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Digital Literacy Integration Model and Creative Thinking for Enhancing Vocational Student Competencies in the Society 5.0 Era

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Abstract

The vocational education sector faces significant challenges in preparing graduates who meet industry demands in the digital era. Data from SMKN 1 Padang shows that the achievement of vocational competencies is still not optimal with aspects of knowledge 65%, skills 70%, occupational safety and health 70%, and work tests 70%. This study aims to analyze the influence of Digital Literacy, Learning Styles, and Critical Thinking on Student Competencies of SMKN 1 Padang. This study uses a quantitative approach with an explanatory survey design. The sample consisted of 81 active students of SMKN 1 Padang selected using a purposive sampling technique. Data were collected through a structured questionnaire with a Likert scale of 1-5 and analyzed using Partial Least Square Structural Equation Modeling (PLS-SEM) with SmartPLS. The research model showed excellent psychometric quality with all constructs having adequate validity and reliability (Cronbach's Alpha > 0.925, AVE > 0.597). Structural model evaluation revealed that Digital Literacy ($\beta = 0.275$, $p = 0.008$), Learning Styles ($\beta = 0.266$, $p = 0.050$), and Critical Thinking ($\beta = 0.411$, $p = 0.004$) had a positive and significant effect on Student Competencies. The model explained 82.3% of the variance in Student Competencies ($R^2 = 0.823$). The results of the study confirmed the importance of integrating Digital Literacy, appropriate Learning Styles, and the development of Critical Thinking in improving Student Competencies in Vocational High Schools. These findings provide important implications for the development of holistic learning strategies in vocational education.

INTRODUCTION

Vocational education plays a strategic role in producing graduates who are ready to enter the workforce through mastery of technical skills and strengthening work character. Vocational High Schools (SMK) are required to produce graduates with vocational competencies aligned with the

needs of the business and industrial world (DUDI), especially amidst the challenges of the Industrial Revolution 4.0 and the transformation towards Society 5.0 (Sudrajat & Disman, 2021).

Vocational competencies in the digital era encompass not only technical abilities (hard skills), but also digital literacy skills, adaptability to diverse learning styles, and critical thinking skills. Digital literacy is a fundamental competency that requires students not only to be able to access information but also to filter, evaluate, and utilize technology productively and ethically (Gilster, 1997). Meanwhile, understanding diverse learning styles enables educators to design more adaptive and inclusive learning, enabling students to optimally develop their full potential (Fleming, 1987).

Data from a 2023 national tracer study showed that only 35.4% of vocational high school graduates were employed in their fields of expertise, while the remainder worked outside their fields or were not yet absorbed into the workforce (SyababCamp, 2023). This situation indicates challenges in developing relevant and applicable vocational competencies. SMK Negeri 1 Padang, one of the leading vocational education institutions in West Sumatra, also faces similar challenges.

Based on the 2024/2025 SMK Negeri 1 Padang Curriculum Team's KOSP document, the results of the skills competency test indicate that achievement still needs improvement, with percentages for knowledge at 65%, skills at 70%, occupational safety and health at 70%, and work tests at 70%. This achievement is moderate and indicates the need for a more comprehensive and contextual vocational competency strengthening strategy.

Previous research has shown gaps in integrating Digital Literacy, Learning Styles, and Critical Thinking. Permatasari et al. (2021) showed a positive correlation between digital literacy and vocational high school students' work readiness but did not explore its interaction with learning styles and critical thinking skills. Hidayat et al. (2020) indicated that appropriate learning styles can improve academic performance but did not analyze their impact on the holistic development of vocational competencies. Widodo & Juliani (2019) found a significant effect of critical thinking skills on problem-solving skills but did not examine its interaction with digital literacy and learning styles in the context of vocational education.

Based on this background, this study seeks to answer the question of how Digital Literacy affects the Student Competencies of SMKN 1 Padang, how does the influence of Learning Styles on the Student Competencies of SMKN 1 Padang, how does Critical Thinking affect the Student Competencies of SMKN 1 Padang, and how the role of Learning Styles and Critical Thinking mediation in the relationship between Digital Literacy and Student Competencies.

This study aims to analyze the influence of Digital Literacy on Student Competencies of SMKN 1 Padang, analyze the influence of Learning Styles on Student Competencies of SMKN 1 Padang, analyze the influence of Critical Thinking on Student Competencies of SMKN 1 Padang, and analyze the mediating role of Learning Styles and Critical Thinking in the research model.

1. Vocational Competencies

Vocational competence is a set of integrated abilities that include aspects of knowledge (cognitive), skills (psychomotor), and attitude (affective) needed by students to carry out work in accordance with certain areas of expertise. According to Siswahyudi et al. (2022), vocational competence is a person's ability to carry out certain skills-based work effectively, efficiently, and in accordance with established professional standards.

2. Digital Literacy

Digital Literacy is the ability of individuals to use information technology critically, creatively, and ethically in accessing, evaluating, producing, and communicating information through various digital platforms. According to Ng (2012), Digital Literacy includes three main dimensions, namely technical, cognitive, and social-emotional skills required in the digital environment.

3. Learning Styles

Learning Styles are a unique approach that individuals use in managing, processing, and understanding new information obtained during the learning process. The VARK model developed by Fleming (1987) divides Learning Styles into four main types: Visual, Auditory, Reading/Writing, and Kinesthetic.

4. Critical Thinking

Critical Thinking is the ability to generate new, original, and useful ideas in solving problems or creating something of value. According to Guilford, Critical Thinking includes several important dimensions, namely fluency (the ability to produce ideas), flexibility (flexibility in thinking), originality (uniqueness of ideas), and elaboration (the ability to develop ideas).

METHODS

1. Research Design

This research employs a quantitative methodology utilising an explanatory survey design. This strategy was selected to elucidate the causal links among variables and to evaluate the formulated hypotheses.

2. Population and Sample

The research population comprises all active students of SMK Negeri 1 Padang for the 2024/2025 academic year, totalling 414 students. The sample was calculated via the Slovin formula, applying a confidence level of 90% and a margin of error of 10%, resulting in a selection of 81 pupils through purposive sampling.

3. Research Instruments

Data were gathered with a standardised questionnaire employing a Likert scale ranging from 1 to 5. The study instrument comprises four primary variables with validated indicators. Validity and reliability assessments indicate that all instruments satisfy the established standards.

4. Data Analysis Techniques

The analysis utilised Partial Least Squares Structural Equation Modelling (PLS-SEM) facilitated by SmartPLS software. The analysis encompasses the assessment of measurement models (outer model) and structural models (inner model), together with mediation analysis to examine the indirect relationships between variables.

RESULT AND DISCUSSION

1. Characteristics of Respondents

This study involved 81 active students of SMK Negeri 1 Padang as respondents. All respondents were students who met the sampling criteria that had been set, namely active students who participated in regular learning at school.

2. Descriptive Statistical Analysis

Before conducting an inferential analysis, descriptive statistical analysis was carried out to provide an overview of the characteristics of the data collected. Table 1 presents a summary of descriptive statistics for all research variables.

Table 1. Descriptive Statistics of Research Variables

Variable	N	Min	Max	Average	Median	Std. Deviasi	Range
Digital Literacy (X1)	81	15	50	40,95	42,00	5,19	35
Learning Styles (X2)	81	17	50	41,09	42,00	5,49	33
Critical Thinking (X3)	81	8	25	20,21	20,00	3,73	17
Student Competencies (Y)	81	8	25	19,95	20,00	3,87	17

Based on Table 1, it can be observed that the variables Digital Literacy and Learning Styles have a good data distribution with average values close to the median, indicating a relatively normal distribution. Meanwhile, the variables Critical Thinking and Student Competencies showed a smaller range of values with relatively low achievement compared to their maximum potential.

3. Respondent Achievement Level (TCR) Analysis

To provide a proportional picture of respondent achievement, a Respondent Achievement Level (TCR) analysis was carried out which compared the actual score with the ideal maximum score. Table 2 shows the results of the TCR calculation for each variable.

Table 2. Results of Respondent Achievement Level (TCR) Calculation

Variable	Average Score	Maximum Score	TCR (%)	Category
Digital Literacy (X1)	40,95	50	81,90	Good
Learning Styles (X2)	41,09	50	82,18	Good
Critical Thinking (X3)	20,21	50	40,42	Not Good
Student Competencies (Y)	19,95	50	39,90	Not Good

The results of the TCR analysis in Table 2 reveal an interesting pattern, where Digital Literacy and Learning Styles reach the "Good" category with a percentage above 81%, while Critical Thinking and Student Competencies are in the "Poor" category with an achievement of around 40%. These findings confirm the problems identified in the research background and provide an important basis for further analysis.

4. Evaluation of Measurement Models (Outer Model)

Before testing the research hypothesis, the fundamental stage that must be carried out is the evaluation of the measurement model or outer model. This evaluation aims to ensure that the research instrument used has met the validity and reliability criteria required in the PLS-SEM analysis. A good measurement model will guarantee that latent constructs can be accurately measured by the indicators that have been determined, so that the results of the structural analysis carried out later are reliable and have a valid meaning.

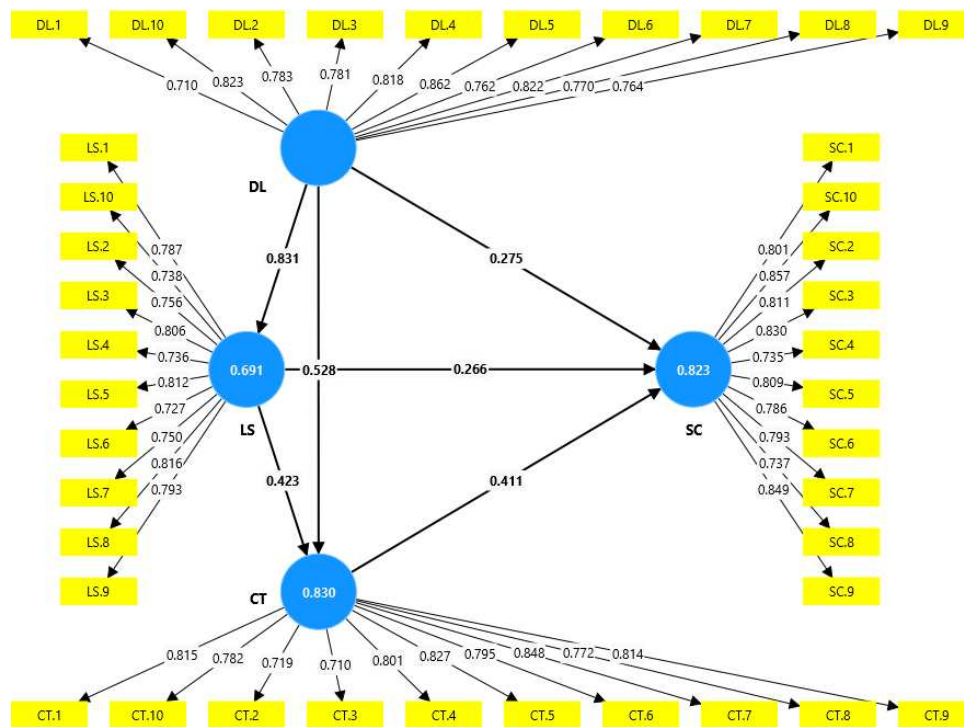


Fig 1. PLS Algorithm Output Results

Figure 1 shows the output results of the PLS algorithm which shows the complete structural model with the loading factor values for each indicator and the path coefficient between constructs. This visualization provides a preliminary idea of the strength of the relationship between variables and the measurement quality of each construct. From the diagram it can be observed that most of the indicators have an adequate loading factor, which indicates good convergent validity.

Evaluation of the measurement model is carried out to ensure the validity and reliability of the instrument before conducting structural model analysis. Table 3 presents the results of the evaluation of outer loading and VIF to detect multicollinearity problems.

Table 3. Outer Loading and VIF

Constructs	Outer loadings	VIF	Decision
CT.1 <- Critical Thinking	0.815	2.871	Valid
CT.10 <- Critical Thinking	0.782	2.329	Valid
CT.2 <- Critical Thinking	0.719	2.165	Valid
CT.3 <- Critical Thinking	0.710	2.231	Valid
CT.4 <- Critical Thinking	0.801	2.617	Valid
CT.5 <- Critical Thinking	0.827	2.840	Valid
CT.6 <- Critical Thinking	0.795	3.142	Valid
CT.7 <- Critical Thinking	0.848	3.343	Valid
CT.8 <- Critical Thinking	0.772	2.367	Valid
CT.9 <- Critical Thinking	0.814	2.711	Valid
LS.1 <- Learning Styles	0.787	2.812	Valid
LS.10 <- Learning Styles	0.738	1.942	Valid
LS.2 <- Learning Styles	0.756	2.604	Valid

Constructs	Outer loadings	VIF	Decision
LS.3 <- Learning Styles	0.806	2.759	Valid
LS.4 <- Learning Styles	0.736	2.131	Valid
LS.5 <- Learning Styles	0.812	2.432	Valid
LS.6 <- Learning Styles	0.727	2.721	Valid
LS.7 <- Learning Styles	0.750	2.287	Valid
LS.8 <- Learning Styles	0.816	2.880	Valid
LS.9 <- Learning Styles	0.793	2.441	Valid
SC.1 <- Student Competencies	0.801	3.705	Valid
SC.10 <- Student Competencies	0.857	4.271	Valid
SC.2 <- Student Competencies	0.811	3.212	Valid
SC.3 <- Student Competencies	0.830	2.940	Valid
SC.4 <- Student Competencies	0.735	2.343	Valid
SC.5 <- Student Competencies	0.809	2.866	Valid
SC.6 <- Student Competencies	0.786	4.022	Valid
SC.7 <- Student Competencies	0.793	2.485	Valid
SC.8 <- Student Competencies	0.737	2.585	Valid
SC.9 <- Student Competencies	0.849	3.562	Valid
DL.1 <- Digital Literacy	0.710	2.510	Valid
DL.10 <- Digital Literacy	0.823	2.697	Valid
DL.2 <- Digital Literacy	0.783	3.063	Valid
DL.3 <- Digital Literacy	0.781	2.326	Valid
DL.4 <- Digital Literacy	0.818	2.727	Valid
DL.5 <- Digital Literacy	0.862	3.338	Valid
DL.6 <- Digital Literacy	0.762	2.263	Valid
DL.7 <- Digital Literacy	0.822	2.817	Valid
DL.8 <- Digital Literacy	0.770	2.422	Valid
DL.9 <- Digital Literacy	0.764	2.141	Valid

The results of the evaluation in Table 3 show that all indicators have an outer loading > 0.7 and a VIF of < 5.0 , confirming the good validity of the convergence and the absence of serious multicollinearity problems. Furthermore, Table 4 presents an evaluation of the reliability and validity of the construct.

Table 4. Reliability and Validity of Constructs

Construct	Cronbach's Alpha	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Critical Thinking	0,932	0,943	0,623
Learning Styles	0,925	0,937	0,597
Student Competencies	0,938	0,947	0,643

Digital Literacy	0,933	0,943	0,625
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Table 4 shows excellent measurement quality for all constructs, with Cronbach's Alpha values > 0.925 , Composite Reliability > 0.937 , and AVE > 0.597 . These results confirm the excellent reliability and validity of the convergent for all study variables.

5. Evaluation of Discriminatory Validity

Discriminant validity was evaluated using HTMT and Fornell-Larcker criteria. Table 5 presents the results of the evaluation of discriminant validity using the HTMT criteria.

Table 5. Discriminant Validity (HTMT)

Construct	Critical Thinking	Learning Styles	Student Competencies	Digital Literacy
Critical Thinking	-	-	-	-
Learning Styles	0,927	-	-	-
Student Competencies	0,938	0,910	-	-
Digital Literacy	0,940	0,889	0,913	-

The results of the HTMT evaluation in Table 5 show values that are close to or exceeding 0.9, indicating a very high correlation between constructs. However, this can be understood in a theoretical context where research variables do have a close relationship in the learning process.

6. Evaluation of Structural Models (Inner Model)

Structural model evaluation begins with the analysis of the determination coefficient to assess the predictive ability of the model. Table 6 presents the results of the R-square analysis for endogenous variables.

Table 6. Coefficient of Determination (R^2)

Construct	R-square	R-square Adjusted	Decision
Critical Thinking	0,830	0,825	Strong
Learning Styles	0,691	0,687	Moderate-Strong
Student Competencies	0,823	0,816	Strong

The results in Table 6 show excellent predictive ability, with the model able to explain 82.3% of Student Competencies variance, 83.0% of Critical Thinking variance, and 69.1% of Learning Styles variance. Furthermore, Table 7 presents the results of the evaluation of the predictive relevance of the model.

Table 7. Cross-Validated Redundancy (Q^2)

Construct	SSO	SSE	$Q^2 (=1-SSE/SSO)$	Decision
Critical Thinking	810,000	424,668	0,476	Good
Learning Styles	810,000	500,483	0,382	Good
Student Competencies	810,000	397,390	0,509	Good
Digital Literacy	810,000	810,000	0,000	-

Table 7 confirms the predictive quality of a good model with all endogenous variables showing positive Q^2 values, indicating that the model has adequate predictive capabilities.

7. Effect Size Analysis

To understand the relative importance of each predictor, an effect size (f^2) analysis was performed. Table 8 presents the results of the effect size analysis for all paths in the model.

Table 8. Effect Size (f^2)

Path	f^2	Decision
Critical Thinking → Student Competencies	0,162	Intermediate Effects
Learning Styles → Critical Thinking	0,325	Big Effects
Learning Styles → Student Competencies	0,093	Small Effects
Digital Literacy → Critical Thinking	0,506	Big Effects
Digital Literacy → Learning Styles	2,236	Huge Effects
Digital Literacy → Student Competencies	0,087	Small Effects

The results of the analysis in Table 8 reveal that Digital Literacy has a very large effect on Learning Styles ($f^2 = 2.236$), which is the strongest effect in the model. This indicates the fundamental role of Digital Literacy in shaping students' learning preferences and ways.

8. Model Suitability Evaluation

The overall fit of the model was evaluated using various goodness of fit indicators. Table 9 presents the results of the model suitability evaluation.

Table 9. Goodness of Fit (GoF)

Indicator	Saturated Model	Estimated Model	Criterion	Decision
SRMR	0,070	0,070	< 0,08	Baik
d_ ULS	4,023	4,023	-	-
d_ G	4,241	4,241	-	-
Chi-square	1365,019	1365,019	-	-
NFI	0,627	0,627	> 0,9	Acceptable

The results of the evaluation in Table 9 show an acceptable model suitability, with SRMR values that meet the criteria (< 0.08) and NFI which, although below ideal, are still acceptable in the context of exploratory research with complex models.

9. Evaluation of the Predictive Capabilities of the Model

The predictive capabilities of the model are evaluated using the PLSpredict procedure which compares the performance of the PLS model with the linear model as a benchmark. Table 10 presents a summary of the results of PLSpredict.

Table 10. PLSpredict Summary

Construct	Q^2 predict (Mean)	PLS vs LM Comparison	Decision
Critical Thinking	0,475	PLS Superior	Highly Predictive
Learning Styles	0,394	PLS Superior	Moderately Predictive
Student Competencies	0,451	PLS Superior	Highly Predictive

The results in Table 10 confirm the predictive superiority of the PLS-SEM model compared to the linear model, with almost all indicators showing better performance, indicating high predictive quality.

10. Hypothesis Testing

Mediation analysis is a pivotal component of this study, designed to elucidate the mechanisms behind connections between variables and to find indirect effect pathways. This approach is crucial for assessing whether Learning Styles and Critical Thinking serve as mediating variables in the link between Digital Literacy and Student Competencies. A comprehension of these mediation

mechanisms will yield significant theoretical and practical insights for the formulation of more effective learning systems.

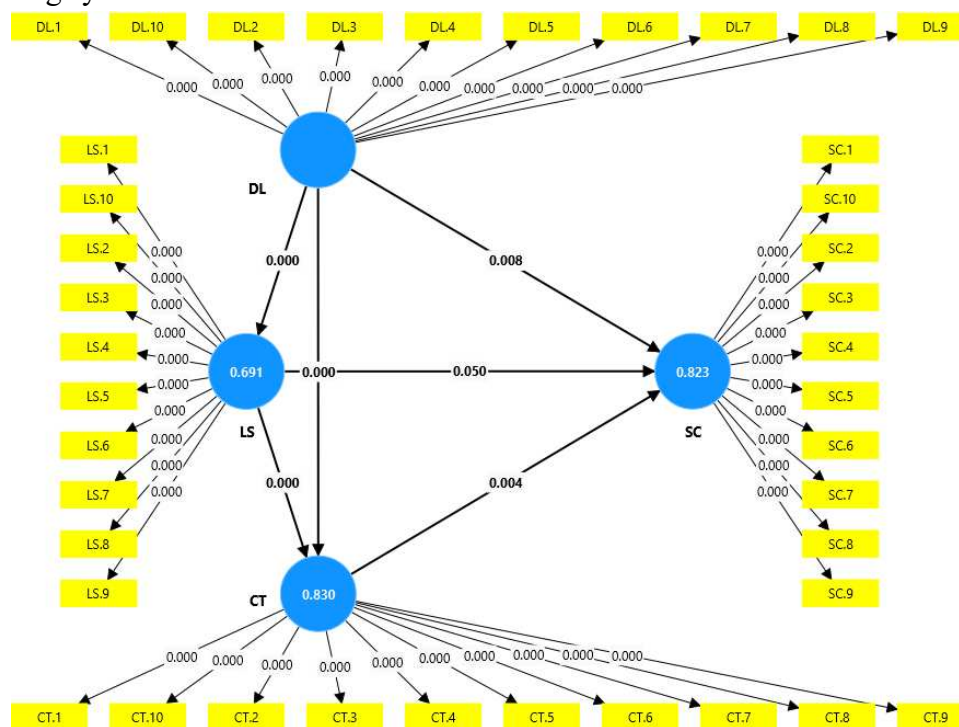


Fig 2. Output Bootstrapping

Figure 2 illustrates the bootstrapping outcomes, presenting the t-statistical values for each pathway in the structural model. This visualisation offers a summary of the statistical importance of each relationship among the constructs in the model. The graphic reveals that the majority of pathways have a t-statistical value surpassing 1.96, indicating statistical significance at the 5% level.

A bootstrapping approach was employed for hypothesis testing to assess the significance of the direct association between constructs. Table 11 displays the outcomes of evaluating the direct influence hypothesis.

Table 11. Results of Direct Influence Hypothesis Testing

Hypothesis	Patch	Original Sample (β)	T Statistics	P Values	Decision
H1	Digital Literacy $\rightarrow$ Student Competencies	0,275	2,424	0,008	Accepted
H2	Learning Styles $\rightarrow$ Student Competencies	0,266	1,645	0,050	Accepted
H3	Critical Thinking $\rightarrow$ Student Competencies	0,411	2,689	0,004	Accepted
H4	Digital Literacy $\rightarrow$ Learning Styles	0,831	17,152	0,000	Accepted
H5	Digital Literacy $\rightarrow$ Critical Thinking	0,528	5,740	0,000	Accepted
H6	Learning Styles $\rightarrow$ Critical Thinking	0,423	4,588	0,000	Accepted

The test results in Table 11 show that all direct influence hypotheses are accepted with varying degrees of significance. The H4 hypothesis shows the strongest empirical support with the highest path coefficient ($\beta = 0.831$) and the largest t-statistic (17.152).

11. Mediation Analysis

Mediation analysis was carried out to test the indirect influence pathway between variables. Table 12 presents the results of the analysis of indirect influences.

Table 12. Indirect Influence Analysis Results

Hypothesis	Patch	Original Sample (β)	T Statistics	P Values
Digital Literacy $\rightarrow$ Learning Styles $\rightarrow$ Student Competencies	0,221	1,596	0,055	Rejected
Digital Literacy $\rightarrow$ Critical Thinking $\rightarrow$ Student Competencies	0,217	2,690	0,004	Accepted
Learning Styles $\rightarrow$ Critical Thinking $\rightarrow$ Student Competencies	0,174	2,011	0,022	Accepted
Digital Literacy $\rightarrow$ Learning Styles $\rightarrow$ Critical Thinking $\rightarrow$ Student Competencies	0,144	2,049	0,020	Accepted

The results of the mediation analysis in Table 12 confirm three of the four mediation pathways tested. Critical Thinking has been shown to act as an effective mediator, while direct mediation through Learning Styles is insignificant.

12. Analisis Variance Accounted For (VAF)

To determine the type of mediation and the magnitude of the mediation effect, a VAF analysis was performed. Table 13 presents the results of the VAF calculation for a significant mediation pathway.

Table 13. Variance Accounted For (VAF) Analysis

Path	Direct Effect	Indirect Effect	Total Effect	VAF (%)	Types of Mediation
Digital Literacy $\rightarrow$ Critical Thinking $\rightarrow$ Student Competencies	0,275	0,217	0,857	25,32	Partial Mediation
Learning Styles $\rightarrow$ Critical Thinking $\rightarrow$ Student Competencies	0,266	0,174	0,440	39,55	Partial Mediation
Digital Literacy $\rightarrow$ Learning Styles $\rightarrow$ Critical Thinking $\rightarrow$ Student Competencies	0,275	0,144	0,857	16,80	No Mediation

The results of the VAF analysis in Table 13 show that most of the mediation pathways are partial, with the largest proportion of mediation occurring in the Learning Styles $\rightarrow$ Critical Thinking $\rightarrow$ Student Competencies pathways (39.55%). This indicates the importance of Critical Thinking as a transformation mechanism from learning preferences to actual competencies.

Discussion

1. The Influence of Digital Literacy on Student Competencies

The study's findings indicated that Digital Literacy positively and significantly influenced Student Competencies ($\beta = 0.275$, $p = 0.008$). This discovery aligns with the study of Mardiana et al. (2022), which identified a substantial association between Digital Literacy levels and the

technical proficiency of vocational school students, particularly in digital programming and design. Lee and Rahman's (2023) study revealed that the capacity to evaluate digital information significantly impacts Student Competencies.

This study's findings reinforce Gilster's (1997) theoretical assertion that Digital Literacy abilities are essential for competency development in the digital age. Students with proficient Digital Literacy are more adept at accessing, evaluating, and utilising digital material to enhance their learning. Within vocational education, Digital Literacy enables students to utilise technology as a means to acquire technical skills and devise inventive solutions to practical challenges.

This study advances the findings of Mardiana et al. (2022) by elucidating a mediation mechanism that clarifies how Digital Literacy influences competency via Learning Styles and Critical Thinking. These findings enhance our comprehension of the intricate nature of relationships that encompass both direct interactions and profound psychological and educational dynamics.

2. The Dominant Role of Digital Literacy in the Model

The most striking finding in this study is the dominant role of Digital Literacy in the model, especially for Learning Styles ($\beta = 0.831$) with a very large effect size ($f^2 = 2.236$). These results are in line with research by Arif & Zuryani (2021) which found that access to digital infrastructure and teacher support are significant predictors of the level of Digital Literacy of vocational school students in West Sumatra.

These findings confirm the concept of digital natives put forward by Prensky (2001), who states that the generation that grew up with digital technology has a different way of learning than previous generations. Digital Literacy not only acts as a learning tool but also shapes the way students learn. Digitally literate students tend to develop more flexible and multimodal learning preferences, utilizing a variety of digital platforms that suit their learning needs.

Compared to the study by Chen & Williams (2021) which identified complex patterns of interaction between Digital Literacy and learning preferences, this study provides strong quantitative empirical evidence of the dominance of Digital Literacy in shaping students' Learning Styles. This has important implications for learning designs that must consider Digital Literacy as an enabler that facilitates the development of effective Learning Styles.

3. Critical Thinking as a Key Mediator

The most significant finding in this study is the role of central Critical Thinking as a mediator in various relationship pathways. Critical Thinking not only has a direct effect on Student Competencies ($\beta = 0.411$), but also mediates the relationship between Digital Literacy and Student Competencies (VAF = 25.32%) as well as between Learning Styles and Student Competencies (VAF = 39.55%).

These findings confirm the results of research by Nakamura et al. (2022) which show that interventions to improve Critical Thinking skills result in significant improvements in technical problem-solving abilities and product innovation capabilities. However, this research makes a unique contribution by identifying Digital Literacy and Learning Styles as important antecedents for the development of Critical Thinking.

Garcia et al. (2023) in their meta-analysis found a consistent positive effect of Critical Thinking ability on technical competence. This study deepens the analysis by showing that in the context of vocational schools in Indonesia, Critical Thinking has a very important mediating role

with the highest VAF in the Learning Styles → Critical Thinking → Student Competencies pathway (39.55%).

4. Model Integration and Theoretical Contribution

This study validates the Rodriguez et al. (2024) model which uses structural equations to analyze the simultaneous relationships of the three variables, while deepening the analysis with a focus on the specific Indonesian context. The R^2 value obtained in this study (Student Competencies = 0.823) showed higher explanatory ability compared to the study of Rodriguez et al., which indicates that the developed model is very suitable for the characteristics of vocational school students in Indonesia.

The results of this study also provide a new perspective on the findings of Johnson et al. (2021) on the effect of moderation of cultural context on the relationship between Learning Styles and competency achievement. In the Indonesian context, especially at SMK Negeri 1 Padang, this study found that Learning Styles not only have a direct effect on competence but also play a mediator in the relationship between Digital Literacy and competence.

Findings on the mediating effects of the Digital Literacy → Learning Styles → Critical Thinking → Student Competencies series make significant theoretical contributions to the literature. This mechanism has never been identified in previous research and provides a new understanding of how digital technologies can affect learning outcomes through a series of sequential psychological and pedagogical processes.

5. Implications for Vocational Education Practice

The results of this study have important implications for vocational education practice. Compared to the research of Hartono & Sutrisno (2022) who developed a project-based learning model to increase creativity and competence, this study provides a clearer roadmap for education practitioners on how to develop students' creativity through Digital Literacy optimization and personalization of Learning Styles.

The findings on the dominance of Digital Literacy in shaping Learning Styles imply the need for a learning strategy that focuses not only on developing technical skills using technology but also on critical evaluation skills, digital ethics, and the use of technology for collaborative learning. This is in line with the recommendations of Hendri & Yulastri (2022) regarding the need to strengthen the integration of digital technology in the vocational curriculum.

CONCLUSIONS

Based on the results of the analysis and discussion, it can be concluded that Digital Literacy has a positive and significant effect on the Student Competencies of SMK Negeri 1 Padang ($\beta = 0.275$, $p = 0.008$), confirming the importance of digital skills in achieving vocational competencies. Learning Styles had a positive and significant effect on Student Competencies ($\beta = 0.266$, $p = 0.050$), demonstrating the importance of personalizing learning based on individual preferences. Critical Thinking has a positive and significant effect on Student Competencies ($\beta = 0.411$, $p = 0.004$) and plays a key mediator in the research model. The research model has excellent quality with the ability to explain 82.3% of the variance of Student Competencies, indicating the accuracy of the model in capturing learning dynamics in the digital era. Digital Literacy showed the most dominant influence in the model, especially in shaping students' Learning Styles ($\beta = 0.831$), confirming the fundamental role of technology in modern learning. Critical Thinking has proven to

be an effective mediator with the highest proportion of mediation in the Learning Styles → Critical Thinking → Student Competencies pathway (VAF = 39.55%).

This study recommends the development of an integrated Digital Literacy program that focuses not only on technical abilities but also on stimulating creativity and adaptation of Learning Styles. The implementation of personalized learning by utilizing technology to accommodate various learning styles of students is also an important recommendation. Strengthening creativity-based learning methods such as project-based learning and design thinking is needed to optimize the mediation pathways that have been identified. Advanced research with longitudinal design is recommended to understand the dynamics of competency development in the long term.

CONFLICTS OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest related to this manuscript.

AUTHOR CONTRIBUTIONS

Cici Suriyani (C.S.) served as the lead researcher and corresponding author, conceptualized the research framework integrating digital literacy with creative thinking in vocational education, designed the comprehensive research methodology including PLS-SEM analysis approach, conducted primary data collection through structured questionnaires, performed statistical analysis using SmartPLS software, and prepared the initial manuscript draft including the development of all tables, figures, and comprehensive discussion of findings. Yeka Hendriyani (Y.H.) contributed to research design and theoretical framework development, provided expertise in vocational education and digital literacy assessment, participated in instrument validation and reliability testing, supervised data collection procedures at SMK Negeri 1 Padang, and contributed to the interpretation of statistical results and manuscript revision. Fahmi Rizal (F.R.) developed the theoretical foundation for learning styles integration in vocational education, contributed to the systematic literature review and gap identification, participated in questionnaire design and validation process, assisted in data analysis interpretation particularly regarding learning styles impact, and provided critical feedback during manuscript preparation. Asrul Huda (A.H.) provided expertise in critical thinking assessment and measurement, contributed to the development of research instruments and their psychometric evaluation, participated in statistical analysis validation and model evaluation, assisted in results interpretation particularly regarding the mediating role of critical thinking, and contributed to the technical review of methodology and findings presentation. All authors collaboratively discussed the research objectives and hypotheses, reviewed and validated the theoretical framework, participated in data interpretation and discussion of implications, contributed to manuscript preparation and critical revision, and approved the final version of the manuscript for publication.

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