



The Relationship between Mathematical Ability and Problem-Solving Skills of Basic Physics 1 among First-Semester Students

Army Al Islami Ali Putra¹, Anis Zahrotin²
STKIP Modern Ngawi, Ngawi, Indonesia
armyalislami@gmail.com^{1,*}, aniszahrotin1@gmail.com²

^{*)}Corresponding author

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ABSTRACT

This study aims to analyse the relationship between mathematical ability and problem-solving skills in Basic Physics 1 for first-semester students of the Science Education Study Program, STKIP Modern Ngawi. The research applied a quantitative approach with a correlational design and total sampling methods on 20 students. The tools used were written tests that had been validated by experts, including aspects of algebra, trigonometry, vector operations, as well as basic differential and integral calculus to evaluate mathematical ability, along with indicators of problem understanding, strategy design, concept implementation, and answer presentation to evaluate problem-solving skills. Data were analysed using the Shapiro-Wilk normality test, Levene's homogeneity test, and Pearson correlation analysis. The findings of the study explained that the data from the two variables are distributed normally and homogeneously. The Pearson correlation analysis showed a correlation coefficient of -0.337 with a significance mark of 0.146 (> 0.05), which indicated that there was no significant statistical relationship between mathematical ability and problem-solving skills in Basic Physics 1 for first-semester students.

INTRODUCTION

Physics and mathematics are two mutually related fields of knowledge, strongly connected in the sectors of education, science, and engineering. Mathematics is a universal and fundamental science that drives technological progress; thus, it plays a significant role in various fields of science, including physics (Wahidaturrahmi & Baidowi, 2022). In learning physics, students often require reasoning and mathematically accurate arguments, as well as the skills to apply various mathematical methods to solve problems (Badmus & Jita, 2024). Thus, a sufficient mastery of mathematics is one of the important foundations for students' success in learning physics, especially at the undergraduate level.

Problem-solving is one of the necessary basic skills that students must master in physics studies. Various studies show a significant connection between students' mathematics skills and their performance in solving physics problems (Siombone & Niwele, 2023; Tong et al., 2024). Research at the university level showed a positive connection between students' mathematics abilities and their exam results in physics courses (Hafiz et al., 2023; Rahmadhani & Yanti, 2024). Findings confirm that

mathematical ability is not only supportive but also an important condition in the physics learning process.

At the college level, especially for first-semester students, the transition from a medium of education to higher education often becomes a distinct challenge. Studies on learning transfer showed that first-year students need to transfer the mathematics skills they have learned to solve physics problems in subsequent semesters, a process that involves metacognitive strategies in a recurring manner (Nakakoji & Wilson, 2020). This knowledge transfer process is not always smooth, and many students face challenges in connecting mathematical concepts with the context of physics.

Field data showed that low mathematics ability is one of the main reasons for the challenges students face in studying basic physics. Students' difficulties in understanding basic physics material are caused by several factors, including low mastery of basic mathematics, minimal understanding of physics concepts, lack of motivation to learn, inadequate effort, and insufficient practice with independent physics problems outside of lecture assignments (Puspitasari, 2024). Interviews with students revealed that the main problems stem from a lack of mastery of basic mathematics, limited understanding of physics concepts, and low utilisation of independent learning strategies (Darwata et al., 2025; Sari et al., 2025).

This condition is reinforced by empirical findings at the research site that directly measured students' mathematical abilities in the context of physics. The results of a pretest on 60 students using mathematics problems relevant to physics showed an average score of only 34.5 out of a total score of 60, equivalent to 57.5%. This achievement indicates that most students do not have an adequate understanding of basic mathematics as a prerequisite for applying it in the context of physics (Arifuddin et al., 2023). Furthermore, when students fail to solve physics problems that require mathematical skills, a fundamental problem arises regarding the source of the failure, namely whether it is caused by low basic mathematical abilities or a lack of understanding of the physics concepts themselves (Nissa et al., 2022). This issue aligns with the findings of international research that identified weak mathematical skills and a lack of understanding of problems as major obstacles in the domain of physics problem-solving skills (Hidaayatullaah et al., 2020). In fact, the primary source of students' difficulties in physics often lies in the mathematical rigour required, where the use of mathematics in physics is not merely for calculation but also serves to represent meaning about physical systems (Badmus & Jita, 2023). Furthermore, recent research using Structural Equation Modelling also confirmed that students' success in solving physics problems does not depend only on mastery of physics concepts but is largely determined by their mathematical skills (Wei et al., 2024). Thus, the problems with students' mathematical abilities and problem-solving skills found in this research location are not isolated phenomena but rather reflect challenges that are also widely faced in physics learning across various educational contexts.

On the other hand, studies on the relationship between mathematics ability and physics problem-solving, especially for first-year students, are still very limited, especially in the context of higher education in Indonesia. Students' difficulties in using the mathematics knowledge they have acquired to solve physics problems have been widely researched, but more studies are still needed, particularly at the higher education level (Badmus & Jita, 2024; Riantoni et al., 2023). Research on the relationship between basic mathematics ability and problem-solving skills in physics has been conducted, analysing two independent variables and one dependent variable, but it still needs to be expanded in a context that includes a more varied student population (Bowers et al., 2024; Musengimana et al., 2025; Wenno, 2015).

Based on the background described, this study aims to analyse the relationship between basic mathematical abilities and physics problem-solving skills in first-year college students. Specifically, this study seeks to identify the extent to which basic mathematical mastery contributes to students' ability to solve physics problems, as well as to describe the mathematical factors that most dominantly influence physics problem-solving performance. Thus, the results of this study are expected to provide

a comprehensive empirical picture of the relationship between these two variables, as well as serve as a basis for consideration in the development of more effective learning strategies in basic physics courses, particularly in higher education settings in Indonesia.

RESEARCH METHOD

This study applied a quantitative approach with a correlational design, aiming to analyse the connection as well as the strength of the relationship between mathematical ability and problem-solving skills in Basic Physics 1 for first-semester students of the Science Education Study Program, STKIP Modern Ngawi. This research was non-experimental because no treatment was specifically applied to the subjects; rather, it only observed and analysed emerging variables naturally. The study population covered all first-semester students who took the Basic Physics lecture 1. Considering the relatively limited population, this research used total sampling or saturated sampling, so that the entire population was made into a sample of 20 students. The selection method is based on the opinion of Arikunto (2006), who stated that if the number of study subjects is not enough out of 100, it would be better for the entire population to be made into a sample to ensure that the study results are more representative.

This study included two main variables, namely mathematical ability as the independent variable and problem-solving skills in Basic Physics 1 as the dependent variable. Mathematical ability was measured through various aspects, including algebra, trigonometry, vector operations, as well as the basics of differential and integral calculus. Meanwhile, the ability to solve problems was assessed based on predetermined indicators, including understanding physics problems, developing problem-solving strategies, implementing physics and mathematics correctly, and delivering logical, systematic, and appropriate answers following scientific procedures. The study instruments consisted of written tests that had been validated by experts to ensure compatibility with the variable indicators, with the evaluation of each item being objective to facilitate quantitative data processing.

Data was collected through the distribution of tests on mathematical ability and problem-solving skills to the entire sample, followed by coding, processing, and data arrangement for statistical analysis. Before the main analysis, the data underwent prerequisite tests to ensure that statistical assumptions were fulfilled. Normality testing was conducted using the Shapiro-Wilk test, while homogeneity of variance was examined using Levene's test. If the data meet both normality and homogeneity assumptions, Pearson correlation analysis is employed to determine the existence and strength of the relationship between mathematical ability and problem-solving skills in Basic Physics 1. However, if the data is found to be not normally distributed, the analysis is carried out using Spearman's-Rank correlation as a non-parametric alternative, which does not require the assumption of normality.

RESULTS AND DISCUSSION

This study objective for identifying relationship between ability in mathematics and skills in problem-solving of Basic Physics 1 for first-semester students. This research involved 20 first-semester students from the Science Education study program of STKIP Modern Ngawi who were currently undergoing the lecture of Basic Physics 1. Before carrying out the Pearson relationship analysis, normality testing was performed to verify that the data are normally distributed. The normality test used the Shapiro-Wilk method. The proposed hypotheses were H₀: data is normally distributed, and H₁: data is not normally distributed. The criteria for decision-making were used as Sig. > 0.05, so H₀ was accepted. The results of the normality test are shown in Table 1.

Based on Table 1, the value Signification for variable X is 0.476 and for variable Y is 0.170. Second, the p-value is more than 0.05, so we can conclude that the distribution is normal. Next, it carries out testing for homogeneity to determine whether the data is homogeneous or not. Here homogeneity test results in Table 2.

Table 1. Results of the Shapiro-Wilk Normality Test

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Mathematical Ability (X)	.161	20	.188	.956	20	.476
Problem-Solving (Y)	.205	20	.027	.879	20	.170

Table 2. Results of Homogeneity Test

Levene Statistics	df1	df2	Sig.
8,211	1	38	.07

Based on Table 2 results of the homogeneity test, the obtained mark significance is 0.07. Because this value is more than the level of significance 0.05, it can be concluded that the data between groups fulfil assumptions homogeneity variance, so that the variance between groups can be considered homogeneous. With fulfilment assumptions of normality and homogeneity, so can to be continued for analysis Pearson correlation.

Analysis correlation Pearson done to measure the direction and strength of the relationship between mathematical ability and problem-solving skills in Basic Physics 1. The results analysis correlation Pearson can be seen in Table 3.

Table 3. Analysis of Pearson Correlation

		Mathematical Ability (X)	Problem-Solving (Y)
Mathematical Ability (X)	Pearson Correlation	1	-.337
	Sig. (2-tailed)		.146
	N	20	20
Problem-Solving (Y)	Pearson Correlation	-.337	1
	Sig. (2-tailed)	.146	
	N	20	20

The analysis findings indicate that the Pearson correlation coefficient linking mathematics ability and problem-solving skills is $r = -0.337$. This value signifies a negative correlation with low correlation strength. The negative relationship suggests that enhancements in mathematics skills within this study sample did not correspond with advancements in problem-solving skills; instead, they exhibited a contrary trend. Nevertheless, the comparatively weak strength of the association shows that the connection between the two variables is not robust. This discovery contrasts with the majority of earlier research that indicates a positive correlation between mathematics skills and physics problem-solving skills. These variations in outcomes could be affected by several elements, including the traits of respondents, the size of the sample, the research tools employed, and the indicators of ability assessed (Pranata, 2024; Tong et al., 2024).

Additionally, the findings from the significance test indicated a Sig. (2-tailed) value of 0.146, exceeding the 0.05 significance threshold. Consequently, the connection between math skills and problem-solving skills is not statistically significant. This indicates that the data collected does not provide enough evidence to assert that the two variables exhibit a significant linear relationship within the population. The correlation found might still result from random fluctuations in the research sample (Tong et al., 2024).

A suspected factor affecting the negligible results is the relatively limited sample size, which comprised just 20 participants. In correlation analysis, the size of the sample greatly influences statistical power. Small samples often yield more variable estimates of correlation coefficients, raising

the likelihood of errors in statistical decision-making. Thus, even though a correlation coefficient of -0.337 was found, this outcome cannot serve as a solid foundation for characterising the relationship between the two variables in the broader population (Tong et al., 2024). Mathematically speaking, proficiency in mathematics is a skill that enhances effective problem-solving.

CONCLUSION

Based on research and data analysis that has been done, conclusions can be drawn as follows: Analysis of Pearson correlation yielded a correlation coefficient of -0.337 with a significance level of 0.146. Because the significance value is greater than 0.05, the null hypothesis was accepted, which means there was no significant connection between mathematical ability and problem-solving skills in Basic Physics 1 for first-semester students of the Science Education Study Program, STKIP Modern Ngawi. Although the direction of the correlation shows a negative characteristic and is classified as weak, the relationship is not significant in a statistical context in this study sample. This study shows that physics problem-solving ability is not only influenced by mathematical ability but may also be influenced by other factors such as understanding of physics concepts, learning motivation, metacognitive strategies, and independent study experience. Therefore, lecturers and educational institutions must consider more comprehensive learning methods and not only focus on the development of mathematical ability.

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