 shows that the correlation coefficient (R) was 0.760, indicating a strong linear relationship between the two variables at a level of 76%.

The coefficient of determination (R Square) indicates the extent to which the independent variable influences the dependent variable (Saputro, 2022). The coefficient of determination describes the proportion of variance in the dependent variable explained by the independent variable, expressed as a percentage (Sehangunaung et al., 2023). Table 7 shows that the R Square value was 0.578, meaning that basic mathematics ability contributed 57.8% to students'

science performance. The remaining 43.2% of the variance in science performance was influenced by other factors not examined in this study.

Table 7. Results of the Coefficient of Determination Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.760[a]	.578	.570	12.58178

a. Predictors: (Constant), SainsPerforma

3.2 Hypothesis Testing Results

Hypothesis testing was conducted to determine whether there was a significant effect of the independent variable on the dependent variable. Using a significance level of 0.05 and the null hypothesis (H_0) stating that the regression model is not significant, the results showed that H_0 was rejected because the Sig. value was $0.000 < 0.05$. This indicates that the regression model is appropriate for predicting science performance based on basic mathematics ability. The results of the hypothesis test are presented in Table 8.

Table 8. Linear Regression Test

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	12124.244	1	12124.244	76.590	.000[b]
	Residual	8864.860	56	158.301		
	Total	20989.103	57			

a. Dependent Variable: SainsPerforma

b. Predictors: (Constant), MatematikaDasar

Table 8 shows that the significance value was $0.000 < 0.05$. In other words, H_0 is rejected and H_a is accepted, indicating that there is a significant effect of basic mathematics ability on the science performance of pre-service *madrasah ibtidaiyah* teachers.

3.3 Linear Regression Model

The linear regression equation was used to examine the effect of the independent variable (basic mathematics ability) on the dependent variable (science performance). Data analysis was conducted using SPSS to ensure accurate and efficient computation. The regression coefficients obtained from the SPSS output are presented in Table 9.

Table 9. Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1(Constant)	-89.143	18.106		-4.923	.000
SainsPerforma	1.787	.204	.760	8.752	.000

a. Dependent Variable: SainsPerforma

Table 9 shows that the constant value (a) was -89.143, while the regression coefficient for basic mathematics ability (b) was 1.787. Therefore, the linear regression equation can be written as:

$$Y = a + bX$$
$$Y = -89.143 + 1.787X$$

The interpretation of this regression equation is as follows: (1) The constant value of -89.143 indicates that if students' basic mathematics ability is assumed to be zero, their science performance would decrease accordingly; (2) The regression coefficient of 1.787 indicates that for every one-unit increase in basic mathematics ability, students' science performance increases by 1.787 units.

The results of the study presented are important data obtained from the results of data collection in the field (test results, questionnaires, interviews, documents, etc.). Research results can be supplemented by tables, figures, or graphs to clarify the results of the study. Avoid presenting similar data in separate tables. Tables, figures and graphics must be commented or discussed. All tables, figures and graphics must be centered and numbered consecutively. For qualitative research, the results section contains detailed sections in the form of sub-topics that are directly related to the research focus and categories.

4. Discussion

The results of the statistical analysis indicate that basic mathematical ability has a significant and strong effect on students' science performance, while also providing clear empirical evidence of a functional relationship between the two variables. This finding is supported by the linear regression analysis, which yielded a significance value of 0.000 (< 0.05), confirming that basic mathematical ability has a statistically significant effect on the science performance of pre-service *madrasah ibtidaiyah* teachers. The correlation coefficient (R = 0.760) indicates a strong relationship between basic mathematical ability and science performance, while the coefficient of determination ($R^2 = 0.578$) suggests that 57.8% of the variance in students' science performance can be explained by their basic mathematical ability. These findings position basic mathematical ability not merely as a supporting factor, but as a primary predictor in physics-related science learning within the PGMI context (Nanda & Rani, 2025; Tong et al., 2024).

The magnitude of this contribution demonstrates that students' science performance is highly sensitive to their level of mastery of basic mathematics. Empirically, the regression equation obtained, Y = -89.143 + 1.787X, indicates that every one-unit increase in basic mathematical ability is followed by an increase of 1.787 units in students' science performance. This positive and significant regression coefficient confirms that basic mathematical ability functions as a driving force in students' success in solving physics-related science problems. The negative constant value (-89.143) further indicates that without adequate mastery of basic mathematics, students' science performance tends to decline substantially, even when students have received conceptual instruction in science (Bervell et al., 2024; Kaur et al., 2022; Savelsbergh et al., 2019).

The influence of basic mathematical ability on students' science performance does not occur in an abstract manner, but rather through concrete cognitive mechanisms involved in the

process of science problem solving (Chatain et al., 2025; Gilmore, 2023; Savelsbergh et al., 2019 b). Field findings reveal that some students are able to identify known and required information and to write down relevant physics formulas, yet fail at the stage of mathematical computation. Difficulties in operating fractions, decimals, exponents, as well as performing accurate multiplication and division, prevent students from correctly executing physics formulas, despite their understanding of the problem context. This condition indicates that weaknesses in basic mathematical ability directly hinder the completion of quantitative and multi-step science problem-solving tasks.

From the perspective of mathematical conceptual understanding theory, these findings reflect weaknesses in students' relational understanding, namely the ability to connect mathematical concepts and apply them meaningfully in new contexts (Fahrudhin et al., 2018; Radiusman, 2020). Students have not yet reached the stage of automaticity in basic number operations, resulting in increased cognitive load when solving physics-related science problems that require integration of conceptual understanding and computational skills. Consequently, students' cognitive resources are largely consumed by calculation processes rather than by scientific reasoning or deep understanding of science concepts.

The results of this study further reinforce the view that mathematics serves as the primary cognitive foundation in science learning. Almost all topics in Advanced Science (such as Temperature and Heat, Newton's Laws, Work and Energy, and Impulse and Momentum) require the ability to compare quantities, convert units, and accurately manipulate mathematical equations. Without mastery of basic mathematical operations, students struggle to represent physical phenomena in meaningful mathematical models, causing science learning to stagnate at the level of formula memorization. These findings align with the perspective of Park Rogers et al. (Meredith et al., 2007), who emphasize that mathematics functions as a core representational tool for understanding scientific phenomena, as well as McBride and Silverman (Mcbride & Silverman, 1991), who argue that strong mathematical understanding enables students to achieve deeper and more applicable science comprehension.

Furthermore, the findings of this study confirm the results of Tulende et al. (2021), who reported that strengthening basic mathematical concepts contributes to improved physics problem-solving ability. However, this study offers a more specific and robust contribution by demonstrating that basic mathematical ability has a predictive and dominant role in pre-service *madrasah ibtidaiyah* teachers' science performance, accounting for more than half of the variance in science performance (57.8%). These findings extend the work of Riwanto et al. (2019) and Yopi et al. (2021) by providing stronger quantitative evidence within the context of preservice elementary Islamic teacher education. In addition, this study reinforces the view of Ndungo and Mugizi (2019) that almost no scientific concept can be fully explained without mathematical support. In the PGMI context, weaknesses in basic mathematical ability not only affect students' academic performance at the university level, but also have the potential to influence the quality of science instruction they will deliver at the elementary school level in the future.

The findings of this study indicate that improving pre-service *madrasah ibtidaiyah* teachers' science performance cannot be achieved without systematic and well-planned reinforcement of basic mathematical ability. Given that basic mathematical ability accounts for

57.8% of the variance in students' science performance, basic mathematics can no longer be positioned merely as a supporting course, but must be recognized as a core cognitive foundation for learning Advanced Science. Therefore, the implications of this study are not only normative, but also demand concrete changes in curriculum design, instructional strategies, and assessment systems within the PGMI program.

At the curricular level, the results provide strong empirical justification for establishing Basic Mathematics as a prerequisite course before students enroll in Advanced Science. This requirement is not merely administrative, but is grounded in evidence showing that insufficient mastery of basic mathematics significantly hinders students' ability to understand and solve physics-related science problems. In addition, the learning outcomes of the Basic Mathematics course should be designed in a more functional manner, emphasizing mastery of number operations, unit conversions, and equation manipulation relevant to elementary-level science contexts .

At the pedagogical level, basic mathematics instruction should adopt a contextual and application-oriented approach that is integrated with science-related problems (Kusnirova et al., 2026). Instruction that focuses solely on computational procedures without linking them to scientific phenomena risks producing fragmented understanding. Therefore, lecturers are encouraged to develop instructional models that emphasize the relationship between mathematical concepts and their application in science problem solving, enabling students not only to calculate, but also to comprehend the mathematical meaning underlying the physical phenomena being studied.

At the assessment level, these findings imply the necessity of conducting diagnostic assessments of basic mathematical ability at the beginning of the Advanced Science course. Such diagnostic assessments serve to map students' cognitive readiness and provide a basis for targeted reinforcement or remediation in mathematics (Tannert et al., 2026). Without early assessment, science instruction risks becoming ineffective due to unaddressed heterogeneity in students' mathematical abilities.

At the institutional level and in the preparation of future *madrasah ibtidaiyah* teachers, this study emphasizes that weaknesses in pre-service *madrasah ibtidaiyah* teachers' basic mathematical ability may have long-term consequences for the quality of science instruction in *madrasah ibtidaiyah*. Pre-service *madrasah ibtidaiyah* teachers are not only prepared to pass courses, but also to become teachers capable of delivering meaningful science learning to their future students. Therefore, strengthening pre-service *madrasah ibtidaiyah* teachers' basic mathematical ability represents a strategic investment in improving the quality of elementary science education, while also supporting the development of professional and competent PGMI graduates.

5. Limitations

The findings of this study should be interpreted in light of several limitations. First, the cross-sectional design and the use of simple linear regression identify statistical associations but do not establish a causal relationship between basic mathematical ability and science performance. Second, although the regression model explained 57.8% of the variance in students' science performance, the remaining 42.2% indicates that other cognitive and non-

cognitive factors, such as scientific reasoning, conceptual understanding, spatial ability, learning motivation, self-efficacy, prior academic achievement, instructional quality, and learning strategies, were not examined in this study. Third, the participants were limited to PGMI students from a single Islamic higher education institution in Indonesia, which may restrict the generalizability of the findings to other educational settings or preservice teacher populations. Finally, science performance was measured only through physics-related topics in the Advanced Science course, and therefore may not fully represent students' achievement across other science domains or broader scientific competencies. Future research is recommended to employ longitudinal or experimental designs, include multiple predictor variables using more comprehensive analytical approaches such as multiple regression or structural equation modeling, and investigate the cognitive mechanisms such as quantitative reasoning, problem representation, and cognitive load that mediate the relationship between basic mathematical ability and science performance.

6. Conclusion

This study provides empirical evidence that basic mathematical ability is a strong and significant predictor of pre-service *madrasah ibtidaiyah* teachers' science performance, particularly in the Advanced Science course, which is dominated by physics-related content. The regression analysis indicates that basic mathematical ability contributes 57.8% of the variance in students' science performance, meaning that more than half of students' academic achievement in science learning can be explained by their mastery of basic mathematical concepts. The remaining variance is influenced by other factors beyond the scope of this study. Students with strong mastery of basic mathematical skills including number operations, fractions, decimals, and exponentsare demonstrably more capable of executing physics formulas and solving quantitative, multi-step science problems. Conversely, weaknesses in basic mathematical ability constitute a major obstacle in the science problem-solving process, even when students have already understood the problem context and the underlying physics concepts. These findings confirm that low science performance among pre-service *madrasah ibtidaiyah* teachers is not solely attributable to the complexity of science content, but rather stems from inadequate foundations in basic mathematics. Therefore, this study has important strategic implications for the development of the PGMI curriculum, particularly the need to designate Basic Mathematics as a prerequisite course prior to students' enrollment in Advanced Science, as well as to strengthen mathematics instruction that is integrated with science contexts in order to enhance academic quality and professional readiness among prospective *madrasah ibtidaiyah* teachers.

Author Contributions

Author a conceived and designed the study. Author b collected and analyzed the data. Author a, Author b, Author C, and Author D wrote and revised the manuscript. All authors have read and approved the final version of the manuscript.

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