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Learning Styles and Self-Efficacy as Predictors of Biology Education Students' Learning Experiences

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Abstract

This study aims to analyze the influence of learning styles and self-efficacy on the learning experiences of students in the Biology Education Study Program. The background of this research is based on the importance of understanding the variation in individual characteristics in the learning process, as different learning styles can influence how students receive, process, and remember information. Meanwhile, self-efficacy serves as an internal factor that determines students' belief in their ability to effectively complete academic tasks. This research uses an associative quantitative approach with the Partial Least Squares (SmartPLS) method to analyze the relationships between variables. Data was collected by distributing a Likert-scale questionnaire to Biology Education students. The research results show that all indicators have outer loading values above 0.70, thus meeting the criteria for convergent validity and construct reliability. Evaluation of the structural model (inner model) shows that learning style has a positive and significant effect on learning experience (t = 4.560; p = 0.000), and self-efficacy also has a positive and significant effect on learning experience (t = 7.375; p = 0.000). This indicates that students with a suitable learning style and high self-efficacy have a more positive and meaningful learning experience. These findings confirm the importance of the role of lecturers in designing learning strategies that are adaptive to students' learning styles and in promoting self-efficacy to improve overall student engagement and learning outcomes.

Keywords: learning style; self-efficacy; learning experience; biology education; SmartPLS.

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Introduction

Higher education is crucial for producing Human Resources (HR) that are not only talented but also adaptable to technological and scientific advancements. All these needs translate into the need for independent learning, critical thinking, and adapting to the complex learning dynamics in higher education (Mulyani & Haliza, 2021). In the Biology Education study program, this issue is becoming increasingly apparent because learning is increasingly emphasizing the mastery of abstract theoretical concepts and laboratory practical skills, the ability to analyze scientific data, and the application of knowledge in real-world situations. This complexity demands an ideal and in-depth learning experience for students (Mutia et al., 2023)

The interaction of various internal and external elements affects students' success in learning. Learning styles have long been the focus of empirical research as an important internal component (Arif et al., 2022). The VARK theory by Fleming and Mills divides learning styles into five main categories: visual, auditory, reading/writing, kinesthetic, and multimodal. Previous studies, such as those conducted by, have shown that visual and kinesthetic learning enhances students' understanding of cell biology concepts. (Virany et al., 2021) found similar results, concluding that the alignment between teachers' and students' learning styles can increase engagement and memory retention in learning.

Self-efficacy is another important internal component that has been supported by numerous studies (Supriyatin & Masanggeni, 2022). Self-efficacy is a person's belief in their ability to regulate and perform the actions necessary to achieve a specific level of performance. When facing difficulties, highly effective students tend to show more perseverance, persistence, and intrinsic motivation (Fatima et al., 2021). A study conducted by found that academic self-efficacy is an important factor indicating students' academic resilience and academic achievement. A biology study found that high self-efficacy increases students' success in practical work.

But after reviewing previous research, we found some research gaps. First, previous research typically examined learning styles and self-efficacy separately from cognitive learning outcomes, such as grades or GPA (Kumalasari & Kasidi, 2021). However, learning experiences are rarely considered dependent variables because they encompass affective, psychomotor, and meaning-making aspects (Ami & Yanti, 2024). Second, there is not much research that specifically investigates the relationship between learning styles and self-efficacy in shaping learning experiences. This is especially true for Biology Education study programs, which have many practical and theoretical features (Rahim & Fadhilah, 2022). Third, the analysis methods used are often too conventional and do not comprehensively model the relationships between latent variables (Asfahani, 2023).

As a result, this study aims to fill that gap. The objective of this research is to examine how learning styles and self-efficacy influence the learning experiences of students in the Biology Education program, both partially and simultaneously. To achieve this goal, this study uses the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach, assisted by SmartPLS software. This approach was chosen for its ability to perform predictive analysis and model complex latent variables, such as learning styles, self-efficacy, and learning experiences.

The expected contributions of this research are twofold. Theoretically, it is hoped that the results of this research will add to the knowledge in the field of educational psychology and science pedagogy, especially by providing empirical evidence on how students' internal factors shape their broad learning experiences. Practically, the results of this research can be used as a basis for developing more unique and student-characteristic-based learning strategies. They can also be used as a reference for designing pedagogical interventions aimed at improving the quality of learning in higher education institutions, particularly in the Biology Education study program.

Method

This research uses an associative quantitative approach because the researcher does not manipulate the variables, but rather analyzes the relationships and influences between variables that have occurred naturally (Wahyuni & Rindrayani, 2025). The population in this study is students from the Biology Education Study Program. The research sample was determined using a purposive sampling technique with the criteria of active first-semester students who had taken practicum and project-based learning courses. The sample size used was 88 respondents (Subhaktiyasa, 2024). The research instrument used in this study is a Likert scale, which serves as a measurement tool to obtain quantitative data regarding students' perceptions and attitudes toward the research variables: learning style, self-efficacy, and learning experience. The Likert scale is a commonly used form of psychometric scale in social and educational research to measure respondents' level of agreement with the statements presented (Wulan et al., 2024)

Table 1. Scoring Guidelines Description

Score	Description
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

1. The Learning Style variable (X_1) is measured using indicators adapted from the learning style model, including visual, auditory, reading/writing, kinesthetic, and multimodal dimensions.
2. The Self-Efficacy variable (X_2) is measured using indicators that include Time Management, Material Comprehension, Independent Learning, Method Adaptation, and Academic Achievement
3. The Learning Experience variable (Y) is measured through cognitive indicators, increased self-confidence, and learning motivation, which reflect the quality of students' experiences during the learning process.

Data analysis was conducted using SmartPLS version 4.0, which consists of two main stages:

1. Measurement Model (Outer Model) Evaluation to test convergent validity, discriminant validity, and construct reliability. Convergent validity criteria are met if the outer loading value is > 0.70 and the Average Variance Extracted (AVE) value is > 0.50. A construct is considered reliable if the Composite Reliability (CR) is > 0.70 (Bhakti et al., 2025)

Structural Model (Inner Model) Evaluation to assess the strength of relationships between variables through the R-square (R^2), path coefficient, and t-statistic values obtained from the bootstrapping process. The significance level was set at a 95% confidence level (p-value < 0.05) (Sofyani & Survei, 2025).

Results and Discussion

The results of this study illustrate a significant relationship between learning styles, self-efficacy, and the learning experiences of students in the Biology Education Study Program. Data analysis was conducted using Partial Least Squares (SmartPLS version 4.0) to test the validity, reliability, and strength of the relationships between variables.

1. Measurement Model Evaluation (Outer Model) The purpose of evaluating the measurement model or outer model is to assess the extent to which the indicators used are able to represent the latent constructs measured in the research model. In research based on Partial Least Squares Structural Equation Modeling (PLS-SEM).

Table 2. Cross Loading

Variable	Self-Efficacy	Learning Style	Learning Experience
ED1	0,790		
ED2	0,891		
ED3	0,760		
ED4	0,902		
ED5	0,818		
ED6	0,903		
ED7	0,948		
ED8	0,904		
ED9	0,900		
ED10	0,900		
GB1		0,837	
GB2		0,807	
GB3		0,863	
GB4		0,788	
GB5		0,897	

Variable	Self-Efficacy	Learning Style	Learning Experience
GB6		0,874	
GB7		0,826	
GB8		0,805	
GB9		0,932	
GB10		0,856	
HB1			0,822
HB2			0,859
HB3			0,702
HB4			0,887
HB5			0,872

The analysis results show that all indicators for the learning style, self-efficacy, and learning experience variables have Cross-loading values above 0.70, which means that each indicator is able to optimally represent the latent construct. These values indicate a strong and significant relationship between each indicator and its construct, so these indicators can be considered valid in measuring the concept.

Table 3. Nilai AVE

Variable	Composite Reliability	Average Variance Extracted (AVE)
Self-Efficacy	0,970	0,763
Learning Style	0,963	0,721
Learning Experience	0,917	0,690

The Average Variance Extracted (AVE) values for each construct are in the range of 0.690–0.763, which means the constructs have an adequate ability to explain the variance of the indicators. The Composite Reliability (CR) values ranged from 0.917 to 0.970, indicating excellent levels of reliability (Hair & Alamer, 2022).

2. Evaluation of the Structural Model (Inner Model)

The evaluation of the structural model (inner model) aims to assess the causal relationships between latent constructs and test the extent to which the developed theoretical model has predictive ability for endogenous variables. This stage includes testing the R-square (R^2) value, path coefficients, t-statistic values, and p-values.

Table 4. R Square

Variabel	R Square
Learning Experience	0,925

The R-squared value (R^2) for the learning experience variable is 0.925, indicating that 92% of the variability in learning experience can be explained by learning style and self-efficacy, while the remaining 8% is influenced by other unstudied variables (Nurhalizah & Kholijah, 2023).

Table 5. Path Coefficient

Variable	T Statistics	P Values
Self-Efficacy -> Learning Experience	7,375	0,000
Learning Style -> Learning Experience	4,560	0,000

The results of the path coefficient testing show that:

- Learning Style has a positive and significant effect on Learning Experience (t = 4.560; p = 0.000).
- Self-efficacy has a positive and significant influence on Learning Experience (t = 7.375; p = 0.000).

The results of this study indicate that both independent variables, namely learning style and self-efficacy, have a positive and significant influence on the learning experience of Biology Education students. This finding confirms that students' success in gaining meaningful learning experiences is not solely determined by cognitive ability, but also by the alignment of their learning styles and their self-belief in their academic capabilities

1. The Influence of Learning Styles on Learning Experiences The analysis results indicate that learning styles have a positive and significant influence on students' learning experiences (t = 4.560; p = 0.000).
   This suggests that the more closely students' learning styles align with the teaching strategies used, the higher the quality of their learning experiences.
   In the context of Biology Education, students with visual and kinesthetic learning styles tend to be more effective in understanding material through practical activities, field observations, or laboratory simulations. Conversely, students with an auditory learning style benefit more from verbal explanations and group discussions. Thus, lecturers are expected to be able to apply diverse and interactive learning strategies to accommodate various student learning styles, making the learning experience more meaningful and in-depth.
2. The Influence of Self-Efficacy on Learning Experience Self-efficacy has also been proven to have a positive and significant influence on students' learning experiences (t = 7.375; p = 0.000). This indicates that students with high levels of self-efficacy are more capable of managing the learning process, facing academic challenges, and maintaining motivation in achieving learning goals. In the context of biology learning, which requires scientific thinking skills, practical skills, and critical analysis, students with high self-efficacy tend to show strong confidence in conducting experiments, compiling observation reports, and actively participating in scientific discussions

The research findings indicate that learning styles and self-efficacy significantly contribute to the learning experiences of Biology Education students. This relationship can be explained through several theoretical foundations of educational psychology and contemporary learning (Karimah et al., 2025)

How learning styles influence the learning experience is explained by cognitive learning theory, or cognitive learning theory. This theory emphasizes that processing information according to an individual's cognitive preferences allows for a more effective learning process (Hafidz et al., 2022). If the learning strategy aligns with information processing preferences such as kinesthetic, visual, or auditory, students will be better able to develop strong mental representations. Although the topics are abstract and visible, such as anatomy, cell structure, and ecosystems, they influence

how students understand and internalize the material in biology education (Kumar et al., 2025) . Kolb's theory of experiential learning, which states that students "experience" learning in ways they prefer, such as laboratory practice, simulations, or reflective discussions, also supports this (Rahmawati et al., 2024)

However, social cognitive theory can help us understand the influence of self-efficacy on learning experiences. A person's belief in their ability to complete specific tasks is influenced by their self-efficacy, which in turn affects their choices regarding behavior, effort, persistence, and responses to challenges (Baherimoghadam et al., 2021). Students with high self-efficacy are more likely to have better self-control, a more complex learning approach, and be more resilient to academic challenges (Rupa et al., 2024). Self-efficacy serves as a psychological driver in biology learning, which demands an understanding of experiments, data analysis, and scientific reasoning. This encourages students to actively try, experiment, and not give up easily when lab results don't meet expectations (Putri et al., 2022)

Constructivist Learning Theory views learning experiences as the product of meaning construction based on the interaction between internal factors (such as self-efficacy and motivation) and external factors (such as teaching methods and classroom environment) (Khoiriyah, 2024). This aligns with the simultaneous relationship between both variables and the learning experience. Students are more capable of gaining a significant and in-depth understanding when learning styles are well-matched, and they have strong self-confidence (Wulandari et al., 2023)

With a high R-squared value (0.925), it can be concluded that learning styles and self-efficacy are the main components that shape students' learning experiences. This indicates that pedagogical interventions should not only focus on delivering material, but also on changing teaching strategies and providing psychological reinforcement for students. In other words, to provide an exceptional learning experience, different pedagogical approaches must be used together to boost students' academic self-confidence (Abdillah et al., 2025)

This finding reinforces the understanding that students' learning experiences depend not only on their cognitive abilities but also on their self-perception as students and how they interact with their learning environment. This multi-theoretical method allows for the creation of more humanistic, individual, and interactive biological learning models. This model combines self-confidence and learning preferences as the foundation for academic success (Musalimah, 2023).

Conclusion

The results of this study empirically show that learning styles and self-efficacy have a positive and significant influence on the learning experiences of students in the Biology Education Study Program. Both variables play an important role in shaping the quality of student engagement during the learning process, including cognitive, affective, and motivational aspects. Learning styles that align with individual characteristics have been proven to increase learning effectiveness, as students can more easily understand and internalize material through approaches that suit their preferences. In the context of biology education, the application of various learning approaches, such as visual, auditory, kinesthetic, and multimodal, has proven to enrich the learning experience, especially in practical activities, experiments, and scientific problem-solving.

Meanwhile, self-efficacy has a more dominant contribution to learning experiences compared to learning styles. Students with high self-efficacy demonstrate strong confidence in facing academic difficulties, are able to independently manage their learning strategies, and show perseverance in achieving their academic goals. This strengthens Bandura's (1997) theory that self-efficacy functions as an internal motivational factor that encourages individuals to behave proactively in the learning process. Overall, this research confirms that improving the quality of students' learning experiences cannot be separated from understanding variations in learning

styles and strengthening self-efficacy. Therefore, educators are expected to design adaptive and reflective learning strategies, taking into account student characteristics and providing support that can foster self-confidence and independent learning. This kind of approach is expected to create a more effective, interactive, and holistic learning process that focuses on developing students' potential.

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