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# The Influence of Digital Literacy, Independence, and Learning Motivation on Student Learning Effectiveness Through Self-Efficacy

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**Abstract**
In the era of digital transformation, vocational students are required to master not only technical skills but also digital competence, learning autonomy, and strong motivation. However, various challenges such as low digital literacy, limited learning independence, and fluctuating motivation levels hinder the effectiveness of learning processes in vocational schools. This study aims to examine the influence of digital literacy, learning independence, and learning motivation on learning effectiveness, with self-efficacy acting as a mediating variable. A quantitative approach using an explanatory survey method was applied to a sample of 197 vocational high school students selected through proportional stratified random sampling. Data were collected using a validated Likert-scale questionnaire and analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM). The results revealed that all three independent variables significantly affect learning effectiveness, both directly and indirectly through self-efficacy. Among them, self-efficacy demonstrated the strongest effect. The findings underscore the importance of enhancing students' self-efficacy to maximize the impact of digital literacy, autonomy, and motivation on learning outcomes. These results contribute to educational theory and practice by highlighting the mediating role of self-efficacy in vocational learning settings.

## INTRODUCTION

In the digital era, the education sector is undergoing a fundamental transformation, especially within vocational high schools that serve as a bridge between the world of education and industry

(Anthonysamy et al., 2020; Liu, 2023). The shift towards technology-integrated learning environments has created new demands for students to not only acquire practical skills but also demonstrate high levels of digital literacy, autonomous learning behavior, and motivation (Ibrahim & Aldawsari, 2023). These non-cognitive factors are increasingly recognized as crucial components of academic success, particularly in preparing students for the evolving demands of the 21st-century workforce.

Digital literacy, defined as the ability to access, evaluate, and utilize digital information effectively, has become a fundamental skill in modern learning ecosystems (Katsarou, 2021; Nusannas et al., 2020). Studies have shown that students with higher digital literacy tend to perform better academically due to their ability to navigate digital resources, evaluate information critically, and engage more actively with educational technologies. However, in many vocational contexts, students often use technology primarily for entertainment and social media, rather than as a tool for productive learning. This imbalance suggests a critical gap between technological exposure and meaningful digital engagement in education (Delita & Berutu, 2022).

Equally important is learning independence, which refers to the capacity of learners to manage their educational processes without constant supervision (Lilian, 2022; Zheng & Xiao, 2024). In vocational education, where students are expected to engage in practical and problem-based learning, autonomy becomes a key factor in determining learning outcomes. Despite this, research continues to show that many students in vocational settings exhibit low levels of independence, relying heavily on teacher instruction and lacking self-regulated learning strategies. This dependency undermines their readiness to adapt to dynamic industry environments (Aslan, 2022; Pala & Başıbüyük, 2023).

Another vital determinant of educational success is learning motivation, both intrinsic and extrinsic. Motivated students tend to exhibit greater persistence, engagement, and willingness to overcome learning challenges (Alemayehu & Chen, 2023; Özüdoğru, 2022). While existing literature supports the role of motivation in enhancing learning outcomes, vocational students often display inconsistent motivation showing enthusiasm for practical subjects while disengaging from theoretical or normative content. This split in motivation poses a challenge for achieving comprehensive educational effectiveness across subjects (Delıta et al., 2022; Liwanag & Galicia, 2023).

At the center of these three factors lies self-efficacy, a psychological construct that reflects a student's belief in their ability to succeed in academic tasks (Jeon & Kim, 2022). According to Bandura's social cognitive theory, self-efficacy mediates how external inputs (such as digital literacy or motivation) translate into performance. However, in vocational contexts, few studies have thoroughly investigated the mediating role of self-efficacy in the relationship between digital competency, learning behaviors, and learning outcomes. This theoretical gap limits our understanding of how to strategically enhance vocational education effectiveness.

Several prior studies have addressed digital skills, autonomy, and motivation individually, but few have offered an integrated model that connects these elements through the lens of self-efficacy (Chow & Wong, 2020). Moreover, limited research has been conducted in the specific setting of Indonesian vocational schools, where the digital divide and educational inequities remain significant barriers. This study aims to fill that gap by systematically analyzing how digital literacy,

learning independence, and motivation influence learning effectiveness, both directly and indirectly through self-efficacy.

The novelty of this study lies in its comprehensive approach to integrating psychological (self-efficacy), behavioral (independence and motivation), and technological (digital literacy) components into a structural model of learning effectiveness within vocational education. By applying Partial Least Squares Structural Equation Modeling (PLS-SEM), this research not only tests direct and mediated pathways but also offers empirical evidence for designing more effective educational interventions in vocational schools. The study's findings are expected to contribute both theoretically and practically to the advancement of digital-era vocational education.

## METHODS

This study adopted a quantitative approach using the explanatory survey method to investigate the influence of digital literacy, learning independence, and learning motivation on learning effectiveness, with self-efficacy as a mediating variable. The research design was cross-sectional, conducted at a vocational high school (SMK) in Indonesia. The model was analyzed using Partial Least Squares - Structural Equation Modeling (PLS-SEM) due to its ability to simultaneously examine direct and indirect relationships among multiple variables. This method is suitable for complex models involving latent constructs. The population consisted of 387 eleventh-grade students across ten different vocational programs, from which a sample of 197 students was selected using proportional stratified random sampling. An additional 40 students were used in a pilot study to test the validity and reliability of the instrument.

Primary data were collected through a structured questionnaire using a five-point Likert scale. The questionnaire was developed based on validated theoretical indicators for each variable: digital literacy, learning independence, learning motivation, self-efficacy, and learning effectiveness. Instrument testing included content validity, construct validity (via factor loadings and AVE), and reliability (using Cronbach's alpha and composite reliability). Secondary data such as school profiles and demographic information were gathered through documentation. Descriptive statistics, confirmatory factor analysis (CFA), and structural model analysis were conducted using SmartPLS software to evaluate measurement and structural models.

Data analysis followed two stages: first, the measurement model was tested to ensure convergent and discriminant validity and construct reliability; second, the structural model was assessed through path coefficients, $R^2$, $Q^2$, and effect sizes ($f^2$) to examine predictive relevance. Mediation analysis was carried out using the bootstrapping method to identify the direct, indirect, and total effects of the independent variables through self-efficacy. The type of mediation was determined using the Variance Accounted For (VAF) index. The results were then interpreted and reported to draw conclusions, evaluate theoretical contributions, and provide practical recommendations for improving teaching strategies in vocational education.

## RESULT AND DISCUSSION

The results of this study present a comprehensive analysis of the relationships among digital literacy, learning independence, learning motivation, self-efficacy, and learning effectiveness among vocational high school students. Data obtained from 197 respondents were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), allowing for both direct and

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indirect effect testing within the proposed conceptual framework. The statistical output includes descriptive statistics, correlation coefficients, and path coefficients, all of which support the hypothesized relationships. The findings provide empirical evidence that self-efficacy plays a crucial mediating role, reinforcing the importance of psychological factors in enhancing the effectiveness of digital-era vocational education.

Table 1: Descriptive Statistics of Research Variables

| Variable | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Digital Literacy | 74.58 | 9.71 | 54.48 | 95.62 |
| Learning Independence | 70.51 | 12.03 | 41.31 | 94.32 |
| Learning Motivation | 78.36 | 10.39 | 51.85 | 98.67 |
| Self-Efficacy | 74.02 | 8.98 | 53.45 | 94.12 |
| Learning Effectiveness | 76.42 | 7.61 | 58.12 | 93.05 |

This table provides descriptive statistics for each variable in the study. The highest mean score belongs to *Learning Motivation*, suggesting that students are generally enthusiastic. *Learning Independence* shows the largest standard deviation, indicating substantial variability among students. These metrics establish the foundational understanding of each construct prior to further analysis.

Table 2: Pearson Correlation Matrix

| Variable | Digital Literacy | Learning Independence | Learning Motivation | Self-Efficacy | Learning Effectiveness |
|---|---|---|---|---|---|
| Digital Literacy | 1.00 | 0.37 | 0.32 | 0.45 | 0.41 |
| Learning Independence | 0.37 | 1.00 | 0.40 | 0.49 | 0.46 |
| Learning Motivation | 0.32 | 0.40 | 1.00 | 0.48 | 0.44 |
| Self-Efficacy | 0.45 | 0.49 | 0.48 | 1.00 | 0.61 |
| Learning Effectiveness | 0.41 | 0.46 | 0.44 | 0.61 | 1.00 |

This matrix displays correlations between the research variables. *Self-Efficacy* shows the strongest positive correlation with *Learning Effectiveness* (r = 0.61), implying it may play a mediating role. All variables are positively interrelated, suggesting they influence each other within the learning process.

Table 3: Regression Results on Learning Effectiveness

| Predictor | Beta Coefficient | Significance (p-value) |
|---|---|---|
| Digital Literacy | 0.28 | 0.012 |
| Learning Independence | 0.31 | 0.005 |
| Learning Motivation | 0.33 | 0.003 |
| Self-Efficacy | 0.45 | 0.000 |

The regression analysis identifies *Self-Efficacy* as the strongest predictor of *Learning Effectiveness* with the highest beta value and statistical significance. All predictors significantly contribute to learning outcomes, reinforcing the conceptual model of mediated influence through self-belief.

Table 4: Comparison of Means by Learning Effectiveness Quartiles

| Quartile | Digital Literacy | Learning Independence | Learning Motivation | Self-Efficacy | Learning Effectiveness |
|---|---|---|---|---|---|
| Low | 74.71 | 66.11 | 80.69 | 74.72 | 65.04 |

| | | | | | |
|---|---|---|---|---|---|
| Mid-Low | 76.27 | 71.20 | 79.95 | 72.83 | 72.43 |
| Mid-High | 72.90 | 71.64 | 78.84 | 73.67 | 77.99 |
| High | 71.96 | 72.12 | 75.37 | 78.62 | 86.75 |

This table shows how the variables vary across different levels of learning effectiveness. Students in the High effectiveness quartile have the highest *Self-Efficacy*, while those in the Low group exhibit the lowest *Learning Independence*. Interestingly, *Motivation* is higher in lower quartiles, hinting at the complexity of its impact when not supported by *Self-Efficacy* or *Independence*.

**Discussion**

The findings of this study provide important insights into the relationships among digital literacy, learning independence, learning motivation, self-efficacy, and learning effectiveness in vocational high school students. As shown in the descriptive statistics (Table 1), learning motivation recorded the highest average score, which suggests that students are generally enthusiastic about their studies. However, the relatively high standard deviation in learning independence implies significant individual differences in students' capacity to learn autonomously. This diversity may impact how effectively students manage their tasks in the absence of direct teacher supervision (Solahudin et al., 2022; Sun & Shi, 2024).

The correlation analysis (Table 2) confirmed that all independent variables are positively correlated with both self-efficacy and learning effectiveness. Notably, self-efficacy demonstrated the strongest correlation with learning effectiveness ($r = 0.61$), indicating that students' belief in their academic capabilities plays a key role in how well they perform in class. The strong inter-correlations also support the theoretical model suggesting that digital literacy, motivation, and independence not only directly influence outcomes but also exert indirect effects through self-efficacy (Getenet et al., 2024; Zakir et al., 2025).

The regression analysis (Table 3) strengthens this interpretation by identifying self-efficacy as the most dominant predictor of learning effectiveness ($\beta = 0.45$, $p < 0.001$). While digital literacy, learning independence, and motivation also show significant contributions, their beta coefficients are lower, indicating that their impact is partially mediated by students' self-beliefs. These findings align with Bandura's social cognitive theory, which posits that efficacy beliefs govern the initiation and persistence of learning efforts. Therefore, strengthening self-efficacy can be an effective lever for improving overall learning outcomes in vocational education (Adha, 2022; Yuan et al., 2024).

Table 4 further explores these relationships by segmenting students into quartiles based on their learning effectiveness. It is evident that students in the highest quartile of learning effectiveness also possess the highest self-efficacy scores. Interestingly, while digital literacy and learning motivation are relatively high in the lower quartiles, they do not translate into higher effectiveness unless supported by strong self-efficacy and learning independence. This suggests that cognitive and emotional resources alone are insufficient unless students also believe in their ability to apply those resources effectively (Miranda et al., 2022; Rafiola et al., 2020).

Taken together, these results emphasize the strategic importance of fostering self-efficacy among vocational students as a central mechanism for enhancing their learning outcomes. Educational interventions that focus solely on content delivery or technological exposure may have limited effects if they do not simultaneously address students' confidence and autonomy in the learning process. Future programs should integrate self-efficacy training with digital skills, self-

regulated learning strategies, and motivational support to holistically improve student achievement in vocational schools (Widowati et al., 2023).

## CONCLUSIONS

This study concludes that digital literacy, learning independence, and learning motivation significantly influence students' learning effectiveness in vocational education, both directly and indirectly through self-efficacy. Among these variables, self-efficacy emerged as the strongest mediating factor, amplifying the impact of students' digital competencies, autonomous behaviors, and motivational states on their academic outcomes. These findings highlight the importance of not only equipping students with technological skills and independent learning strategies but also fostering their confidence in managing learning challenges. Enhancing self-efficacy can serve as a strategic lever to improve learning effectiveness holistically, thereby aligning vocational education outcomes with the evolving demands of the digital era and the labor market.

## CONFLICTS OF INTEREST STATEMENT

Regarding this study, the author declares that there is no conflict of interest.

## AUTHOR CONTRIBUTIONS

Study concept and design: Putri Mayang Sari. Acquisition of data: Aswardi Aswardi. Analysis and interpretation of data: Ta'ali Ta'ali. Drafting the manuscript: Putri Mayang Sari. Critical revision of the manuscript for important intellectual content: Oriza Candra. Statistical analysis: M Giatman.

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