

Predictors of Physics Learning Outcomes: The Role of Prior Knowledge and Growth Mindset

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Abstract – Growth mindset plays an important role in facilitating students' understanding of physics concepts. This study aimed to examine the effects of prior knowledge and growth mindset on students' physics learning outcomes. A quantitative approach with a correlational research design was employed. The sample consisted of 36 students from the Physics Education Study Program at UIN Sunan Kalijaga who were enrolled in the Fundamental Physics course, selected using a saturated sampling technique. Data were collected using a growth mindset questionnaire, a prior test (pretest), and a physics learning outcomes test (posttest). The research instruments were validated and tested for reliability before use. Data were analyzed using descriptive and inferential statistics, including prerequisite tests, multiple linear regression, and Pearson correlation analysis. The results showed that prior knowledge and growth mindset jointly had a significant effect on physics learning outcomes, with an R value of 0.775 and an R^2 value of 0.600, indicating that the two variables explained 60% of the variance in learning outcomes. The ANOVA results confirmed that the regression model was statistically significant ($F = 24.787$, $p < 0.001$). Partially, prior knowledge had a positive and significant effect on physics learning outcomes ($\beta = 0.689$, $p < 0.001$), whereas growth mindset had a negative but non-significant effect ($\beta = -0.414$, $p = 0.295$). These findings indicate that prior knowledge is the dominant factor influencing students' physics learning outcomes, whereas growth mindset serves as a complementary supporting factor. Therefore, instructional design should emphasize diagnostic assessment and the reinforcement of prerequisite knowledge before introducing new concepts. In addition, students' growth mindset should continue to be fostered to encourage reflective learning and strengthen their confidence in overcoming academic challenges.

Keywords: Physics; Learning Outcomes; Prior Knowledge; Growth Mindset.

INTRODUCTION

Physics, as a branch of science, emphasizes not only mastery of concepts but also the ability to understand natural phenomena scientifically. In the learning process, students are required to develop critical thinking, reasoning skills, and the ability to relate concepts to real-life contexts. However, in practice, physics learning often remains focused on the conventional delivery of material and provides limited opportunities for students to construct a deeper understanding. This condition affects students' physics learning outcomes, which remain suboptimal. This is reflected in their low conceptual understanding, difficulties in solving reasoning-based problems, and

limited ability to connect physics concepts with everyday life.

Low physics learning outcomes are influenced by various factors, both cognitive and non-cognitive. One important cognitive factor is prior knowledge. Prior knowledge refers to the information or learning experiences that students already possess before receiving new instruction, which serves as a foundation for constructing an understanding of more complex concepts. Students' prior knowledge in physics makes a substantial contribution to their learning outcomes (Wahyudhi, 2020). However, insufficient prior knowledge, whether among students or teachers, may lead students to perceive physics as a difficult and

confusing subject, thereby making the material more difficult to understand (Bura et al., 2022). Therefore, adequate prior knowledge is essential to support optimal learning outcomes. In addition, the alignment between students' prior knowledge and the new knowledge acquired during instruction can facilitate the learning process and enhance conceptual understanding (Harso et al., 2021). This prior knowledge serves as an essential factor in the meaning-making process during learning.

In constructivist theory, learning occurs when students connect new information with their existing knowledge structures. Students with sufficient prior knowledge are more likely to understand the lesson easily, whereas those with limited prior knowledge may struggle to connect concepts and require more time to learn (Ummah & Oktova, 2024). Students who lack sufficient prior knowledge will experience difficulties in understanding and applying new knowledge, as they do not have a foundation for connecting newly learned concepts (Hasanuddin, 2020). Students' initial ability is highly important because it can enhance the efficiency of the learning process and improve learning outcomes. By possessing initial ability, students already have the basic knowledge required to participate in lessons, making it easier for them to understand the materials and concepts taught by the teacher (Rahmadani et al., 2022). On the other hand, educators need to identify students' initial abilities in order to design an appropriate learning process.

However, the presence of prior knowledge does not always guarantee optimal learning success. In some cases, inaccurate prior knowledge or prior knowledge containing misconceptions may instead hinder the learning process.

Moreover, the effectiveness of prior knowledge largely depends on how it is activated and utilized during instruction. This indicates that, although prior knowledge is an important factor, its influence on learning outcomes is complex and does not operate independently.

In addition to cognitive factors, non-cognitive factors also make a significant contribution to learning outcomes, one of which is mindset. The concept of a growth mindset emphasizes that intellectual ability is not fixed, but can develop through effort, practice, and appropriate learning strategies. Individuals with a growth mindset believe that personal abilities, such as intelligence, can continue to be improved through learning processes and experiences, and are therefore not limited to their initial abilities (McClendon et al., 2017; Sahagun et al., 2021). Students with a growth mindset tend to demonstrate high learning motivation, greater persistence in facing difficulties, and resilience when experiencing failure. They view failure as part of the learning process that encourages self-improvement, as they believe that effort plays an important role in achieving success (Rahmania & Utami, 2024; Rhew et al., 2018). Furthermore, individuals with a growth mindset believe that the limits of a person's abilities cannot be predicted, because with enthusiasm, hard work, and consistent practice, one can achieve outcomes beyond what was initially imagined (Megawanti, 2022; Sabriyani et al., 2025). Therefore, students need to possess a growth mindset as an essential asset in the learning process.

In the context of physics learning, which is known to be complex and challenging, the presence of a growth mindset is highly important. Students are not only required to understand abstract concepts but also to solve problems that demand perseverance and effective thinking

strategies. Therefore, a growth mindset serves as a psychological factor that encourages students to optimize their cognitive abilities, including the effective use of prior knowledge. The relationship among growth mindset, prior knowledge, and motivation indicates that these three factors play an important role in determining students' learning success (Ng, 2018). Overall, a growth mindset helps students develop their potential, increase learning engagement, and continuously promote better academic achievement (Harapan, 2025; Zeeb et al., 2020). Thus, a growth mindset is an important factor in learning physics concepts.

Although various studies have shown that prior knowledge and growth mindset individually influence learning outcomes, studies that integrate these two variables as predictors of physics learning outcomes remain relatively limited. Theoretically, these two variables complement each other: prior knowledge serves as a cognitive foundation for understanding new concept, whereas growth mindset functions as a non-cognitive factor that supports persistence, confidence, students' responses to learning challenges, and influences how students utilize their potential. The lack of integration of these two factors in research may lead to a less comprehensive understanding of the factors that affect physics learning outcomes. This study addresses this research gap by examining prior knowledge as a cognitive factor and growth mindset as a non-cognitive factor within a correlation model.

Therefore, this study is expected to provide a more comprehensive overview of the factors influencing students' learning success and to serve as a basis for developing instructional strategies that focus not only on cognitive aspects but also on students' psychological aspects. Thus, the findings of

this study are expected to contribute to efforts to improve the quality of physics learning in a more effective and sustainable manner.

RESEARCH METHODS

This study employed a quantitative approach with a correlational research design, aiming to analyze the relationships and effects among variables without providing any treatment. The variables in this study consisted of prior knowledge (X_1) and growth mindset (X_2) as independent variables, and physics learning outcomes as the dependent variable (Y). The research sample consisted of 36 students from the Physics Education Study Program at UIN Sunan Kalijaga who were enrolled in the Basic Physics course. The sample was determined using a saturated sampling technique, in which all members of the population were included as the research sample.

Data were collected through a questionnaire, an initial ability test (pretest), and a learning outcomes test (posttest). The questionnaire was used to measure students' growth mindset using a Likert scale. The initial ability test (pretest) was used to measure students' prior knowledge before instruction, whereas the final test (posttest) was used to measure physics learning outcomes after the learning process. The questionnaire and test instruments were first tested for validity and reliability to ensure their feasibility as measurement tools.

The data obtained were analyzed using descriptive and inferential statistics. Descriptive analysis was used to describe the characteristics of the data, while inferential analysis began with prerequisite tests, including tests of normality, linearity, multicollinearity, and heteroscedasticity. Furthermore, multiple linear regression analysis was used to determine the effect of

prior knowledge and growth mindset on physics learning outcomes. In addition, Pearson correlation analysis was used as a supporting analysis to examine the relationships among variables.

RESULTS AND DISCUSSION

Results

Table 1. Results of the Descriptive Statistical Test

Variable	Mean	N
Posttest	43.0278	36
Growth Mindset	78.2128	36
Pretest	48.8542	36

Based on the results of data analysis, the descriptive statistics showed that the students' mean posttest score was 43.03, indicating considerable variation in learning outcomes. Meanwhile, the mean growth mindset score was 78.21, suggesting that most students had a relatively good and homogeneous level of growth mindset. In addition, the pretest score, as an indicator of prior knowledge, had a mean of 48.85, indicating substantial differences in students' initial abilities.

Table 2. Results of the Linear Regression Test

Model	R	R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
1	.775 ^a	.600	17.10345	.600	24.787	2	33	.000

a. Predictors: (Constant), Pretest, Growth_Mindset
 b. Dependent Variable: Posttest

Furthermore, the results of the regression analysis showed that the R value of 0.775 indicated a strong relationship between prior knowledge and growth mindset and learning outcomes. The R Square value of 0.600 indicated that 60% of

the variation in physics learning outcomes could be explained by these two variables, while the remaining variation was influenced by other factors outside the scope of this study. Subsequently, further testing was conducted.

Table 3. Results of the ANOVA Test

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	14501.549	2	7250.774	24.787	.000 ^b
Residual	9653.423	33	292.528		
Total	24154.972	35			

a. Dependent Variable: Posttest
 b. Predictors: (Constant), Pretest, Growth Mindset

The ANOVA test results also showed that the regression model was simultaneously significant, with an F value of 24.787 and a significance value of 0.000.

Therefore, it can be concluded that prior knowledge and growth mindset jointly influence physics learning outcomes.

Table 4. Results of the Partial Test

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	41.743	30.351		1.375	.178
Growth_Mindset	-.414	.389	-.118	-1.064	.295
Pretest	.689	.098	.780	7.037	.000

a. Dependent Variable: Posttest

However, based on the partial test, only prior knowledge had a positive and significant effect on learning outcomes, with a coefficient value of 0.689 and a significance value of 0.000. Meanwhile, growth mindset had a negative but non-significant effect, with a coefficient value of -0.414 and a significance value of 0.295. This indicates that prior knowledge is the most dominant factor in determining physics learning outcomes, whereas growth mindset does not have a direct effect. Nevertheless, simultaneously, the two variables still make a substantial contribution to students' learning outcomes.

Discussion

The results of the study showed that prior knowledge and growth mindset simultaneously made a significant contribution to students' physics learning outcomes. This is indicated by the coefficient of determination (R Square) of 0.600, suggesting that the two variables were able to explain 60% of the variation in students' learning outcomes. This finding confirms that learning success is influenced not only by cognitive aspects but also by psychological factors that support the overall learning process.

Partially, prior knowledge was proven to have a positive and significant effect on physics learning outcomes. This indicates that students with a strong knowledge foundation are more likely to understand new concepts, particularly in physics learning, which is abstract in nature and requires higher-order thinking skills. Prior knowledge serves as a foundation for connecting new information with students' existing cognitive structures. This finding is consistent with previous research stating that the level of prior knowledge directly affects students' physics learning outcomes (Ummah & Oktova, 2024). In addition, prior

knowledge also contributes to improving problem-solving abilities and fostering a deeper conceptual understanding of physics (Rufaida & Sujiono, 2013). Thus, the better the students' prior knowledge, the greater their opportunity to achieve optimal learning outcomes.

On the other hand, growth mindset in this study did not show a significant direct effect on learning outcomes. This finding indicates that, although students believe that abilities can be developed through effort, such beliefs do not necessarily lead directly to improved academic achievement. Dweck (2021) raised an important point that, in certain contexts, individuals may believe that they have a growth mindset, while in fact they may still be trapped in a fixed mindset. This perspective is relevant to the findings of the study. Student may perceive themselves as having a growth mindset in learning basic physics, but their actual responses to learning challenges, mistakes, or academic difficulties may still reflect fixed mindset tendencies. In line with this argument, Zhang & He (2024) reported a discrepancy between self-reported growth mindset and actual classroom practices. This finding supports the view that research on growth mindset should not rely solely on survey-based measures. Therefore, the use of a self-report questionnaire to measure growth mindset may be considered one of the limitations of the study.

Demirdöğen & Lewis (2023) also explained that some students may believe they are able to adapt to challenges during the learning process, but they may not necessarily adapt effectively in practice. Conversely, students with higher prior knowledge may not feel a strong need to adjust their learning strategies because they already possess the foundational knowledge required to succeed. This explanation may be relevant to the study. Student enrolled in

a basic physics course may already have a certain level of interest in physics and adequate prior knowledge, which could make them feel capable of following the course. As a result, growth mindset may not emerge as a significant predictor of physics learning outcomes in this context.

In the context of physics learning, which is known to be complex and requires deep conceptual understanding, limited prior knowledge may become a major obstacle for students. This condition makes it difficult for students to understand the material; therefore, even if they have a positive mindset, their learning outcomes may not necessarily be optimal. In other words, a growth mindset alone is not sufficient without adequate cognitive readiness. Therefore, prior knowledge remains a more dominant factor than growth mindset in determining physics learning outcomes.

Nevertheless, the role of growth mindset remains important in supporting the learning process. A growth mindset helps students develop positive attitudes toward learning, increase motivation, and encourage active engagement in the learning process. Previous studies have shown that growth mindset interventions have a moderate impact on improving academic performance and are more effective under certain conditions (Pambudi, 2025). Growth mindset does not always influence academic outcomes without the support of other factors, however it is associated with increased persistence in learning (Fitri et al., 2022). This means that growth mindset remains an important factor in students' success in learning complex physics concepts. Therefore, the integration of strengthening prior knowledge and developing a growth mindset becomes an important strategy for improving the quality of physics learning.

Overall, the findings of this study confirm that prior knowledge is the main factor that directly influences physics learning outcomes, whereas growth mindset serves as a supporting factor that strengthens the learning process. Therefore, efforts to improve students' learning outcomes should focus on strengthening students' basic understanding while also developing a positive mindset in order to create a more optimal and sustainable learning process.

CONCLUSION

Based on the findings of this study, it can be concluded that prior knowledge and growth mindset simultaneously have a significant effect on students' physics learning outcomes. This indicates that success in learning physics is not only determined by cognitive aspects but is also influenced by psychological factors that support the learning process. The coefficient of determination of 0.600 shows that prior knowledge and growth mindset explain 60% of the variation in physics learning outcomes, while the remaining variation is influenced by other factors outside the scope of this study.

Partially, prior knowledge was proven to have a positive and significant effect on physics learning outcomes. Thus, students with better prior knowledge tend to understand physics concepts more easily and achieve more optimal learning outcomes. Prior knowledge serves as a cognitive foundation that helps students connect new information with their existing knowledge structures.

Meanwhile, growth mindset did not show a significant direct effect on physics learning outcomes. Nevertheless, growth mindset remains important as a supporting factor in the learning process, particularly in fostering students' motivation, perseverance, and positive attitudes in facing

learning difficulties. Therefore, efforts to improve physics learning outcomes should be carried out by strengthening students' prior knowledge while also developing their growth mindset so that the learning process becomes more effective, optimal, and sustainable. Future research is needed to confirm the finding of this study, particularly by involving larger samples, broader research settings, and more varied data collection methods.

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[8425](#)

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