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The Effect of Numeracy Literacy-Based Learning Management and Digital Media Utilization on Students' Perceived Mathematics Learning Outcomes in Public Junior High Schools

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ABSTRACT

Mathematics education in Indonesia continues to face challenges, as evidenced by low national rankings in PISA 2022 and ANBK assessments, reflecting persistent gaps in numeracy competency and contextual problem-solving skills among students. This study aimed to examine the effect of numeracy literacy-based learning management and digital media utilization, both partially and simultaneously, on students' perceived mathematics learning outcomes. A quantitative explanatory approach with a correlational design was employed. Data were collected from 163 eighth-grade students selected through proportional random sampling from a population of 275 students across two public junior high schools in Paal Dua District, Manado City, using validated Likert-scale questionnaires analyzed through multiple linear regression. Numeracy literacy-based learning management exerted a positive and significant effect on perceived learning outcomes ($\beta = 0.548$, $t = 9.512$, $p < 0.001$), and digital media utilization also had a positive and significant effect ($\beta = 0.333$, $t = 5.769$, $p < 0.001$). Simultaneously, both independent variables significantly explained 57.2% of the variance in students' perceived mathematics learning outcomes ($F = 106.820$, $p < 0.001$). Numeracy literacy-based learning management was identified as the more dominant predictor. Integrating numeracy literacy-oriented learning management with effective digital media utilization constitutes a relevant and essential strategy for improving the quality of mathematics learning in 21st-century education. Educational practitioners and policymakers should prioritize teacher professional development that emphasizes

both numeracy literacy integration and purposeful digital media use to enhance student mathematics achievement.

Keywords: digital media, junior high school, learning management, numeracy literacy, perceived mathematics learning outcomes.

INTRODUCTION

Mathematics is a foundational subject that plays a critical role in developing students' logical, analytical, critical, and systematic thinking competencies. However, despite its recognized importance, mathematics achievement among Indonesian students remains persistently low. The Programme for International Student Assessment (PISA) 2022 results placed Indonesia in the lower tier of participating countries for mathematics performance, with students demonstrating significant difficulties in problem-solving, numerical context interpretation, and mathematical reasoning (OECD, 2023). These challenges are further corroborated at the school level by Asesmen Nasional Berbasis Komputer (ANBK) data, which indicates that a substantial proportion of students have not achieved the Minimum Competency Criteria (KKM), particularly on items requiring analytical thinking and conceptual understanding.

Two interrelated factors have been identified as key contributors to this persistent gap. First, learning management practices in many Indonesian classrooms have yet to be systematically grounded in numeracy literacy, resulting in procedural, formula-memorization approaches that fail to connect mathematics to real-life contexts. Second, the utilization of digital media in mathematics learning remains suboptimal, despite substantial evidence demonstrating its potential to enhance interactivity, conceptual visualization, and student motivation (Dewi & Kurniawan, 2022; Dzikri et al., 2023).

Prior research has addressed each of these factors in isolation. Putra (2021) demonstrated that integrating numeracy literacy in learning management can enhance students' mathematical analysis skills. Septian et al. (2024) similarly confirmed that numeracy literacy integration improves problem-solving capacity and conceptual understanding. Regarding digital media, Dewi and Kurniawan (2022) reported that interactive digital media, including GeoGebra and interactive quiz applications, effectively increases conceptual understanding and mathematics learning motivation. Ariyanti and Pratama (2023) further found a positive relationship between digital learning media usage and student mathematics achievement. Dzikri et al. (2023) conducted a systematic literature review concluding that digital learning media consistently exerts positive effects on mathematics learning outcomes.

However, a critical limitation of the existing literature is that studies predominantly examine either numeracy literacy management or digital media utilization in isolation. Very few studies have empirically tested the joint, simultaneous effects of both factors within a single integrated model. Furthermore, most prior research was conducted in general educational contexts without sufficient attention to local secondary school conditions in Indonesia, particularly at the junior high school level.

The research gap identified from the review of prior studies is threefold: (1) there is an absence of studies that simultaneously model the effects of numeracy literacy-based learning management and digital media utilization on mathematics learning outcomes; (2) existing instruments rarely capture the

full depth of numeracy literacy integration and digital media quality; and (3) there is limited empirical evidence from the Indonesian local secondary school context.

The novelty of this study lies in its simultaneous examination of two pivotal 21st-century educational variables, numeracy literacy-based learning management and digital media utilization, as co-predictors of students' perceived mathematics learning outcomes in a single empirical model. By targeting eighth-grade students in a specific local context and employing a rigorously validated instrument, this study provides empirical evidence that fills the identified gap and offers actionable insights for educational practitioners and policymakers in Indonesia.

This study aimed to: (1) Examine the partial effect of numeracy literacy-based learning management on students' perceived mathematics learning outcomes; (2) Examine the partial effect of digital media utilization on students' perceived mathematics learning outcomes; (3) Examine the simultaneous effect of both variables on students' perceived mathematics learning outcomes.

THEORETICAL FRAMEWORK

Numeracy Literacy-Based Learning Management

Learning management refers to the systematic process of planning, implementing, and evaluating learning activities to achieve educational objectives effectively and efficiently (Sagala, 2013; Uno, 2011). When grounded in numeracy literacy, this management process specifically integrates students' capacities to read, interpret, and apply numerical information to solve real-world problems (Kemendikbud, 2021; OECD, 2019).

Numeracy literacy is broadly understood as the ability to access, use, interpret, and communicate mathematical information and ideas to engage in and manage the mathematical demands of a range of situations in adult life (OECD, 2019). In classroom practice, it entails directing students beyond procedural computation toward contextual understanding, data interpretation, and mathematical reasoning. Septian et al. (2024) and Pratiwi and Wibowo (2022) affirm that integrating numeracy literacy into the planning, implementation, and evaluation phases of classroom learning can substantially deepen conceptual understanding and problem-solving performance.

Digital Media Utilization in Mathematics Learning

Digital media in education encompasses all technology-based tools and platforms employed to facilitate learning, including educational applications, interactive video, Learning Management Systems (LMS), mathematical simulations, and digital quiz platforms (Arsyad, 2017; Daryanto, 2016). The theoretical foundation for digital media in learning is anchored in Mayer's (2009) Cognitive Theory of Multimedia Learning, which posits that combining verbal and visual information channels stimulates deeper cognitive processing and enhances understanding.

In mathematics specifically, where many concepts are inherently abstract, digital media enables concrete visualization of relationships between variables, dynamic simulation of geometric and algebraic concepts, and interactive engagement that sustains motivation (Hidayat & Kurniawan, 2021; Ariyanti & Pratama, 2023). Furthermore, digital media supports self-regulated learning by allowing students to access information independently, revisit material at their own pace, and engage in self-

assessment (Heinich et al., 2016).

Perceived Mathematics Learning Outcomes

Perceived learning outcomes in this study refer to students' subjective assessments of their own level of understanding, conceptual mastery, computational ability, problem-solving competency, and capacity to apply mathematical concepts in everyday contexts (Sudjana, 2016; Robbins & Judge, 2017). This construct is operationalized through a Likert-scale questionnaire rather than objective test scores, reflecting the perspective that individual perceptions of learning attainment are themselves meaningful indicators of educational quality and student engagement (OECD, 2019).

METHOD

Research Design

This study employed a quantitative explanatory approach using a correlational design to test causal relationships among variables (Sugiyono, 2022). Multiple linear regression analysis was applied to examine both the partial and simultaneous effects of the two independent variables, numeracy literacy-based learning management (X_1) and digital media utilization (X_2), on perceived mathematics learning outcomes (Y). The regression model is expressed as: $\hat{Y} = a + b_1X_1 + b_2X_2 + e$, where a is the constant, b_1 and b_2 are regression coefficients, and e is the error term.

Participants

The study population comprised 275 eighth-grade students from two public junior high schools in Paal Dua District, Manado City, during the even semester of the 2025/2026 academic year: SMP Negeri 2 Manado (n = 246) and SMP Negeri 9 Manado (n = 29). Using Slovin's formula with a 5% margin of error, a sample of 163 students was determined. Proportional random sampling was applied to ensure representation from both schools (SMP Negeri 2: n = 146; SMP Negeri 9: n = 17). Of the total sample, 55.21% were female and 44.79% were male, with ages distributed between 13 and 14 years.

Instruments

Data were collected using three structured Likert-scale questionnaires (scale 1–5). The X_1 instrument (Numeracy Literacy-Based Learning Management) comprised 35 validated items measuring planning, implementation, numeracy literacy strategies, evaluation, and literacy culture dimensions. The X_2 instrument (Digital Media Utilization) included items assessing availability, classroom use, interactivity, learning impact, and independent learning dimensions. The Y instrument (Perceived Mathematics Learning Outcomes) contained 20 items measuring perceptions of conceptual understanding, computation ability, problem-solving, and real-world application.

Instrument validity was assessed using Pearson Product Moment correlation at $\alpha = 0.05$. Of the original 40 items in the X_1/X_2 instrument, five items (Items 25, 26, 33, 35, and 38) were excluded due to r-values below the threshold (r-table = 0.361). All 20 items of the Y instrument achieved validity. Reliability was confirmed through Cronbach's Alpha: $X_1/X_2 = 0.893$ (highly reliable) and Y = 0.767 (reliable), both exceeding the 0.60 threshold.

Data Analysis

Classical assumption tests were performed prior to regression analysis: normality was tested via Kolmogorov-Smirnov (Asymp. Sig. = 0.200 > 0.05, indicating normal distribution); multicollinearity via VIF (X_1: VIF = 1.241; X_2: VIF = 1.241; Tolerance = 0.806 > 0.10, indicating no multicollinearity); and heteroscedasticity via Glejser Test (X_1: Sig. = 0.757; X_2: Sig. = 0.836; both > 0.05, indicating homoscedasticity). Hypothesis testing employed t-tests for partial effects, F-test for simultaneous effect, and the coefficient of determination (R^2) to assess explained variance. Statistical analyses were performed using IBM SPSS Statistics.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1 presents the descriptive statistics for the three study variables based on responses from 163 participants.

Table 1. Descriptive Statistics of Study Variables

Variable	N	Min	Max	Mean	SD
Numeracy Literacy-Based Learning Mgt (X_1)	163	34	85	59.43	9.412
Digital Media Utilization (X_2)	163	38	75	64.79	7.705
Perceived Mathematics Learning Outcomes (Y)	163	36	82	59.61	7.990

Frequency distribution analysis revealed that for X_1, the majority of respondents (59.52%) fell in the 'moderate' category. For X_2, 55.83% were in the 'very high' category and 41.10% in 'high', indicating widespread positive digital media exposure. For Y, 65.65% scored in the 'moderate' range, while 18.40% were categorized as 'high' and 15.95% as 'low', indicating a generally adequate but improvable level of perceived learning outcomes.

Hypothesis Testing

Multiple Linear Regression and Partial Effects (t-test)

Table 2 presents the regression coefficients and t-test results for partial hypothesis testing.

Table 2. Multiple Linear Regression Coefficients and t-test Results

Model	B	Std. Error	Beta (β)	t	Sig.
Constant	9.613	3.701	-	2.597	.010

Numeracy Literacy-Based Learning Mgt (X_1)	0.465	0.049	0.548	9.512	<.001
Digital Media Utilization (X_2)	0.345	0.060	0.333	5.769	<.001

Dependent Variable: Y (Perceived Mathematics Learning Outcomes)

The regression equation derived is: $\hat{Y} = 9.613 + 0.465X_1 + 0.345X_2$. Both X_1 ($t = 9.512$, $p < 0.001$) and X_2 ($t = 5.769$, $p < 0.001$) demonstrated statistically significant positive partial effects on Y. The standardized coefficient (β) indicates that X_1 ($\beta = 0.548$) is the more dominant predictor compared to X_2 ($\beta = 0.333$).

Simultaneous Effect (F-test)

Table 3 presents the ANOVA results for the simultaneous hypothesis test.

Table 3. ANOVA Results for Simultaneous Effect

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	5913.715	2	2956.857	106.820	<.001
Residual	4428.936	160	27.681	-	-
Total	10342.650	162	-	-	-

Predictors: (Constant), X_2, X_1; Dependent Variable: Y

The F-test yielded a highly significant result ($F = 106.820$, $p < 0.001$), confirming that X_1 and X_2 simultaneously exerted a significant positive effect on Y.

Coefficient of Determination (R^2)

The coefficient of determination ($R^2 = 0.572$) indicates that 57.2% of the variance in students' perceived mathematics learning outcomes was explained by numeracy literacy-based learning management and digital media utilization combined. The Adjusted $R^2 = 0.566$, confirming the model's explanatory power remains stable after adjustment for the number of predictors. The remaining 42.8% of variance is attributable to other factors not included in this model, such as student motivation, prior ability, learning style, and classroom environment.

Effect of Numeracy Literacy-Based Learning Management on Perceived Mathematics Learning Outcomes

The significant positive effect of numeracy literacy-based learning management on perceived mathematics learning outcomes ($\beta = 0.548$, $t = 9.512$, $p < 0.001$) is consistent with and extends prior literature. Putra (2021) reported that numeracy literacy integration in learning management significantly enhanced students' mathematical analytical abilities, a finding directly corroborated by the present study. Septian et al. (2024) similarly concluded that systematic numeracy literacy integration across planning, implementation, and evaluation phases promotes deeper conceptual

understanding and problem-solving, an outcome reflected in students' improved perceptions of their own learning achievement in the current study.

Furthermore, the present findings align with Pratiwi and Wibowo (2022), who conducted a systematic review affirming that numeracy literacy-oriented teaching consistently improves mathematics learning quality. The theoretical grounding for this effect draws on the proposition that effective learning management, when oriented toward numeracy literacy, shifts instruction from procedural memorization toward contextual reasoning (Sagala, 2013; Uno, 2011). When students engage in planning-driven, contextually rich learning that incorporates data interpretation and real-world problem-solving, their perceived mastery of mathematical concepts increases substantially.

In contrast to studies that report mixed results when numeracy literacy is applied superficially or inconsistently (Nasution & Siregar, 2024), the present study's strong effect size ($\beta = 0.548$) likely reflects the relatively structured and systematic implementation of numeracy literacy at the sampled schools, which have formally adopted the Merdeka Belajar curriculum framework. This underscores that the quality and systematicity of numeracy literacy integration, not merely its presence, is pivotal to outcomes.

Effect of Digital Media Utilization on Perceived Mathematics Learning Outcomes

The significant positive effect of digital media utilization ($\beta = 0.333$, $t = 5.769$, $p < 0.001$) corroborates a robust body of prior evidence. Dewi and Kurniawan (2022) found that interactive digital media, including GeoGebra and video-based learning, positively influenced conceptual understanding and mathematics learning motivation. The current study confirms these findings and extends them to the domain of students' perceived learning outcomes, suggesting that digital media benefits are not limited to observable test performance but also to students' self-assessed competence.

Dzikri et al. (2023), in a systematic literature review, concluded that digital learning media consistently exerts positive effects on mathematics learning, a conclusion broadly consistent with the present study's $\beta = 0.333$. However, the present study's partial beta is somewhat smaller than the effect sizes reported by Ariyanti and Pratama (2023) in their study of international school contexts, which may reflect differences in digital infrastructure quality and pedagogical integration depth between international contexts and Indonesian public junior high schools. Hidayat and Kurniawan (2021) also reported a positive but moderate relationship between digital media use and student achievement, noting that the quality of instructional design accompanying digital media use is an important moderating variable.

The theoretical framework of Mayer's (2009) Cognitive Theory of Multimedia Learning provides a compelling explanation for the observed effects: the dual-channel processing enabled by visual-verbal digital media facilitates deeper cognitive encoding, thereby enhancing students' sense of mastery and understanding, which is precisely what the perceived learning outcomes construct captures in this study.

Simultaneous Effect and the Integrated Model

The simultaneous effect of X_1 and X_2 on Y ($F = 106.820$, $p < 0.001$; $R^2 = 0.572$) is a central contribution of this study, as it empirically demonstrates that both factors act as complementary and mutually reinforcing predictors of perceived mathematics learning quality. This finding addresses the

primary research gap identified in the introduction: prior studies examined these variables independently, leaving their combined explanatory power unexamined.

The R^2 of 57.2% indicates a substantial level of explained variance, considerably higher than what would be expected from either variable alone, supporting the notion that numeracy literacy-based management and digital media utilization interact synergistically within the classroom ecosystem. This is theoretically consistent with frameworks positing that digital tools are most effective when embedded within a pedagogically coherent management structure (Gagne et al., 2005; Heinich et al., 2016). Specifically, numeracy literacy-based management provides the conceptual scaffolding and instructional intentionality that enable digital media to be deployed purposefully rather than incidentally.

This integrated finding diverges from studies that have reported limited or inconsistent effects of digital media when deployed without accompanying instructional design quality (see Hidayat & Kurniawan, 2021). It reinforces the position that the pedagogical environment, shaped by learning management quality, moderates the effectiveness of technological tools in mathematics classrooms.

CONCLUSION

This study provides empirical evidence that numeracy literacy-based learning management ($\beta = 0.548$) and digital media utilization ($\beta = 0.333$) each exert positive and significant effects on eighth-grade students' perceived mathematics learning outcomes, and together explain 57.2% of the variance in those outcomes ($F = 106.820$, $p < 0.001$). Numeracy literacy-based learning management was identified as the more dominant predictor. These findings affirm that the quality and systematicity of numeracy literacy integration within learning management, supported by purposeful digital media utilization, are essential conditions for improving mathematics learning quality in the 21st-century educational context. Future research should extend this model to include mediating variables such as student motivation and prior achievement, examine causal pathways using structural equation modeling, and test the model across different educational levels and subject areas.

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