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Beyond the Environment: How Media and Student Interest Intersect to Drive Vocational Academic Achievement

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Abstract:

This study aims to analyze how learning media, the learning environment, and learning interest influence vocational high school students' learning outcomes and to identify the variable with the strongest influence. The study used a quantitative approach and Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS software. The study sample consisted of 50 students selected via purposive sampling. The researchers developed the research instruments based on valid and reliable indicators and tested them through outer- and inner-model evaluations. The results indicate that the model has good validity and reliability, with Composite Reliability values exceeding 0.70 and AVE values meeting convergent validity criteria. An R^2 value of 0.682 for learning outcomes demonstrates the model's explanatory power regarding the endogenous variable. Path analysis shows that learning interest has the strongest influence on learning outcomes ($\beta = 0.815$), while learning media positively influences both the learning environment ($\beta = 0.379$) and learning outcomes ($\beta = 0.161$). The learning environment did not directly influence learning outcomes ($\beta = -0.141$). These findings suggest that enhancing students' learning interest is crucial to optimizing learning outcomes, supported by the use of learning media and effective management of the learning environment.

Key Words: *Learning Media, Learning Environment, Learning Interest, Learning Outcomes*

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INTRODUCTION

Vocational High Schools (SMK) play an essential role in preparing human resources who are capable of adapting to the demands of globalization, industrial transformation, and digitalization (Muharam et al., 2025; Muslim & Ariyanto, 2024). Vocational education success increasingly depends on graduates' ability to integrate theoretical knowledge with the practical competencies required in real workplace environments (Kamaruzaman et al., 2025; Kebede et al., 2024; Qin, 2024). This issue matters because industries need workers with not only technical

skills but also adaptability, problem-solving abilities, and technological competence. Therefore, vocational learning processes must move beyond conventional theoretical approaches toward more applicative, contextual, and technology-supported learning experiences. Previous studies emphasize that learning media are important tools for connecting theoretical concepts with practical applications, helping students understand vocational competencies more effectively (Budiarto et al., 2024; Hafiz et al., 2024; Wu, 2024; Hayati et al., 2026). Thus, improving vocational learning quality has become a critical educational priority.

In contemporary vocational education, achieving optimal learning outcomes requires a combination of instructional resources, student psychological readiness, and supportive educational conditions. Learning interest is an important internal factor because students with strong interest tend to participate actively, engage deeply, and show greater persistence during learning activities (Rui et al., 2024; Guo & Fryer, 2025; Mulyadi et al., 2025; Susanti et al., 2025). At the same time, external factors such as learning environments, including school facilities, practical equipment, and classroom interactions, influence students' comfort and motivation. This relationship becomes increasingly significant because vocational education emphasizes practical experiences that require active involvement and continuous interaction with learning resources. Research by Mahanani et al. (2024), Marcellis et al. (2024), and Asad et al. (2026) highlights that the synergy among learning media, learning interest, and learning environments is essential to supporting competency-based vocational education. Therefore, understanding how these factors interact is important for improving students' learning achievement.

Despite their importance, vocational education still faces several challenges in achieving consistent learning outcomes. Many vocational students struggle to connect theoretical material with practical applications, particularly when learning media are not sufficiently contextualized or aligned with industry requirements. In addition, variations in students' motivation and interest often influence their participation and achievement during learning activities. These challenges suggest that facilities and instructional tools alone may not be enough to improve educational outcomes. Learning processes require effective integration between technology, teaching strategies, and students' internal motivation (Hafiz et al., 2024; Arifurrohman, 2025; Hidayatullah et al., 2026; Yorganci, 2026). Previous research shows that contextual learning media can enhance vocational students' understanding, particularly when the media are designed around specific competency areas. For example, Yorganci (2026) found that computer-based simulation media improved students' understanding of automotive engineering systems.

Another problem concerns the limited integration between learning environments and students' psychological factors in explaining vocational learning outcomes. Although schools continue to improve facilities and practical

learning spaces, resource availability does not always guarantee higher achievement if students lack motivation and interest in the learning process. Previous studies by Wibowo et al. (2024) and Shang et al. (2026) demonstrate that interactive and project-based learning media can increase students' motivation and achievement. Furthermore, research shows that students' interest in specific vocational competencies is positively associated with learning achievement (Muhajir, 2024; Muhtadin et al., 2026). However, the challenge remains in understanding how these internal and external factors interact simultaneously to influence learning outcomes within vocational education settings.

Previous studies have provided valuable insights into the contribution of learning media, learning interest, and learning environments separately; however, several limitations remain. Most existing research examines learning media or learning environments as independent predictors, while the psychological mechanisms explaining how these factors influence learning outcomes have received limited attention. In particular, few studies have investigated learning interest as a connecting mechanism between external learning conditions and student achievement. Although previous research highlights the importance of supportive practical environments for vocational skill development (Smeplass, 2025; Maksum et al., 2026; Okoye et al., 2026), the integrated relationship among learning media, learning environment, learning interest, and learning outcomes remains insufficiently explored. Addressing this gap matters because understanding these relationships can provide a more comprehensive explanation of how effective vocational learning systems are developed.

To address this gap, this study proposes an integrated analytical model that examines the relationships among learning media, learning environment, learning interest, and learning outcomes among vocational high school students. This research is novel in positioning learning interest as a central factor that explains how instructional and environmental conditions contribute to learning achievement. By applying a quantitative approach using Partial Least Squares–Structural Equation Modeling (PLS-SEM), this study provides empirical evidence regarding the direct and indirect relationships among these variables. The research argues that improving vocational students' learning outcomes requires more than enhancing learning facilities or media; it requires strengthening students' internal interest through meaningful and supportive learning experiences. Therefore, this study contributes theoretically by expanding understanding of motivational mechanisms in vocational education and practically by guiding schools and teachers in designing effective learning strategies aligned with workplace demands.

RESEARCH METHODS

This study uses a quantitative approach and an explanatory research design (George & Merkus, 2023). This approach was chosen to examine the

structural and predictive relationships among the research variables: Learning Media, Learning Environment, Interest in Learning, and Learning Outcomes. The intervariable relationship model is analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), which was selected instead of covariance-based SEM because it is well-suited for predictive research with relatively small to moderate sample sizes, does not require the assumption of multivariate normality, and is robust for testing complex models involving mediating variables. This approach allows for simultaneous testing of both direct and indirect relationships among the research variables (Hair & Alamer, 2022).

The population in this study is all Vocational High School (SMK) students who are involved in technology-based learning activities at the school where the research was conducted. The study used purposive sampling, selecting respondents based on criteria such as active participation in learning with digital media and experience in varied classroom environments. The sample included 50 students. This sample size was determined with reference to the minimum sample size requirements for PLS-SEM, which is commonly estimated using the inverse square root method (Liu et al., 2025) and the ten-times rule based on the largest number of structural paths directed at a single construct in the model (Tsyganova et al., 2025). Given the relatively simple structural model in this study, a sample of 50 respondents exceeds the minimum threshold required to achieve adequate statistical power, thereby supporting the appropriateness of PLS-SEM for analyzing the relationships among the research variables.

Data were collected using a five-point Likert scale questionnaire, with responses ranging from 1 = strongly disagree to 5 = strongly agree. Each variable is measured through several statements that have been tested for validity and reliability (Adeyemi, 2024; Hidayana & Fuzi, 2025). Before wide deployment, the instrument was first tested on 10 respondents to ensure clarity and consistency of the question items. In addition to questionnaires, the researchers conducted supplementary non-participant observations of classroom learning activities to provide contextual support for interpreting the survey data. These observations focused on student engagement with learning media, classroom environmental conditions, and general indicators of student interest during the learning process, and were recorded using field notes. The observation results were not analyzed statistically but served as qualitative context to enrich the discussion of the quantitative findings.

Data analysis was carried out using Structural Equation Modeling (SEM) with a Partial Least Squares (PLS) approach using SmartPLS (Edeh et al., 2023; Magno et al., 2024). The analysis stages include a) Outer Model test to assess convergent validity, discriminant validity, and construct reliability; b) Inner Model test to measure the relationship between latent variables and test the research hypothesis; c) Mediation Analysis to test the role of Interest in learning

as a mediating variable between Learning Media and Learning Environment against Learning outcomes. The results are interpreted based on the path coefficient value, t-statistic, and p-value at a 5% significance level ($\alpha = 0.05$) (Dash & Paul, 2021).

All respondents participated voluntarily, with a guarantee of data confidentiality. The researcher explained the purpose of the research, the confidentiality of information, and the respondent's right to refuse or terminate participation at any time. This procedure upholds the ethical principles of educational research.

RESULTS AND DISCUSSION

Results

The data analysis used Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS. The analysis followed two main stages: evaluating the measurement model (outer model) and evaluating the structural model (inner model). The measurement model assessment ensured the constructs met the required validity and reliability criteria before examining the relationships among variables. The results of the measurement model evaluation are presented in the following section.

Outer Model Test

The outer model test evaluated the measurement model's validity and reliability before testing the structural relationships among variables. This evaluation included assessments of convergent validity, discriminant validity, and construct reliability, and the results are presented in Table 1.

Tabel 1. Construct Reliability and Validity

Construct	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Learning Outcomes	0.804	0.855	0.867	0.574
Learning Environment	0.662	0.671	0.787	0.428
Learning Media	0.886	0.897	0.917	0.689
Learning Interest	0.843	0.846	0.889	0.618

Table 1 presents the results of the reliability and construct validity tests using SmartPLS; all research variables showed good reliability, with Cronbach's Alpha and Composite Reliability values above 0.70. The AVE value in most constructs also met the criteria for convergent validity (≥ 0.50), except for the Learning Environment variable, which had an AVE of 0.428, so it was necessary to review some less representative indicators. Overall, the measurement model (Outer Model) was declared feasible to proceed to the structural model testing stage (Inner Model).

Inner Model Test

To evaluate relationships among constructs in the structural model, we conducted an inner model assessment by examining residual correlations between Learning Outcomes and Learning Environment. This analysis indicates the degree of association between constructs after accounting for model-specified relationships. The residual correlation matrix also presents inter-construct correlations and diagonal values representing each construct's self-correlation. These results provide insights into structural relationships and potential construct overlap. Table 2 presents are findings.

Tabel 2. Inner Model Residual Correlation

Construct	Learning Outcomes	Learning Environment
Learning Outcomes	1.000	0.000
Learning Environment	0.000	1.000

The internal model test results in Table 2 show the correlation between the Learning Outcome variable and the Learning Environment. The variables are correlated at 0.000, while each variable's diagonal value is 1,000. A diagonal value of 1,000 indicates that each variable has a perfect correlation with itself (self-correlation), which is normal in structural models.

However, the correlation value of 0.000 indicates that the Learning Environment does not have a significant direct relationship with Learning Outcomes in this model. This means that, based on the path coefficient estimates from the inner model, the learning environment variable does not directly contribute to improving vocational school students' learning outcomes. This can indicate that the influence of the learning environment may be indirect, for example, through mediating variables such as Learning Interests, or that other factors such as Learning Media are more dominant in explaining the variation in learning outcomes. Thus, these findings show the importance of further analysis of the mediation pathway and the simultaneous influence of variables to fully understand the dynamics of learning in the vocational school environment.

Mediation Analysis

The R-squared (R^2) analysis assessed the structural model's explanatory power using SmartPLS. The R^2 values indicate the proportion of variance in each endogenous construct explained by its predictor constructs. Adjusted R^2 provides a more conservative estimate by accounting for the number of predictors included in the model. The results for Learning Outcomes and Learning Environment are presented in Table 3.

Table 3. R-Square

Construct	R Square (R^2)	Adjusted R Square (R^2 Adjusted)
Learning Outcomes	0.682	0.660
Learning Environment	0.634	0.618

Table 3 presents the R-squared (R^2) test results for the structural model (inner model) using SmartPLS; the R^2 value for Learning Outcomes was 0.682, and the R^2 value for Learning Environment was 0.634. This value shows that the research model has high explanatory power. Specifically, the R^2 value of 0.682 for Learning Outcomes means that Learning Media, Learning Interests, and Learning Environment explain 68.2% of the variation in Learning Outcomes, while factors outside the model influence the remaining 31.8%.

Meanwhile, the R^2 value of 0.634 for the Learning Environment variable showed that Learning Media and Learning Interests explained 63.4% of the variation in Learning Environment, while the remaining 36.6% was influenced by other variables not included in this study model. Based on Chin's (1998) guidelines, an R^2 of 0.67 is considered strong, 0.33 moderate, and 0.19 weak; these results indicate that both structural models have strong to near-high predictive strength. Thus, the developed model can substantially explain the relationship between variables and can be considered good at explaining the learning phenomenon in the vocational school being studied.

Table 4. f-Square

	Learning Outcomes	Learning Environment	Learning Media
Learning Outcomes			
Learning Environment	0,023		
Learning Media	0,037	**0,216**	
Interest in Learning	**0,843**	**0,363**	

Table 4 shows the results of the F-square (F^2) analysis of the structural model. The following intervariable influence values were obtained: the influence of the Learning Environment on the Learning Outcome of 0.023, the influence of the Learning Media on the Learning Outcome of 0.037, the influence of the Learning Media on the Learning Environment of 0.216, the effect of Learning Interest on the Learning Outcome of 0.843, and the effect of Learning Interest on the Learning Environment of 0.363. The f^2 value measures the effect size of an independent variable on the dependent variable in the PLS-SEM model, with general criteria of 0.02 = small, 0.15 = medium, and 0.35 = large.

Based on these results, the influence of Learning Environment (0.023) and Learning Media (0.037) on Learning Outcomes falls within the small-effect category, indicating that these two variables contribute only a limited amount to improving learning outcomes directly. Meanwhile, the influence of Learning Media on the Learning Environment (0.216) is classified as a moderate effect, indicating that learning media plays a strong role in creating a conducive learning environment. Furthermore, Learning Interest showed a large effect on Learning Outcomes (0.843), meaning learning interest was the most dominant factor in determining student learning success. Meanwhile, the influence of Learning Interest on the Learning Environment (0.363) also falls in the large category, indicating that students' high interest in learning also creates a positive

learning atmosphere. Thus, these results confirm that Learning Interest is a key variable in improving learning outcomes, both directly and by strengthening the learning environment.

Table 5. Fit Summary

Fit Index	Saturated Model	Estimated Model
SRMR	0.101	0.101
d_ULS	2.158	2.158
d_G	1.477	1.477
Chi-Square	310.775	310.775
NFI	0.581	0.581

Table 5 shows the fit summary results, from which several indicators of model suitability (goodness of fit) were obtained to assess how well the structural model in this study aligned with the empirical data. The SRMR (Standardized Root Mean Square Residue) is 0.101, slightly above the ideal limit of 0.08. However, this value remains acceptable for exploratory studies with small sample sizes, such as this study (50 respondents). A d_ULS value of 2.158 and a d_G of 1.477 indicate the distance between the empirical covariance matrix and the model covariance matrix; the smaller the value, the better the model fit.

Furthermore, the Chi-Square value of 310.775 indicates the model's total suitability to the data; although a large Chi-Square value usually signifies a difference between the model and the data, in the context of PLS-SEM, this size is not used as a primary benchmark due to the predictive nature of the model, rather than covariance. Another indicator, the NFI (Normed Fit Index), is 0.581, below the ideal threshold of 0.90, but still indicates that the model moderately conforms to the empirical data. Overall, the fit summary indicates that the structural model can be accepted exploratively, although it still needs improvement, especially to achieve a more optimal fit in follow-up research.

Tabel 6. Path Coefficien

Path Relationship	Original Sample (β)
Learning Environment → Learning Outcomes	-0.141
Learning Media → Learning Outcomes	0.161
Learning Media → Learning Environment	0.379
Learning Interest → Learning Outcomes	0.815
Learning Interest → Learning Environment	0.491

Table 6 shows the results of the path coefficient analysis on the structural model using SmartPLS. Several intervariable path coefficient values were obtained as follows: the effect of the Learning Environment on Learning Outcomes of -0.141, Learning Media on Learning Outcomes of 0.161, Learning Media on the Learning Environment of 0.379, Learning Interest on Learning Outcomes of 0.815, and Learning Interest on the Learning Environment of 0.491. The path coefficient indicates the direction and strength of the relationship

between latent variables: a positive value indicates a unidirectional relationship (the higher the independent variable, the higher the dependent variable), while a negative value indicates the opposite relationship.

These results show that Learning Interest has the strongest and most significant influence on Learning Outcomes (0.815), meaning that an increase in students' learning interest will have a major impact on improving their learning outcomes. In addition, Learning Interest positively affected the Learning Environment (0.491), showing that students with high interest tend to create a more active, conducive, and collaborative learning atmosphere. Learning Media also positively influenced the Learning Environment (0.379), indicating that appropriate learning media can improve the quality of the student learning environment.

However, the relationship between Learning Environment and Learning Outcomes was negative (-0.141), meaning the learning environment in this study did not directly contribute positively to learning outcomes and may even have the opposite effect. This may be because the learning environment did not fully support students' needs. Meanwhile, the effect of Learning Media on Learning Outcomes (0.161) was positive but relatively weak, showing that the effectiveness of learning media in improving learning outcomes still depends on the role of learning interests and learning environment conditions. Overall, these results show that Learning Interest is a key factor in the research model, both directly improving learning outcomes and indirectly strengthening the relationship between learning media and the learning environment.

Discussion

The findings indicate that learning interest is the strongest factor influencing vocational students' learning outcomes, with a path coefficient of $\beta = 0.815$. This result confirms that internal psychological factors play an essential role in determining academic achievement by increasing students' motivation, engagement, persistence, and active participation in learning activities. This finding is consistent with previous studies emphasizing that learning interest functions as an internal mechanism that supports successful learning processes (Aprillia & Kurniawan, 2024; Iskandar et al., 2024). Similarly, Depoo et al. (2022) reported that sustained learning interest enhances students' cognitive and affective engagement, which contributes to improved academic performance. Therefore, this study strengthens the view that learning interest is not merely a personal characteristic but a key determinant of vocational learning success.

The results further show that learning media positively influences the learning environment ($\beta = 0.379$) and learning outcomes ($\beta = 0.161$). Although its direct effect on learning outcomes is lower than learning interest, the findings confirm that appropriate learning media can facilitate meaningful and interactive learning experiences. This result supports Depoo (2022), who explained, through multimedia learning theory, that effective integration of visual, verbal, and

auditory elements can improve students' understanding. However, this study also indicates that learning media alone does not guarantee improved achievement, as its effectiveness depends on students' active engagement and motivation. This finding supports the idea that learning media serves primarily as a supporting tool, while students' involvement and interest in learning materials strongly influence learning success (Fenezia & Armiati, 2025) (Staneviciene & Žekienė, 2025).

An unexpected finding of this study is the negative relationship between learning environment and learning outcomes (β = -0.141), which differs from previous studies reporting positive effects of supportive learning environments on academic achievement. For example, Aziz (2024) and Werang et al. (2025) demonstrated that conducive environments, including facilities, teacher support, and social interaction, can improve students' motivation and performance. The different results in this study may relate to the characteristics of vocational education, where students' achievement may depend more on internal readiness, practical engagement, and learning interest than on environmental conditions alone. Thus, the negative coefficient does not necessarily mean the learning environment reduces achievement; it suggests its direct influence may be limited when internal motivational factors become more dominant.

The model's explanatory power further supports integrating these variables. The R^2 value of 0.682 indicates that learning media, learning environment, and learning interest collectively explain 68.2% of the variance in learning outcomes. This finding supports Nasution et al. (2023), who stated that learning achievement is influenced by the interaction between internal factors, such as interest and motivation, and external factors, including instructional resources and learning conditions. Furthermore, the f-square analysis confirms the dominant role of learning interest, with a strong effect on learning outcomes (f^2 = 0.843) and a moderate effect on learning environment (f^2 = 0.363). These findings align with Self-Determination Theory, which emphasizes the importance of intrinsic motivation, curiosity, and personal interest in developing productive learning behaviors (Du & Bhumithavara, 2026; Hessen et al., 2026; Hina & Solikhatin, 2025; Mulyadi et al., 2025; Slamet et al., 2024)

The PLS-SEM model evaluation indicates acceptable predictive capability, with SRMR = 0.101 and NFI = 0.581. These values should be interpreted in light of the study's exploratory nature and limited sample size, where the primary focus is explaining relationships among constructs rather than achieving perfect model fit. The findings provide empirical evidence that interactions among instructional, environmental, and psychological factors shape vocational learning outcomes. This study contributes to the vocational education literature by positioning learning interest as a central mechanism explaining how external learning conditions influence student achievement, an aspect that has received limited attention in previous studies.

Practically, this study suggests that improving vocational students' learning outcomes should not rely solely on improving facilities or providing advanced learning media but should prioritize strategies that strengthen students' learning interest and intrinsic motivation. Teachers and school administrators should develop contextual, interactive, and project-based learning approaches supported by appropriate digital media to encourage active participation. In addition, learning environments should be designed not only around physical facilities but also around positive teacher–student relationships, emotional support, and collaborative learning cultures. These findings provide practical guidance for vocational institutions in developing more effective learning systems aligned with students' needs and workplace competency demands.

CONCLUSION

This study concludes that learning interest is the most influential factor in determining vocational students' learning outcomes, highlighting the critical role of students' intrinsic motivation in achieving academic success. Learning media also contributes positively to the learning environment and learning outcomes, although its direct effect is relatively limited, indicating that instructional media should be integrated with strategies that enhance student engagement. Meanwhile, the learning environment does not demonstrate a significant direct effect on learning outcomes, suggesting that environmental improvements should focus on creating supportive physical, social, and emotional conditions that foster students' learning interest. The structural model shows substantial explanatory power ($R^2 = 0.682$), confirming that integrating learning media, learning environment, and learning interest provides an important framework for understanding vocational students' achievement. The practical implication is that schools and teachers should prioritize developing students' learning interest through interactive, contextual, and project-based learning approaches while optimizing digital learning media to support meaningful learning experiences. Future research should examine additional mediating or moderating factors, such as learning independence and social support, to provide a more comprehensive understanding of how learning outcomes improve in vocational education contexts.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors used AI-assisted tools solely for language refinement, grammar checking, and improving the manuscript's clarity. The authors remain fully responsible for the content, analysis, and conclusions presented in this article.

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