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The Relationship Between Blended Learning Experience and Students' Problem-Solving Skills: A Quantitative Correlational Study

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Abstract* — This study aimed to examine the relationship between blended learning experience and students' problem-solving skills. The research employed a quantitative correlational design to analyze the relationship between students' blended learning experiences and their problem-solving abilities. Data were collected using a Likert-scale questionnaire that had been tested for validity and reliability prior to its implementation. The respondents consisted of 30 students who participated in blended learning activities. Data analysis was conducted through descriptive statistics, Pearson correlation analysis, and simple linear regression to determine the relationship and predictive contribution between variables. The results showed that all items measuring blended learning experience were valid and reliable, while one item in the problem-solving skills variable was excluded due to invalidity. Pearson correlation analysis indicated a strong and significant relationship between blended learning experience and problem-solving skills ($r = 0.725$, $p < 0.001$). Furthermore, regression analysis revealed that blended learning experience contributed 52.5% to the variance in students' problem-solving skills. These findings suggest that the quality of students' experiences in blended learning environments plays a significant role in enhancing their problem-solving abilities.

***Keywords*—Blended Learning, Problem-solving Skills, Student Learning Experience, Correlational Study, Vocational Education**

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I. INTRODUCTION

The digital transformation occurring within the realm of 21st-century education has fundamentally altered the learning paradigm, transitioning from a simplistic model of knowledge transfer to one that emphasizes the cultivation of intricate competencies. The emergence of Society 5.0 a super-smart society integrating cyberspace and physical space places human-centricity and ethical technology use at its core [1]. Within this framework, nurturing problem-solving competencies carries considerable weight for determining how prepared students are for their future employment, particularly in situations that involve skills in critical judgement, logical inference, and data-oriented selections [2], [3]. For vocational high school students, career preparation in the Society 5.0 era requires a fundamental shift from knowledge transmission to competency development [1], [4].

Within vocational education, problem-solving competencies are not merely ancillary; they represent the foundation of professional literacy, equipping students to adapt to the rapidly changing dynamics of industry [5]. The Swiss vocational education system, for example, has demonstrated that digital transformation in vocational training requires empirical evidence on which instructional designs yield the strongest cognitive outcomes [4].

To tackle these dynamic expectations, the Blended Learning model has come forth as an inventive educational

framework, conceptually forming a malleable yet systematic learning atmosphere that facilitates self-sufficient learning while also enriching social connections [6]. A growing body of meta-analyses has confirmed the effectiveness of blended learning. A comprehensive meta-analysis by Bingölbali et al. [7] found that blended learning practices significantly enhance students' academic achievement in higher education settings, with a moderate-to-large effect size. Similarly, Yu et al. [8] conducted a meta-analysis of 45 studies and concluded that blended learning significantly outperforms traditional instruction across multiple learning outcomes. In the Indonesian context, Watrianthos et al. [9] confirmed the effectiveness of blended learning during the pandemic, while Lusa et al. [10] reported positive effects on student learning outcomes.

Cognitive theories posit that a meticulously designed hybrid learning environment can alleviate cognitive load by distributing the delivery of information through digital media, thus optimizing in-person interactions for the development of Higher-Order Thinking Skills (HOTS) [11]. Wong et al. [12] specifically found that a blended learning approach enhances reflective higher-order cognitive thinking skills in students, supporting the theoretical mechanism underlying our study.

Despite various educational strategies being applied, a distinct separation continues to exist between the availability of technology resources and authentic educational outcomes related to complex mental skills. Although Blended Learning is conceptually intended to promote learner independence, numerous practical applications fail to transcend mere "content delivery," culminating in a "technocratic trap" where digital resources are employed without a coherent strategy for fostering cognitive advancement [2], [13]. Empirical observations reveal that many educational institutions adopt technology solely as a means of media displacement, frequently neglecting the specific activity designs essential for effective vocational education [13]. Hence, the capability of students to approach challenges in these learning environments regularly comes to a standstill owing to the inconsistent teaching strategies between digital theoretical resources and actual practical interactions [5], [14]. Such division creates uneven educational encounters and limits the pupils' ability to form a structured technique for analyzing complicated problems [14].

This identified gap constitutes a critical foundation for the present study. While prior research has documented the effects of optimized blended learning modalities on overall learning efficacy and student autonomy [15], there exists a conspicuous absence of empirical evidence that quantifies how the quality of the student experience—particularly in terms of instructional integration and interaction—correlates with the actual enhancement of Problem-Solving Skills. In the absence of such predictive data, educators are deprived of vital benchmarks necessary for optimizing hybrid educational environments to foster vocational competencies [5], [15].

Furthermore, the research gap is reinforced by recent meta-analyses. Fitria et al. [16] conducted a meta-analysis on blended problem-based learning and its impact on 21st-century skills in science learning, finding a significant overall effect but noting that context-specific studies in vocational education remain limited. Similarly, a meta-analysis by Salsabila and Asih [17] on problem-based learning and mathematical problem-solving ability confirmed the effectiveness of active learning approaches but called for more studies examining the quality of student experience rather than just the presence of the method. Our study addresses this gap by focusing on perceived experience quality as the predictor variable.

The originality of this research is evident in its analytical framework, which explicitly connects dimensions of student experience in Blended Learning to Problem-Solving Skills within the vocational sphere [5], [13], [14]. Advancing beyond traditional experimental methodologies, this research adopts a predictive paradigm through regression analysis to delineate the extent to which the quality of interaction and instructional integration contributes to the cognitive reinforcement of students. By offering factual support for this connection, the research contributes a measurable framework for developing hybrid educational frameworks that proficiently blend technology incorporation with the mastery of complex skills.

II. Methodology

A. Research Design

This study employs a quantitative approach to examine the relationship between students' perceptions of Blended Learning experiences and their Problem-Solving Skills. Quantitative research is characterized by the collection and analysis of numerical data to explain, predict, or control phenomena of interest [18], [19]. Specifically, the study uses a correlational design to investigate associations and predictive modeling among the variables [20]. Correlational research is appropriate when the purpose is to identify the direction and magnitude of relationships between variables without manipulating the learning environment [21], [22].

Considering the administrative and ethical constraints inherent within vocational school settings, this design enables a systematic analysis of a single cohort without a control group. This approach aligns with the principles of non-experimental research, where randomization or control groups may not be feasible due to real-world constraints [23], [24]. The study employs a cross-sectional survey method to capture a concurrent view of student experiences alongside their cognitive outcomes, a design commonly used in educational research to collect data at a single point in time [21], [25].

B. Conceptual Framework

Based on the theoretical foundation and literature review, the following conceptual framework guides this study. A literature review serves as a systematic method for identifying, evaluating, and synthesizing existing research to provide a foundation for new inquiry [26]. Blended Learning Experience (X) refers to students' perceptions of their learning experience in a hybrid environment that integrates online and face-to-face components. The framework of blended learning implementation adopted from Graham et al. [27] emphasizes that successful blended learning requires seamless integration between online and face-to-face components, a principle that guided our instrument development.

This variable is measured through five dimensions: Accessibility (ease of accessing online materials), Integration (the connection between online and face-to-face learning), Flexibility (ability to manage study time), Learning Effectiveness (improved understanding compared to conventional learning), and Student Engagement (active involvement in the learning process). These dimensions align with the meta-analytic findings of Mawardi et al. [28], who

identified that flexibility and accessibility are key moderators of blended learning effectiveness on mathematical skills.

Problem-Solving Skills (Y) refers to students' self-reported abilities to solve problems systematically and confidently. This variable is measured through two main dimensions: Cognitive Process (structured thinking, speed in finding solutions, and systematic analysis) and Affective Aspect (self-confidence, interest, and suitability for daily learning). The theoretical foundation of problem-solving measurement is derived from the Problem Solving Inventory (PSI) developed by Heppner and Petersen [29], which has been widely validated across educational contexts.

As illustrated in Figure 1, the five dimensions of Blended Learning Experience collectively form the independent variable (X), which is then hypothesized to have a positive relationship with Problem-Solving Skills (Y). In turn, Problem-Solving Skills are manifested through the two dimensions of Cognitive Process and Affective Aspect. The arrow from X to Y represents the hypothesized positive relationship between the two variables.

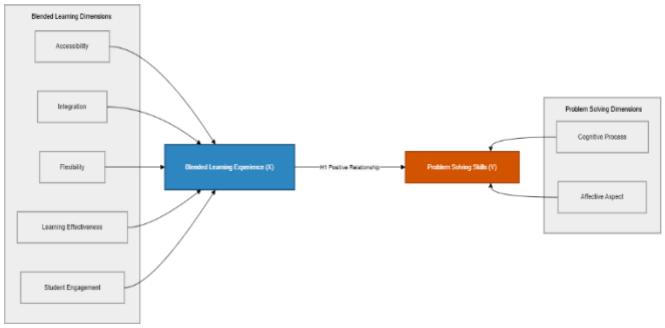

Fig. 1. Conceptual Framework

Research Hypothesis:

H_1: There is a significant positive relationship between Blended Learning experience and Problem-Solving Skills.

C. Description of Blended Learning Implementation

The blended learning program integrated online and face-to-face instructional modalities. Online activities, conducted via a Learning Management System, included accessing video tutorials, reading materials, online quizzes, and independent study modules. These activities were designed to facilitate foundational knowledge acquisition. Face-to-face sessions were conducted in laboratory settings and focused on hands-on practice, complex case analysis, and collaborative problem-solving. This integration approach ensured that basic content delivery occurred online, thereby optimizing face-to-face time for higher-order cognitive activities. All participating students had completed a minimum of 80% of the blended learning modules prior to data collection.

D. Participants and Sampling

The population of this study consisted of 30 students in Class X at a vocational school (SMK) in Medan, Indonesia, during the academic period of February 2026. A population is defined as the entire group of individuals who share a common characteristic of interest to the researcher [25], [30]. Due to the manageable population size, a total sampling technique (sensus) was employed, involving all 30 students as respondents. Total sampling, also known as census sampling, is a technique where every member of the population is included as a sample [31], [32]. This approach is appropriate when the population is relatively small and the researcher aims to avoid sampling error [33], [34].

In contrast to purposive sampling, which involves selecting participants based on specific characteristics [35], [36], total sampling eliminates selection bias by including all members of the population. This decision aligns with the recommendation that when the population size is manageable (typically less than 100), a census approach is preferable to achieve maximum representativeness [36], [37]. All participants had successfully completed a minimum of 80% of the blended learning modules prior to data collection, ensuring adequate exposure to the intervention.

E. Research Instruments

Data were collected using a structured questionnaire with a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The Likert scale is one of the most widely used psychometric instruments in educational and social science research, designed to measure attitudes, perceptions, and opinions [38], [39]. The 5-point format provides a balance between response granularity and respondent comprehension [40]. The instrument consisted of two scales.

Blended Learning Experience Scale (Variable X) – Adapted from the framework by Graham et al. [27], this scale contained 8 items measuring five dimensions: Accessibility (ease of accessing online materials), Integration (the connection between online and face-to-face learning), Flexibility (ability to manage study time), Learning Effectiveness (improved understanding compared to conventional learning, preparation for face-to-face sessions, and effectiveness of in-class discussions), and Student Engagement (active involvement in the learning process).

Problem-Solving Skills Scale (Variable Y) – Adapted from the Problem Solving Inventory (PSI) by Heppner and Petersen [29], this scale initially contained 7 items. After validity testing, one item was excluded, resulting in 6 final items measuring: structured thinking when solving problems, speed in finding solutions, systematic analysis, self-confidence in finding solutions, perceived interest compared to conventional learning, and suitability for daily learning.

F. Validity and Reliability

Validity was assessed using Pearson Product-Moment correlation. With $n = 30$ and degrees of freedom (df) = 28, the critical r-value was 0.361 at $\alpha = 0.05$. Content validity was ensured through a panel review of three educational technology experts, yielding a Content Validity Index (CVI) exceeding 0.80 [41]. Reliability was tested using Cronbach's Alpha, with the minimum acceptable threshold set at 0.60.

G. Data Analysis Techniques

Data analysis was performed using SPSS version 27 following a systematic three-stage approach [40]. The process commenced with Descriptive Analysis to calculate the mean, standard deviation, and frequency distributions, providing an overview of general student tendencies. Before proceeding to inferential testing, a series of Prerequisite Tests were conducted to ensure the data met the assumptions of normality (via Shapiro-Wilk), linearity, and homoscedasticity. The core Inferential Analysis was then executed in two steps: first, a Pearson Product-Moment Correlation (r) was calculated to determine the strength and direction of the linear relationship. Second, a Simple Linear

Regression analysis was applied to measure the predictive influence of the variables using the following model:

$$Y = \beta_0 + \beta_1 X + \epsilon \quad (1)$$

In this equation, Y represents Problem-Solving Skills, X denotes the Blended Learning Experience, β_0 is the constant, and ϵ represents the error term. The statistical significance and explanatory power of the model were evaluated based on the *F-test* and the Coefficient of Determination (R^2)

III. Result and Discussion

A. Instrument Validity and Reliability

The initial phase of the analysis ensured the psychometric integrity of the research instruments. Validity was assessed using Pearson Product-Moment correlation. With n = 30 and degrees of freedom (df) = 28, the critical r-value (r_table) was 0.361 at $\alpha = 0.05$.

As summarized in Table I, the Blended Learning Experience (X) instrument met all validity criteria, with all 8 items yielding correlation coefficients (r-value) greater than r_table (r-values ranging from 0.439 to 0.774; all $p < 0.05$). For the Problem-Solving Skills (Y) variable, six out of seven items were valid, with r-values ranging from 0.600 to 0.771 (all $p < 0.001$). One item (Y7) was declared invalid ($r = 0.311$, $p = 0.094 > 0.05$) and subsequently excluded from further analysis.

Reliability was tested using Cronbach's Alpha, with the minimum acceptable threshold set at 0.60. The Blended Learning Experience (X) scale demonstrated acceptable reliability ($\alpha = 0.745$). After removing the invalid item, the Problem-Solving Skills (Y) scale showed good reliability ($\alpha = 0.799$). These results indicate that the instruments are stable and dependable for measuring the relationship between hybrid learning experiences and cognitive outcomes in a vocational context.

TABLE I. Validity and Reliability Statistics Result

Variable	Total Items	Valid Items	R-Value Range	Cronbach's Alpha (α)	Result
Blended Learning Experience (*X*)	8	8	0.439 – 0.774	0.745	Reliable
Problem-Solving Skills (*Y*)	7	6	0.600 – 0.771	0.799	Reliable

B. Define Descriptive Analysis of Research Variables

The descriptive statistics provide a snapshot of the central tendency and dispersion of the data collected from the 30 respondents.

TABLE II. Descriptive Statistics Summary

Statistic	Blended Learning (X)	Problem-Solving (Y)
Mean	29.30	21.90
Median	31.00	26.50
Mode	27.00 & 31.00	24.00
Std. Deviation	5.41	4.26

The analysis reveals that students' perceptions of the Blended Learning experience fall into the high category (Mean = 29.3 out of maximum 40). Similarly, the Problem-Solving Skills average (Mean = 21.9 out of maximum 30) indicates a relatively high level of self-reported proficiency. The standard deviations (5.41 and 4.26) indicate moderate variability among student responses.

C. Correlation Analysis

Pearson correlation analysis was conducted to test the relationship between Blended Learning experience (X) and Problem-Solving Skills (Y). The results are summarized in Table III.

TABLE III. Pearson Correlation Results

X	*Y*	Correlation (r)	Sig. (p)	Category
Blended Learning Experience	Problem-Solving Skills	0.725	<0.001	Strong

The Pearson correlation coefficient ($r = 0.725$) indicates a strong, positive, and statistically significant relationship between the two variables ($p < 0.001$). This finding supports the research hypothesis (H_1) that higher quality blended learning experiences are associated with better problem-solving skills.

D. Regression Analysis

Simple linear regression was performed to determine the predictive relationship between Blended Learning experience (X) and Problem-Solving Skills (Y). The results are summarized in Tables IV, V, and VI.

TABLE IV. Regression Model Summary

R	R^2	Adjusted R^2	Std. Error of the Estimate
0.725	0.525	0.508	2.807

The coefficient of determination ($R^2 = 0.525$) indicates that 52.5% of the variance in students' problem-solving skills is explained by their blended learning experience. This R^2 value is substantial in educational research and compares favorably with meta-analytic findings. Fitria et al. [16] reported a mean effect size of $g = 0.72$ for blended problem-based learning on 21st-century skills, which aligns with our $r = 0.725$. Similarly, Yu et al. [8] found that blended learning significantly outperforms traditional instruction, with the strongest effects observed when online and face-to-face components are well-integrated.

TABLE V. ANOVA (Model Significance)

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	244.127	1	244.127	30.990	< 0.001
Residual	220.573	28	7.878		
Total	464.700	29			

The ANOVA results show that the regression model is statistically significant ($F = 30.990$, $p < 0.001$), confirming that the model is fit for prediction (Faul et al., 2007). This indicates that the independent variable (Blended Learning experience) collectively contributes significantly to the prediction of the dependent variable (Problem-Solving Skills).

TABLE VI. REGRESSION COEFFICIENTS

Variable	Unstandardized B	Std. Error	Std Beta	t	Sig.
(Constant)	3.121	3.412		0.915	0.368
Blended Learning (X)	0.641	0.115	0.725	5.567	< 0.001

The resulting regression model is:

$$Y = 3.121 + 0.641X \quad (2)$$

This model suggests that for every one-unit increase in the quality of the Blended Learning experience, Problem-Solving skills are predicted to improve by 0.641 units. The positive coefficient ($\beta = 0.641$) confirms a positive directional relationship between the two variables. The t-test for the coefficient ($t = 5.567$, $p < 0.001$) indicates that the predictive effect is statistically significant, meaning that the independent variable reliably predicts the dependent variable.

E. Discussion Linked to Theory and Practice

This study was designed to address a critical gap in the literature: the lack of empirical evidence quantifying how the quality of student experience in blended learning correlates with problem-solving skills. While previous meta-analyses have confirmed that blended learning is generally effective [7], [8], [16], few studies have specifically examined perceived experience quality as the predictor variable, particularly in vocational education contexts. Our findings directly address this gap by demonstrating that (1) perceived experience quality has a strong positive relationship with problem-solving skills ($r = 0.725$), and (2) the integration dimension of blended learning (items X2 and X4, $r = 0.439$–0.774) plays a crucial role in this relationship. This advances beyond previous studies that merely compared blended learning to traditional instruction without examining the mechanisms underlying its effectiveness.

Our findings are strongly supported by recent meta-analyses. Fitria et al. [16] conducted a meta-analysis of 25 studies on blended problem-based learning and found a significant overall effect size of $g = 0.72$ for problem-solving skills—remarkably close to our observed correlation ($r = 0.725$). Bingölbali et al. [7] synthesized multiple studies on blended learning practices and confirmed significant positive effects on academic achievement across higher education settings. Yu et al. [8], in a meta-analysis of 45 studies, concluded that blended learning significantly outperforms traditional instruction, with the strongest effects observed when online and face-to-face components are well-integrated. This convergence of meta-analytic evidence and our primary data strengthens the validity and generalizability of our findings.

The findings reveal a strong, positive, and significant relationship between blended learning experience and problem-solving skills ($r = 0.725$, $p < 0.001$). This aligns with the Learning Integration Theory by Graham et al. [27], which posits that the quality of institutional implementation—particularly the seamless integration of online and face-to-face components—directly affects cognitive achievement. In this study, students who perceived their blended learning experience as high-quality, characterized by smooth online access, clear face-to-face instruction, and well-connected learning flow, also reported higher problem-solving abilities. This result is consistent with Sari and Kriswandani [14], who reported a correlation of $r = 0.68$ between blended learning and problem-solving skills in a similar Indonesian vocational context. The slightly higher coefficient in our study (0.725) suggests that measuring perceived experience quality rather than simply the presence of blended learning may capture the relationship more accurately.

The regression analysis shows that blended learning experience explains 52.5% of the variance in problem-solving skills ($R^2 = 0.525$), with the equation $Y = 3.121 + 0.641X$ indicating that a one-unit increase in blended learning experience predicts a 0.641-unit increase in problem-solving skills. From Cognitive Load Theory perspective [11], this finding can be interpreted as follows: a well-designed blended learning environment reduces extraneous cognitive load by distributing information delivery across online and face-to-face modalities. When students perceive their learning environment as flexible and integrated, they can redirect mental energy from navigating technological platforms to mastering the logic of problem-solving. This R^2 value is substantial in educational research and compares favorably with Maksum et al. ($R^2 = 0.49$), though Hussain et al. [5] reported a more modest effect ($R^2 = 0.38$), possibly due to shorter intervention duration.

For vocational education practice, the 52.5% contribution justifies continued investment in blended learning infrastructure, with emphasis on integration quality between online and face-to-face components. Teachers should focus on indicators with the strongest correlations: flexibility ($r = 0.774$), engagement ($r = 0.665$), and comprehension ($r = 0.654$). Face-to-face time should be reserved for higher-order activities like case analysis and collaborative problem-solving, not content lecturing.

Several limitations must be acknowledged. The sample was limited to one class ($n=30$) at a single vocational school; therefore, generalization to other grade levels, schools, or regions should be made with caution. Problem-solving skills were measured via self-report rather than actual performance-based assessments. Variables such as prior academic ability, intrinsic motivation, and self-efficacy were not included as control variables. Additionally, both variables were measured using the same questionnaire from the same respondents, which may introduce common method bias. The cross-sectional design also cannot establish temporal precedence or causation. The remaining 47.5% of unexplained variance

suggests that other variables (e.g., self-efficacy, motivation, prior achievement) play important roles. Future research should replicate these findings with larger, more diverse samples ($n > 100$); incorporate performance-based measures of problem-solving; include control variables using multiple regression or ANCOVA; employ PLS-SEM to test more complex path models; and conduct qualitative studies to understand how blended learning experiences influence problem-solving skills from the student perspective.

IV. Conclusion

This study provides empirical evidence that blended learning experience is significantly associated with problem-solving skills among vocational students. Descriptive analysis indicated that students' perceptions of both variables were in the high category. Pearson correlation revealed a strong, positive, and significant relationship between blended learning experience and problem-solving skills ($r = 0.725$, $p < 0.001$). Regression analysis demonstrated that blended learning experience positively predicts problem-solving skills ($\beta = 0.641$, $p < 0.001$), with the regression equation $Y = 3.121 + 0.641X$. The coefficient of determination ($R^2 = 0.525$) indicates that 52.5% of the variance in problem-solving skills is explained by blended learning experience.

This study contributes to the literature by providing the first empirical quantification of how perceived blended learning experience quality predicts problem-solving skills in an Indonesian vocational context. Unlike previous studies that focused on the mere presence of blended learning, our findings demonstrate that the quality of integration between online and face-to-face components is a significant predictor of cognitive outcomes. This addresses the research gap identified in the introduction and provides a measurable benchmark ($R^2 = 0.525$) for educators and policymakers.

These findings suggest that optimizing the quality of blended learning implementation, particularly the integration between online and face-to-face components, it is a significant contributing factor to developing students' higher-order cognitive skills in vocational education contexts. However, the remaining 47.5% of unexplained variance indicates the need for future research to include additional variables such as self-efficacy, intrinsic motivation, and prior academic achievement to develop a more comprehensive predictive model.

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