Journal of Innovative Physics Teaching
Volume 4, Issue 2 Desember 2026, 164 – 177
ISSN: 3021-8551 (Online)
Doi: https://doi.org/10.24036/jipt/vol4-iss2/169
https://jipt.ppj.unp.ac.id/index.php/jipt

Identification and Analysis of Factors Contributing to Senior High School Students' Lack of Interest in Learning Physics: A Structural Equation Modeling

Winda Afriani[1], Pakhrur Razi[2*], Desnita[3], Dea Stivani Suherman[4]
[1,2,3,4] Department of Physics, Universitas Negeri Padang, Padang, Indonesia.

Article Info

Article history:

Received July 02, 2026
Revised July 18, 2026
Accepted July 27, 2026

Keywords:

Identification of Factor
Analysis of Factor
Learning Interest
Structural Equation Modeling

ABSTRACT

Interest in learning physics plays an important role in students' academic success and their motivation to pursue further education in science-related fields. However, many senior high school students still show low engagement in physics learning, making it necessary to examine the factors that influence this condition. This study aimed to analyze the effects of internal and external factors on students' interest in physics and their intention to continue higher education in physics-related disciplines. A quantitative research design was applied using the PLS-SEM approach. The participants consisted of 300 eleventh-grade science students from various senior high schools and Islamic senior high schools in West Sumatra, Indonesia, selected through proportionate stratified random sampling. Data were collected using a validated five-point Likert-scale questionnaire with good reliability and analyzed using SmartPLS4.0. The results showed that both internal and external factors significantly influenced students' interest in physics, with external factors having a stronger effect. In addition, students' interest significantly affected their intention to pursue higher education in physics-related fields. The model demonstrated strong explanatory power with R^2 *values of 0.852 for interest and 0.804 for intention. These findings highlight the importance of supportive learning environments, effective teaching strategies, and self-efficacy in improving physics learning interest.*

***Correspondence:**
Pakhrur Razi, Department of Physics, Universitas Negeri Padang, Padang, Indonesia.
email: fhrrazi@fmipa.unp.ac.id

INTRODUCTION

Physics is a key area of natural science that examines matter, energy, and the forces that control natural occurrences. Fundamentals of Physics articulates that physics offers the conceptual groundwork for comprehending the physical universe and underpins scientific and technological progress (Halliday et al., 2021). In educational settings, the goal of learning physics is to enhance not just students' conceptual comprehension but also to cultivate scientific reasoning, critical thinking, analytical problem-solving, and creativity, all of which are vital skills for lifelong learning. contends that successful physics education must allow students to scientifically clarify natural events, tackle real-world issues, and utilize scientific ideas in daily scenarios (Unsworth et al., 2022). These skills correspond with the requirements of twenty-first-century education, highlighting scientific literacy, critical thinking, and innovation as vital abilities for adjusting to swift advancements in science and technology (Mohammed & Ozdamli., 2024).

Low interest in learning physics negatively affects students' academic performance and contributes to weak scientific literacy. The OECD reports that Indonesian students' scientific literacy remains below the OECD average, indicating difficulties in understanding and applying scientific concepts in real-life situations. This condition may reduce students' motivation to learn physics. Scientific literacy not only involves understanding scientific concepts but also the ability to use scientific evidence to explain phenomena and make informed decisions (Limiansih et al., 2025). Emphasizes that science education should develop scientific reasoning skills and connect concepts to real-life contexts in order to enhance students' interest and engagement in learning science (Zulaika et al., 2025).

Interest in learning is a crucial emotional element that boosts students' engagement in the educational experience. The Four-Phase Model of Interest Development describes how interest evolves over time through the interplay of students' traits and their educational experiences (Hidi & Renninger., 2006). Students who exhibit strong learning interest generally show increased focus, engagement, and perseverance, leading to better learning results. Interest in learning is shaped by internal elements like motivation, self-efficacy, and readiness, along with external elements such as the learning environment, instructional methods, teacher assistance, technology, and educational resources (Hidi & Renninger., 2006). Consequently, an encouraging educational atmosphere is essential to satisfy students' psychological requirements and maintain their motivation and involvement in learning tasks.

The self-efficacy theory posits that individuals' belief in their capacity to strategize and execute actions required for accomplishing specific tasks influences their thoughts, motivation, and behaviours in achieving desired outcomes (Bhati & Sethy., 2022). In learning settings, self-efficacy greatly affects students' engagement in educational tasks. Students who possess high self-efficacy are generally more confident, resilient in overcoming academic obstacles, and engaged in finishing educational assignments. In contrast, students who possess low self-efficacy tend to shy away from difficult academic tasks. Due to the necessity of conceptual understanding and advanced problem-solving abilities in physics education, self-efficacy emerges as a vital element in fostering students' interest in learning and participation in the classroom (Bandura et al., 2022).

Past studies show that the examination of high school students' interest in studying physics is still restricted in both analytical rigor and methodological techniques. Numerous earlier studies have mainly linked students' minimal interest in physics to conventional, teacher-focused, and less contextualized teaching approaches, ignoring the connection between learning interest and students' cognitive traits (Wahyuni et al., 2021). Despite evidence showing that experiential learning boosts student motivation and engagement, much of the data comes from particular educational settings, restricting the broad applicability of the results (Dheafriska & Nofiana., 2023). Moreover, research concerning the Independent Curriculum has primarily centered on teacher preparedness and curriculum execution instead of directly investigating students' excitement for learning physics (Fatonah et al., 2020). Moreover, empirical research demonstrates inconsistent connections among essential variables in physics education, suggesting that the elements influencing students' engagement in learning physics are intricate and necessitate a more extensive analytical framework to explore the interactions between teaching methods, cognitive traits, motivation, and learning interest within the application of the Independent curriculum.

Based on educational assessment information from West Sumatra Province (Center for Educational Assessment., 2025), the mean score for physics was merely 37.06. This score was significantly lower than those of other subjects, including Geography (70.92), Anthropology (69.10), and Arabic Language (67.65). Over 54% of students fell into the "poor" performance category, whereas only around 8.4% reached the "good" category. These outcomes correspond with the PISA 2022 Findings (OECD, 2023), indicating that Indonesian students' scientific literacy remains below the average for OECD nations. this situation indicates that numerous students continue to find it difficult to achieve a profound comprehension of scientific concepts and to utilize scientific knowledge successfully in practical situations.

Low interest in learning physics reduces students' engagement and negatively affects their academic achievement. It also influences students' career choices by decreasing their motivation to pursue physics-related professions and continue higher education in science fields (Hidi & Ann Renninger., 2006). Over time, this condition may reduce the number of graduates entering STEM careers, limiting the availability of qualified professionals in these fields (Wong et al., 2022). This issue is increasingly important as advances in science and technology continue to increase the global demand for skilled STEM workers (Dheafriska & Nofiana., 2023). Therefore, improving students' interest in physics is essential to support academic development and ensure sustainable human resources in STEM fields.

In light of these research gaps, this study seeks to assess high school students' enthusiasm for learning physics and to investigate the effects of internal and external factors on their interest in learning. The research aims to determine the key factors that influence students' interest in studying physics. Additionally, it examines how learning interest influences students' motivation to seek higher education in physics through the SEM-PLS method (Hair et al., 2021). Incorporating these variables into an all-encompassing analytical framework, this research aims to enhance comprehension of the factors influencing students' interest in learning physics. The results are expected to provide empirical support for enhancing physics education and aid in creating effective methods to boost students' interest in physics and their goals of pursuing advanced education in physics and other STEM fields.

METHODS

This study utilized a quantitative research approach with the PLS-SEM. PLS-SEM was chosen because it is appropriate for analysing complex relationships among latent variables while simultaneously assessing measurement and structural models (Hair et al., 2021). Data analysis was conducted using Smart PLS 4.0 software to evaluate the proposed research model. The model consisted of four main constructs: internal factors, external factors, interest in learning physics, and students' intention to pursue higher education in physics-related fields. The PLS-SEM approach was used to examine direct and indirect relationships among constructs and determine the contribution of each variable. This method enabled the development of an empirical model that comprehensively explains the factors influencing high school students' interest in learning physics.

The research was conducted during the second semester of the 2025/2026 academic year at five senior high schools in West Sumatra Province, Indonesia. The participants consisted of 770 eleventh-grade science students from SMAN 1 Padang, SMAN 7 Padang, SMAN 1 Pariaman, SMAN 3 Painan, and SMAN 1 Solok Selatan. The minimum sample size was calculated using the Slovin formula, resulting in 263 participants (Ridwan et al., 2023). However, the sample size was increased to 300 students to improve the robustness and reliability of the PLS-SEM analysis. Participants were selected using proportionate stratified random sampling to ensure proportional representation from each school. The research process began after obtaining approval from the participating schools and establishing a structured data collection schedule.

Before the data collection process, the questionnaire was reviewed by experts to evaluate its content validity, accuracy, and suitability with the research objectives. The instrument was revised based on the experts' recommendations to improve the quality, clarity, and relevance of each questionnaire item. A pilot test was subsequently conducted to assess the reliability and comprehensibility of the instrument before it was applied in the main study. After completing the evaluation and refinement process, the finalized questionnaire was distributed to the selected respondents for data collection. The data were gathered using a structured questionnaire with a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Each questionnaire item was developed based on specific indicators representing the four research constructs, ensuring that the instrument accurately measured the variables examined in the study.

Positive statements were scored from 5 to 1 according to the respondents' level of agreement, while negative statements were scored in reverse order to maintain consistency. The instrument was further tested for validity and reliability to ensure accurate and consistent measurement results (Sugiyono & Lestari., 2021). Data analysis was performed using Smart PLS 4.0 through the PLS-SEM method. Descriptive statistics were used to describe participant characteristics and variable distributions, while the measurement model was evaluated through convergent validity, discriminant validity, and construct reliability. The structural model was assessed using R^2, f^2, Q^2, and bootstrapping analysis to examine explanatory and predictive capabilities (Hair et al., 2021). Hypotheses were accepted when the t-statistic value was greater than 1.96 and the p-value was below 0.05, indicating significant relationships among the studied constructs (Hair et al., 2021).

RESULTS AND DISCUSSION

Results

This study employed hypothesis testing using the PLS-SEM approach with the assistance of Smart PLS 4.0 software. PLS-SEM was selected because it enables the simultaneous analysis of complex relationships among latent constructs while requiring only minimal distributional assumptions (Hair et al., 2021) The method is also capable of providing reliable parameter estimates for both small and large sample sizes, making it suitable for the present study (Hair et al., 2021) Furthermore, PLS-SEM is recognized as an effective multivariate analytical technique for theory development and predictive research. It allows researchers to evaluate both linear and nonlinear relationships among theoretically established constructs (Wang et al., 2024). Accordingly, the first stage of the analysis involved evaluating the measurement model (outer model) to assess the reliability and validity of the measurement instruments before proceeding to the structural model analysis.

Path Diagram of the Research Model

The measurement model was evaluated to examine the validity and reliability of the indicators used in this study following the PLS-SEM approach. The assessment included convergent validity, discriminant validity, and internal consistency reliability to ensure that each construct was measured accurately and consistently. This evaluation was conducted before testing the structural model to verify that all constructs satisfied the required measurement standards. Only constructs that met the established validity and reliability criteria were retained for structural model analysis, and the research path diagram is presented in Figure 1 (Hair et al., 2021).

Figure 1. Path Diagram

Figure 1 illustrates the research model consisting of four latent constructs: Internal Factors (X1), External Factors (X2), Learning Interest (Y), and Interest in Continuing Education (Z). Internal Factors (X1) and External Factors (X2) act as exogenous constructs that influence Learning Interest (Y), while Learning Interest (Y) affects Interest in Continuing Study (Z) as a mediating construct. Each construct is measured through observed indicators, including nine indicators for X1, ten for X2, twelve for Y, and seven for Z. The path diagram represents the proposed relationships among constructs and provides the framework for evaluating the measurement and structural models using the PLS-SEM method.

Validity Test Results

Convergent validity was assessed to ascertain if the measurement indicators sufficiently depicted their corresponding latent constructs, relying on the outer loading values of each indicator and the Average Variance Extracted (AVE) for each construct. Indicators were deemed to exhibit acceptable convergent validity when the outer loading and AVE values satisfied the suggested threshold criteria (Hair et al., 2021). Figure 2 displays the results of the convergent validity evaluation based on the outer loading values for the constructs of Internal Factors, External Factors, Learning Interest, and Interest in Continuing Study.

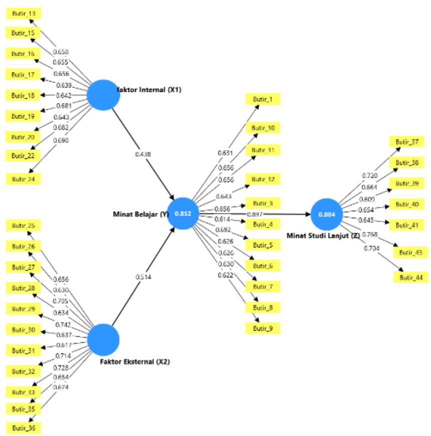

Figure 2. Outer Loadings

Figure 2 presents the outer loading values of each measurement indicator after the initial evaluation of the measurement model. Based on the minimum outer loading criterion of 0.60 (Hair et al., 2021), five indicators, including three from Internal Factors (X1), one from External Factors (X2), and one from Learning Interest (Y), were removed due to insufficient values. After eliminating these indicators, the remaining items showed outer loading values ranging from 0.609 to 0.897, indicating acceptable indicator reliability and convergent validity. The endogenous constructs also demonstrated strong explanatory power, with R^2 values of 0.852 for Learning Interest (Y) and 0.804 for Interest in Continuing Study (Z). Therefore, the revised measurement model fulfilled the criteria for convergent validity and was suitable for further analysis of discriminant validity, reliability, and the structural model using PLS-SEM.

Average Variance Extracted (AVE) was analyzed to further assess the convergent validity of the measurement model following the evaluation of the outer loading values. The AVE value indicates the extent to which the variance in the indicators can be attributed to their related latent construct. A construct is deemed to exhibit satisfactory convergent validity when its AVE value equals or surpasses the suggested threshold for exploratory research (Hair et al., 2021). Table 2 displays the AVE outcomes for all research constructs.

Table 2. Average Variance Extracted (AVE)

Variable	Average variance extracted (AVE)
Factor External (X2)	0.453
Factor Internal (X1)	0.438
Interests Study (Y)	0.412
Study Interests Carry on (Z)	0.466

According to the AVE values displayed in Table 2, every latent construct attained Average Variance Extracted (AVE) values exceeding 0.40, demonstrating that each construct satisfied the acceptable standard for convergent validity in exploratory studies (Hair et al., 2021). Of the four constructs, Interest in Pursuing Higher Education (Z) had the highest AVE value (0.466), with External Factors (X2) close behind (0.453), indicating that their indicators accounted for a comparatively greater share of the variance of the corresponding constructs. Despite Internal Factors (X1) (0.438) and Interest in Learning Physics (Y) (0.412) displaying relatively lower AVE values, they still fell within the acceptable range, suggesting the indicators sufficiently reflected their fundamental constructs. These results indicate that the measurement items utilized in this research displayed adequate convergent validity and effectively assessed the targeted latent variables reliably. Consequently, all constructs were regarded as suitable for the later evaluation of the structural model and hypothesis testing through the PLS-SEM method.

Discriminant validity was evaluated to determine whether each latent construct was empirically distinct from the other constructs in the measurement model. The assessment was performed using the Fornell–Larcker criterion, which compares the square root of the Average Variance Extracted (AVE) of each construct with its correlations with the other latent constructs. A construct was considered to exhibit adequate discriminant validity when the square root of its AVE exceeded the correlation coefficients with all other constructs in the model (Hair et al., 2021). The results of the discriminant validity assessment based on the Fornell–Larcker criterion for the constructs of Internal Factors, External Factors, Learning Interest, and Interest in Continuing Study are presented in Table 3.

Table 3. Fornell Larcker Criterion

Variable	Factor External (X2)	Interests Study (Y)	Study Interests Carry on (Z)	Factor Internal (X1)
Factor External (X2)	0.673			
Interests Study (Y)	0.899	0.642		
Study Interests Carry on (Z)	0.868	0.897	0.682	
Factor Internal (X1)	0.878	0.890	0.827	0.662

The findings shown in Table 3 reveal that the discriminant validity evaluation using the Fornell–Larcker criterion demonstrates that the measurement model has not completely met the suggested discriminant validity standards, as the square root of the Average Variance Extracted (AVE) for each construct was less than multiple correlations with other constructs (Hair et al., (2021). For instance, the correlations between External Factors and Learning Interest (0.899), Learning Interest and Interest in Continuing Study (0.897), and Internal Factors and External Factors (0.878) surpassed the relevant square root of the AVE values, indicating inadequate differentiation among the constructs. Despite the satisfactory outcomes of the assessments for convergent validity and reliability, these results suggest significant conceptual overlap among the latent constructs, indicating certain indicators might reflect comparable underlying phenomena. Consequently, further evaluations of discriminant validity, like the HTMT or a reassessment of the measurement indicators, are suggested prior to the definitive interpretation of the structural model.

An analysis of cross-loading was performed as a supplementary evaluation to confirm the discriminant validity of the measurement model after assessing the Fornell–Larcker criterion. The analysis assessed if each measurement indicator showed a greater loading on its intended latent construct than on other constructs, with indicators deemed to have satisfactory discriminant validity when their loading values consistently surpassed their cross-loadings across all other constructs (Hair et al., 2021). Table 4 displays the full cross-loading values for all measurement indicators that denote Internal Factors, External Factors, Learning Interest, and Interest in Continuing Study.

Table 4. Cross Loadings

Statement	Factor External (X2)	Interests Study (Y)	Study Interests Carry on (Z)	Factor Internal (X1)
Item 1	0.568	0.631	0.581	0.597
Item 10	0.594	0.656	0.582	0.608
Item 11	0.584	0.656	0.533	0.589
Item 12	0.580	0.643	0.620	0.611
Item 13	0.548	0.578	0.523	0.658
Item 15	0.621	0.617	0.577	0.655
Item 16	0.571	0.540	0.522	0.656
Item 17	0.589	0.601	0.586	0.639
Item 18	0.550	0.558	0.543	0.642
Item 19	0.512	0.536	0.459	0.681
Item 20	0.568	0.614	0.578	0.643
Item 22	0.588	0.594	0.522	0.682
Item 24	0.668	0.642	0.599	0.698
Item 25	0.656	0.630	0.587	0.604
Item 26	0.630	0.533	0.567	0.548
Item 27	0.705	0.585	0.599	0.632
Item 28	0.634	0.585	0.551	0.518
Item 29	0.742	0.671	0.690	0.628
Item 3	0.551	0.656	0.591	0.555
Item 30	0.637	0.555	0.494	0.575
Item 31	0.617	0.567	0.511	0.552
Item 32	0.714	0.667	0.657	0.634
Item 33	0.728	0.664	0.592	0.644
Item 35	0.654	0.567	0.537	0.569
Item 36	0.674	0.608	0.619	0.589

Item 37	0.574	0.633	0.720	0.533
Item 38	0.563	0.600	0.664	0.540
Item 39	0.633	0.603	0.609	0.645
Item 4	0.577	0.614	0.549	0.532
Item 40	0.530	0.580	0.654	0.506
Item 41	0.585	0.561	0.645	0.533
Item 43	0.665	0.682	0.768	0.647
Item 44	0.588	0.613	0.704	0.538
Item 5	0.640	0.692	0.611	0.632
Item 6	0.558	0.626	0.535	0.519
Item 7	0.577	0.626	0.574	0.532
Item 8	0.527	0.630	0.525	0.536
Item_9	0.579	0.622	0.612	0.554

The cross-loading results shown in Table 4 reveal that each measurement indicator demonstrated its peak loading on the latent construct it was designed to assess, thus reinforcing sufficient discriminant validity. This result shows that the indicators could differentiate their specific constructs from the other latent constructs present in the measurement model. For instance, the indicators of External Factors (X2), specifically Items 27 (0.705), 32 (0.714), and 33 (0.728), demonstrated greater loading values on their intended construct compared to the other constructs. Likewise, Item 43 for Interest in Continuing Study (Z) attained the top loading value (0.768), whereas Item 24 for Internal Factors (X1) noted the highest loading (0.698) on its respective construct. Despite various indicators showing moderate cross-loadings with other constructs, their highest loading values consistently stayed with the constructs they were intended to measure. Consequently, the cross-loading analysis demonstrates that the measurement model attained acceptable discriminant validity and was suitable for further structural model assessment via the PLS-SEM method.

Reliability Assessment Results

The results from the evaluations of Composite Reliability and Cronbach's alpha indicate that all constructs exceeded the recommended threshold of 0.70, thereby satisfying the reliability criteria and demonstrating sufficient internal consistency (Hair et al., 2021). As a result, all underlying constructs were considered reliable and suitable for additional analysis. Overall, the assessment of the measurement model (external model) confirmed that the proposed model satisfied the recognized criteria for convergent validity, discriminant validity, and internal consistency reliability. Therefore, the model was deemed appropriate for progressing to the evaluation of the structural model.

Table 5. Reliability of Composite Measures and Cronbach's Alpha

Variable	Cronbach's alpha	Composite reliability
Factor External (X2)	0.879	0.881
Interests Study (Y)	0.857	0.857
Study Interests Carry on (Z)	0.807	0.810
factor Internal (X1)	0.840	0.840

The reliability assessment presented in Table 5 indicates that each latent construct satisfied the recommended criteria for internal consistency reliability based on Cronbach's alpha and Composite Reliability values. Hair et al., (2021) assert that reliability is considered adequate when both coefficients exceed the minimum threshold of 0.70, indicating that the measurement indicators reliably represent their corresponding latent constructs. Among the four constructs, External Factors (X2) demonstrated the highest reliability, presenting a

Cronbach's alpha of 0.879 and a Composite Reliability of 0.881, whereas Learning Interest (Y), Internal Factors (X1), and Interest in Continuing Study (Z) achieved satisfactory reliability coefficients ranging from 0.807 to 0.857, all surpassing the recommended threshold. These findings indicate that the retained measurement indicators effectively evaluated their intended constructs and produced reliable data for subsequent statistical analyses. Overall, the results suggest that the measurement model satisfied the standards for internal consistency reliability, confirming the appropriateness of the outer measurement model and justifying further evaluation of the structural model.

Once it was established that the measurement model satisfied the criteria for validity and reliability, the structural model (inner model) was then assessed to evaluate the predictive power of the suggested research model. The initial phase of evaluating the structural model included analyzing the coefficient of determination (R^2), which shows the percentage of variance in endogenous constructs accounted for by their corresponding exogenous constructs. Hair et al. (2021) state that R^2 values of 0.75, 0.50, and 0.25 signify strong, moderate, and weak explanatory power, respectively, where higher values denote improved predictive accuracy, with R^2 values for the endogenous constructs of Learning Interest (Y) and Interest in Continuing Study (Z) detailed in Table 6.

Table 6. R Square

Variable Endogen	R-square	Category
Interests Study (Y)	0.852	Strong
Study Interests Carry on (Z)	0.804	Strong

The results show that the Learning Interest (Y) construct achieved an R^2 value of 0.852, indicating that 85.2% of the variance in learning interest was jointly explained by Internal Factors (X1) and External Factors (X2), while the remaining 14.8% was attributed to other variables not included in the research model. Similarly, the Further Study Interest (Z) construct obtained an R^2 value of 0.804, indicating that 80.4% of the variance in further study interest was explained by Learning Interest (Y), whereas the remaining 19.6% was influenced by factors outside the proposed model. Based on the criteria proposed by Hair et al., (2021), both endogenous constructs demonstrated substantial explanatory power, indicating that the structural model adequately explained the variance of the dependent variables.

After confirming the model's explanatory power through the R^2 values, the next step was to evaluate the path coefficients to determine the strength and direction of the hypothesized relationships among the constructs. In PLS-SEM, path coefficients represent the magnitude and direction of the relationships between latent constructs, where positive coefficients indicate positive relationships and larger absolute values reflect stronger effects (Hair et al., 2021). The results of the path coefficient analysis are presented in Table 7.

Table 7. Path Coefficients

Variable	Factor External (X2)	Factor Internal (X1)	Interests Study (Y)	Study Interests Carry on (Z)
Factor External (X2)			0.514	
Factor Internal (X1)			0.438	
Interests Study (Y)				0.897
Study Interests Carry on (Z)				

The path coefficient analysis revealed that all hypothesized relationships were positive. External Factors (X2) exerted the strongest influence on Learning Interest (Y) with a path coefficient of β = 0.514, followed by Internal Factors (X1) with β = 0.438. These findings indicate that both internal and external factors positively contribute to students' interest in learning physics, although external factors have a relatively stronger influence. Furthermore, Learning Interest (Y) exhibited a very strong positive effect on Further Study Interest (Z) with a path coefficient of β = 0.897, suggesting that students with greater interest in learning physics are more likely to pursue higher education in physics or other STEM-related disciplines. These findings are consistent with the high R^2 values obtained for the endogenous constructs, confirming that the proposed structural model possesses substantial explanatory power and meaningful predictive relationships among the variables.

Statistical Test Results

The significance of the structural relationships was evaluated using the bootstrapping technique within the PLS-SEM framework. Bootstrapping was performed to evaluate the importance of the proposed hypotheses by producing standard errors, t-statistics, and p-values for every structural path (Hair et al., 2021). This method provides a robust statistical basis for assessing the significance of the suggested connections between the latent constructs. The analysis was conducted at a significance level of 5%, a standard commonly often employed in research involving structural equation modeling. The outcomes of the bootstrapping analysis are clearly illustrated in Figure 4. These results established the basis for assessing the proposed research hypotheses comprehensively.

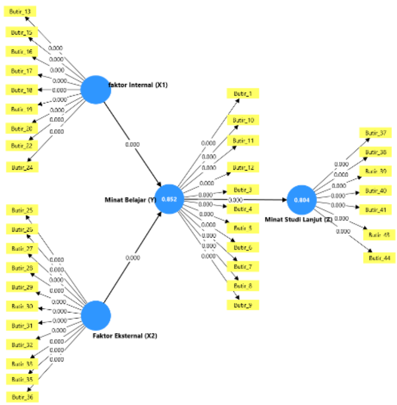

Figure 4. Bootstrapping

Hypothesis testing was performed utilizing the bootstrapping results following the significance standards suggested by Hair et al., (2021). A structural relationship was deemed significant if the t-statistic surpassed 1.96 and the p-value fell below 0.05. On the other hand, relationships with t-statistics under 1.96 and p-values above 0.05 were seen as statistically insignificant. Table 8 displays the outcomes of the hypothesis testing, summarizing the path coefficients, t-statistics, and p-values for each of the suggested relationships. These statistical measures offer proof concerning the direction and importance of every structural connection. Consequently, the results of the hypothesis testing were utilized to ascertain if each suggested hypothesis was validated.

The results of the hypothesis testing derived from the bootstrapping process offer empirical support for the importance of the structural connections among the suggested research constructs. The evaluation involved analyzing the path coefficients, t-statistics, and p-values derived from the PLS-SEM analysis to assess if each proposed relationship had statistical backing (Hair et al., 2021). Table 8 summarizes the outcomes of the hypothesis testing, showing the statistical assessment of each suggested path relationship.

Table 8. Bootstrapping Results

Variable	Original Sample (O)	Sample Mean (M)	Standard Deviation (SD)	T-Statistics	P-Values
Factor External (X2) -> Interests Study (Y)	0.514	0.517	0.068	7.575	0.000
Factor Internal (X1) -> Interests Study (Y)	0.438	0.436	0.067	6.507	0.000
Interests Study (Y) -> Interests Carry On	0.897	0.899	0.012	73.092	0.000

The bootstrapping outcomes displayed in Table 8 demonstrate that all suggested hypotheses (H1, H2, and H3) received statistical backing, evidenced by t-statistics exceeding 1.96 and p-values at 0.000, both of which fall below the 0.05 significance threshold. Every structural path showed positive path coefficients, validating that the associations between latent constructs were positive and aligned with the suggested conceptual framework. External Factors (X2) significantly positively impacted Learning Interest (Y) with a path coefficient of $\beta = 0.514$ and a t-statistic of 7.575, whereas Internal Factors (X1) also positively affected Learning Interest (Y) with a path coefficient of $\beta = 0.438$ and a t-statistic of 6.507, suggesting that both external conditions and students' internal traits enhance learning interest. Nonetheless, the elevated coefficient of External Factors (X2) indicates that external conditions, such as learning environments and instructional elements, play a more significant role than internal factors in accounting for differences in students' learning interest.

The most robust structural connection in the model was identified between Learning Interest (Y) and Interest in Continuing Study (Z), exhibiting a path coefficient of $\beta = 0.897$, a t-statistic of 73.092, and a p-value of 0.000, signifying a notably strong and significant positive relationship. This finding shows that students who possess greater interest in learning are more inclined to form stronger intentions to pursue their education further, especially in physics and associated STEM disciplines. In comparison to other structural relationships, this pathway demonstrated the highest standardized coefficient and the most robust statistical significance, highlighting the crucial predictive function of Learning Interest within the suggested research model. The small standard deviation (0.012) and the closeness of the Original Sample (0.897) to the Sample Mean (0.899) further underscore the stability and dependability of the estimated relationship throughout the bootstrapping resamples. In summary, the reliable path coefficients, low sampling errors, elevated t-statistic values, and meaningful p-values strongly indicate that the suggested structural model possesses sufficient predictive capability in clarifying the connections between internal factors, external factors, learning interest, and students' intentions to pursue further education.

Discussion

This study investigates the impact of Internal Factors and External Factors on students' interest in learning physics, in addition to how Learning Interest affects students' desire to pursue further studies in physics. The connections between these constructs were examined through the PLS-SEM method to assess both the measurement model and the structural model. The results show that every suggested hypothesis has positive and statistically meaningful impacts, as demonstrated by t-statistics exceeding 1.96 and p-values lower than 0.05. Additionally, the structural model shows significant explanatory and predictive strength, as evidenced by R^2 values of 0.852 for Learning Interest and 0.804 for Interest in Continuing Study, surpassing the benchmark for robust explanatory ability (Hair et al., 2021).

In summary, these findings reaffirm that the suggested research model clearly delineates the connections between the study variables and offers strong empirical evidence for the proposed structural framework.

The results showed that Internal Factors had a significant positive effect on students' interest in learning physics ($\beta = 0.438$, $p < 0.001$). Students with higher motivation, self-efficacy, curiosity, and confidence demonstrated stronger interest and engagement in physics learning. Although the effect was lower than external factors, internal factors remained important in shaping students' learning readiness. These findings support Self-Determination Theory and Self-Efficacy Theory, which highlight the roles of motivation, psychological needs, and self-belief in learning persistence (Ryan et al., 2022); Bandura et al., 2022). Previous studies also confirmed that motivation and self-efficacy significantly influence students' engagement, interest, and achievement in physics (Li & Singh, 2021; Wang et al., 2024).

The study found that External Factors significantly influenced students' interest in learning physics ($\beta = 0.514$, $p < 0.001$). Teacher support, learning environments, teaching methods, educational resources, parental support, peer interaction, and technology played important roles in enhancing students' interest in physics. A supportive learning environment encourages active participation and strengthens students' understanding of physics. These findings support the Four-Phase Model of Interest Development by Hidi & Ann Renninger., (2006) and Social Cognitive Theory, which emphasize the role of learning environments in shaping interest and learning behaviours (Bandura et al., 2022). Previous studies also showed that inquiry-based learning, technology integration, and positive teacher–student relationships improve students' motivation and engagement (Rahmawati et al., (2023).

The structural model revealed that Interest in Learning Physics had the strongest positive effect on students' intention to pursue higher education in physics-related fields ($\beta = 0.897$, $p < 0.001$). Students who enjoyed physics and perceived it as valuable were more likely to continue their studies in physics and STEM disciplines. This finding demonstrates that learning interest is a major determinant of educational aspirations. Therefore, increasing students' interest in physics can strengthen their intention to pursue higher education. These findings support the Social Cognitive Career Theory (SCCT), which states that educational experiences, self-efficacy, and outcome expectations shape students' career interests and educational decisions (Wong et al., 2022). Similarly, the Expectancy–Value Theory explains that students choose educational pathways they consider valuable and achievable (Wigfield et al., 2020). Students who experience meaningful and enjoyable physics learning are more likely to develop positive attitudes toward STEM careers. Consequently, fostering interest in physics can encourage greater participation in higher education.

Although the notable results are important, this research has various limitations that must be recognized. Initially, the study used a cross-sectional design, which restricts the capacity to determine causal relationships between the variables over time. Secondly, the research concentrated on students from a small selection of schools in a designated geographical region, potentially limiting the applicability of the results to wider educational environments. Moreover, while the proposed model showed significant explanatory strength, various elements that could affect students' interest in learning and their intention to continue education, including academic performance, socioeconomic status, parental education levels, career goals, teacher effectiveness, and school environment, were excluded from the structural model. Subsequent studies should utilize longitudinal or mixed-method research designs with a wider variety of samples across different educational levels and areas, incorporating more psychological, social, and institutional factors to gain a deeper insight into the elements affecting students' interest in physics and their plans to pursue further studies in physics and other STEM fields.

CONCLUSION

This research shows that Internal Factors and External Factors both positively and significantly impact students' interest in learning physics, with External Factors having a greater effect. These results indicate that students' enthusiasm for learning is influenced not just by personal traits like motivation and self-esteem, but also by the learning environment's quality, teacher assistance, availability of educational resources, and the incorporation of technology in the educational experience. The research additionally verifies that learners' enthusiasm for studying physics greatly influences their intention to engage in advanced studies in physics and other areas within Science, Technology, Engineering, and Mathematics (STEM). The structural model also showed significant predictive ability, evidenced by an R^2 value of 0.852 for Interest in Learning Physics and 0.804 for Intention to Pursue Higher Education, suggesting that the model accurately accounts for students' educational goals. These results endorse the theoretical view that interest in learning acts as a crucial mediating variable connecting internal and external influences to students' future academic decisions. From a practical viewpoint, schools and educators need to create a nurturing learning atmosphere while boosting students' motivation and self-confidence by using innovative, technology-based teaching methods. Additionally, cooperation between schools, parents, and education policymakers is vital for enhancing students' involvement in STEM education. Future studies should explore further factors, including parental engagement, readiness for digital learning, and career goals, to enhance comprehension of the suggested model and boost its explanatory strength.

REFERENCES

Albert Bandura, Ansani, Samsir, & Muhammad, H. (2022). Bandura’s Modeling Theory. *Jurnal Multidisiplin Madani*, 2(7), 3067–3080.

Aldila, F. T., Matondang, M. M., & Wicaksono, L. (2020). Identifikasi Minat Belajar Siswa terhadap Mata Pelajaran Fisika di SMAN 1 Muaro Jambi. *Science Education and Practice*, 4, 22–31.

Bhati, K., & Sethy, T. P. (2022). Self-Efficacy: Theory to Educational Practice. The International *Journal of Indian Psychology*, 10(1), 1123–1128.

Cahyasari, I., & Dewi, R. M. (2016). Kebiasaan Belajar dan Kemandirian Belajar terhadap Hasil Belajar Siswa. *Jurnal Pendidikan Ekonomi*, 4(3), 1–7.

Dheafriska, D. A., & Nofiana, M. (2023). Analisis Kebutuhan Guru Rumpun IPA Terhadap Implementasi Kurikulum Merdeka di SMA Negeri Kabupaten Banyumas. *Proceedings Series on Social Sciences & Humanities*, 13, 58–67.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial least squares structural equation modeling (PLS-SEM) using R.* Springer.

Fatonah, U., Wirayuda, R. P., Wibisono, G., & Sakahuni, S. (2020). Analisis Minat Belajar Kelas XI SMA Negeri 1 Sungai Penuh pada Pembelajaran Fisika. *Jurnal Sains Dan Pendidikan Fisika*, 16(2), 145-152.

Halliday, D., Resnick, R., & Walker, J. (2021). Fundamentals of physics (12th ed.). Wiley.Halliday, D., Resnick, R., &, & Walker, J. (2021). (2021). PHYS 0175 : *Physics for Science and Engineering* 2. 1–5.

Hidi, S., & Ann Renninger, K. (2006). The Four-Phase Model of Interest Development. *Educational Psychologist*, 41(2), 111–127.

Li, Y., & Singh, C. (2021). Effect of Gender, Self-Efficacy, and Interest on Perception of the Learning Environment and Outcomes in Calculus-Based Introductory physics courses. *Physical Review Physics Education Research*, 17(1).

Limiansih, K., Panuluh, A. H., & Sulistyani, N. (2025). Beyond Content Validity: Comprehensive Validation of Scientific Literacy Assessment for Junior High School Teachers. *Jurnal Penelitian Pendidikan IPA*, 11(12), 802–813.

Mohammed, F. S., & Ozdamli, F. (2024). A Systematic Literature Review of Soft Skills in Information Technology Education. *Behavioral Sciences*, 14 (10), 894.

Putri, W. I., Sundari, P. D., Mufit, F., & Dewi, W. S. (2023). Analisis Keterampilan Berpikir Kritis Siswa SMA Pada Materi Pemanasan Global. *Jurnal Ilmiah Profesi Pendidikan*, 8(4), 2620–2631.

Rahmawati, A., Chotimah, H., Erlina, S., Kher, T., & Afriani, W. (2023). Capaian pembelajaran fisika kelas X fase E.

Ridwan, S., & Widiyanto, C. (2023). *Suksma: Jurnal Psikologi Universitas Sanata Dharma*, 4.

Ryan & Deci, 2020. (2022). Applying Self-Determination Theory to Education: Regulations Types, Psychological Needs, and Autonomy Supporting Behaviors. *Canadian Journal of School Psychology*, 37(1), 75–92.

Ryan, R. M., Deci, E. L., Di Domenico, S. I., Ryan, W. S., & Steward, B. A. (2022). A Meta-Review of Meta-Analytic Findings Evaluating Self-Determination Theory. *Contemporary Educational Psychology*, 2, 306–312.

Sugiyono, & Lestari, P. (2021). *Metode penelitian komunikasi*. Alfabeta.

Sugiyono dan Puji Lestari. (2021). *Metode Penelitian Komunikasi*.

Unsworth, L., Tytler, R., Fenwick, L., Humphrey, S., Chandler, P., Herrington, M., & Pham, L. (2022). *Multimodal Literacy in School Science*. Routledge.

Wahyuni, I., Maison, M., & Pathoni, H. (2021). Analisis Minat Belajar Siswa pada Mata Pelajaran Fisika di SMA Negeri 2 Kota Jambi. *Physics and Science Education Journal (PSEJ)*, 1(April), 22.

Wang, X., Yang, L., Chen, K., & Zheng, Y. (2024). Understanding Teacher Emotional Exhaustion: Exploring the Role of Teaching Motivation, Perceived Autonomy, and Teacher–Student Relationships. *Frontiers in Psychology*, 14(January), 1–17.

Wigfield, A., Tonks, S., & Klauda, susan lutz. (2020). *Wigfield-Tonks-Klauda-EV.pdf*.

Wong, B., Chiu, Y.-L. T., Murray, Ó. M., & Horsburgh, J. (2022). End of the Road the Career Intentions of Under-Represented STEM Students in Higher Education. *International Journal of STEM Education*, 9(1), 51.

Zulaika, A., Erlina, & Rachmat Sahputra. (2025). Development of a Science Literacy Test for Junior High School Students Based on the PISA 2025 Framework. *Jurnal Pendidikan MIPA*, 2612(3), 1377–1405.