Jurnal Teknologi Pendidikan, Agustus 2023, 25 (2), 352-359
DOI: http://dx.doi.org/10.21009/JTP2001.6
p-ISSN: 1411-2744 e-ISSN: 2620-3081
Accredited by Directorate General of Strengthening for Research and Development
Available online at http://journal.unj.ac.id/unj/index.php/jtp

The Moderating Role of Self-Efficacy on the Effectiveness of LMS-Based Learning Modules toward Student Learning Outcomes: A Pre-Experimental Study at SMP Laboratorium UM

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Received : June 27, 2023
Revised : July 30, 2023
Accepted : August 31, 2023

Abstract

This research aims to investigate the moderating role of self-efficacy using a pre-experimental one-group pretest-posttest design. Data were collected through cognitive achievement tests (pretest and posttest), a Likert-scale questionnaire measuring perceived LMS module effectiveness, and a self-efficacy questionnaire grounded in Bandura's three-dimensional framework (magnitude, generality, and strength). Data analysis included paired sample t-tests, Wilcoxon Signed-Rank tests, Spearman correlations, and Moderated Regression Analysis (MRA). Results indicated a statistically significant improvement in learning outcomes following the LMS-based module intervention ($t(26) = -8.32$, $p < .001$, Cohen's $d = 1.60$). However, neither perceived LMS effectiveness nor self-efficacy demonstrated significant correlations with posttest scores. The moderation analysis revealed that self-efficacy did not significantly moderate the relationship between LMS effectiveness and learning outcomes ($R^2 = .006$, $p = .839$). These findings suggest that while LMS-based modules effectively enhance cognitive achievement, the homogeneity of self-efficacy levels and ceiling effects in posttest scores may have constrained the detection of moderation effects.

Keywords: learning management system, self-efficacy, learning outcomes, e-module, moderated regression analysis

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How to Cite: Fadhli, M., Prasta, R. I., Zh, M. H. R., & Mahon, D. (2023). The Moderating Role of Self-Efficacy on the Effectiveness of LMS-Based Learning Modules toward Student Learning Outcomes: A Pre-Experimental Study at SMP Laboratorium UM. *JTP - Jurnal Teknologi Pendidikan*, *25*(2), 352–359. https://doi.org/10.21009/jtp.v25i2.67389

INTRODUCTION

The use of learning management system platforms and structured online learning activities by UNESCO (2022) reported that over 70% of member countries have integrated LMS into their educational systems for both distance and blended learning. In Indonesia, data from the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek, 2023) indicate that approximately 68% of secondary schools have adopted LMS platforms to support instruction. The pandemic expedited this adoption and has transformed into a

digital learning strategy in accordance with Sustainable Development Goal (SDG) 4, which underscores equitable access to quality education (Joksimovic et al., 2015).

Earlier studies have treated self-efficacy as an isolated predictor of academic success. In contrast, in the present study, self-efficacy is analyzed as a moderating variable. Based on Bandura's (1997) Social Cognitive Theory, self-efficacy shapes both students' engagement in learning activities and in their capacity to overcome obstacles and persist in digital learning contexts.

This study tested three main hypotheses: (H1) the use of LMS-based learning modules enhances student learning outcomes; (H2) self-efficacy directly impacts learning outcomes; and (H3) self-efficacy affects students' perceptions about efficacy in LMS in enhancing learning outcomes. The research takes place at SMP Laboratorium Universitas Negeri Malang that uses LMS in daily teaching. The study uses a one-group pretest-posttest design and Moderated Regression Analysis (MRA) to carefully examine how these factors interact in educational technology research.

METHODS

Research Design

This study employed a quantitative approach with a pre-experimental one-group pretest-posttest design (Sugiyono, 2021). In this design, a single group of participants was measured before and after treatment, without a control group. The treatment consisted of instruction using an LMS-based e-module on the topic of "Volcanic Eruption Mitigation in Mountainous Regions and Its Connection to SDGs" (STEM Meets Volcanic Eruptions). The design can be represented as: O_1 X O_2, where O_1 represents the pretest, X represents the treatment (LMS-based e-module instruction), and O_2 represents the posttest. Additionally, Moderated Regression Analysis (MRA) was used to test whether self-efficacy (M) moderates the relationship between perceived LMS effectiveness (X) and learning outcomes (Y). This combination of a pre-experimental design and MRA allows the study to assess learning gains and examine the moderating role of self-efficacy within an associative framework.

Population and Sample

The population comprised all international-class students at the SMP Laboratorium Universitas Negeri Malang during the 2023/2024 academic year. Using purposive sampling, one class (VIII-B) consisting of 29 students was selected as the research sample. This class was selected because it enrolled in the STEM-integrated curriculum that used LMS-based e-module. Two of the 29 students could not be included in the inferential analyses because their data was incomplete. This produced a final analytic sample of 27 students (15 male, 12 female). The sample itself is small and corresponds with pre-experimental designs in educational research, where full groups of classes serve as the analysis (Arikunto, 2019).

Variables and Operational Definitions

Three variables were investigated: (1) Perceived effectiveness of LMS-based e-modules (independent variable (X), the extent to which students perceive that their learning was enhanced by the particular qualities of performance, interactivity, access flexibility, and feedback provision of a quality online module (Watson & Watson, 2007; Cavus, 2015); (2) the moderating variable (M), self-efficacy, measured by Bandura's (1997) operationalization in three dimensions 1) magnitude: how difficult a task one feels he or she can perform, 2) generality: situations to this efficacy beliefs apply, and 3) strength: resilience of efficacy beliefs against challenge; and lastly (3) the dependent variable (Y): learning outcomes--measured through cognitive achievement scores from pretests and posttest instruments for students at Bloom's revised taxonomy levels C1 (memory: remember) and C2 (understanding: understand) levels (Nafiati, 2021).

Instruments

Three instruments were used. First, a cognitive achievement test consisting of 30 multiple-choice items covering volcanic eruption mitigation and SDGs content at C1 and C2 cognitive levels. The scoring was dichotomous (1 for correct, 0 for incorrect), and transformed to a scale from 0 to 100. Second, a 25-item Likert-scale questionnaire (4-point scale: 1 = Strongly Disagree to 4 = Strongly Agree) measuring LMS effectiveness based on four backgrounds: quality of material (7 items), interactivity and student engagement (5 items), access convenience and ease of use (6 items), and feedback, learning progress, and comprehension assistance (7 items). Five items were eliminated following empirical validity testing. Third, a 30-item self-efficacy questionnaire (4-point Likert scale) based on Bandura's (1997) framework, measuring magnitude (8 items), generality (12 items), and strength (10 items), including two reverse-scored items.

Validity and Reliability

Content validity was established through expert review by subject matter teachers and educational technology specialists. Empirical validity was assessed using item-total correlations (item-rest correlation), with a threshold of $r \geq .30$ (Azwar, 2017). For the LMS effectiveness questionnaire, 25 of 30 items met the validity criterion ($\alpha = .934$). All 30 self-efficacy items were valid ($\alpha = .947$). All 30 pretest items (r range: .388–.971; $\alpha = .979$) and all 30 posttest items (r range: .512–.966; $\alpha = .988$) met validity and reliability criteria. Reliability was calculated using Cronbach's Alpha for questionnaires and KR-20 (equivalent to Cronbach's Alpha for dichotomous items) for the achievement tests, with a minimum threshold of $\alpha \geq .70$ (Sugiyono, 2021; Arikunto, 2019).

Data Collection Procedures

Data collection followed a sequential procedure consistent with the pre-experimental design. First, students completed the self-efficacy questionnaire to capture baseline psychological characteristics. Second, the pretest was administered to measure initial cognitive ability. Third, students received the treatment, delivered via the LMS-based e-module, during the designated learning

period. Fourth, after treatment, students took the posttest and completed the LMS effectiveness questionnaire.

RESULTS & DISCUSSION

Descriptive Statistics

Table 1 shows pretest, posttest, self-efficacy, and perceived learning management system (LMS) effectiveness scores. Pretest: mean 86.3 (SD = 11.2); moderate baseline knowledge (out of a maximum score of 100) before the intervention. After the LMS-based instructions through the module, the mean posttest score increased to 96.0 (SD = 10.3), a statistically significant improvement. The mean score of self-efficacy was 3.09 (SD = 0.294) with a scale from 1-4. This finding indicates that students displayed almost uniformly strong moderate self-efficacy beliefs with relatively low variability. The mean score for the effectiveness of LMS from the participants was 3.44 (SD = 0.471). This indicates that people liked the e-module, but that these scores were a little more dispersed than self-efficacy.

Table 1. Descriptive Statistics of Research Variables

Variable	N	Min	Max	Mean	SD	α
Pretest	27	40.0	96.7	86.3	11.2	.979
Posttest	27	46.7	100	96.0	10.3	.988
Self-efficacy	27	2.60	3.70	3.09	0.294	.947
LMS Effectiveness	27	2.56	4.00	3.44	0.471	.934

Note. Self-efficacy and LMS Effectiveness scores are on a 1–4 Likert scale; Pretest and Posttest scores are on a 0–100 scale. α = Cronbach's Alpha (KR-20 for tests).

Normality Tests

The Shapiro-Wilk test showed that pretest scores ($W = 0.690$, $p < .001$) and posttest scores ($W = 0.412$, $p < .001$) were not normally distributed, which suggests a ceiling effect where scores were grouped at the top of the scale. In contrast, gain scores (posttest minus pretest) were normally distributed ($W = 0.972$, $p = .655$), meeting the normality requirement for the paired-samples t-test. Self-efficacy scores were also normally distributed ($W = 0.967$, $p = .532$), but LMS effectiveness scores were not ($W = 0.864$, $p = .002$). Residual plots from the regression model showed random scatter around zero, which supports the linearity assumption. After grand-mean centering the predictor variables, multicollinearity checks showed acceptable values (VIF range: 1.00 to 1.05; tolerance range: .950 to .997), so multicollinearity was not an issue in the final model. Cook's distance analysis revealed one observation with a comparatively significant influence (maximum Cook's D=0.312, but it was retained because it showed actual variations in student accomplishment rather than a data entering error.

Effectiveness of LMS-Based E-Module

The paired-samples t-test revealed a statistically significant increase from pretest (M = 86.3, SD = 11.2) to posttest (M = 96.0, SD = 10.3), with $t(26) = -8.32$, $p < .001$. Cohen's d=1.60 reflected a large effect size. The Wilcoxon Signed-Rank test supported these results (W=2.50, p<.001, rbs corr=-0.986), meaning that nearly all students scored better on the posttest, as reported in Table 2.

Table 2. Results of Paired Comparisons of Pretest and Posttest Scores

Test	Statistic	df	p	Effect Size	Interpretation
Paired t-test	$t = -8.32$	26	< .001	$d = 1.60$	Large effect
Wilcoxon	W = 2.50	—	< .001	$r = -0.986$	Very strong effect

Note: Wilcoxon test used as a nonparametric confirmation due to non-normal posttest distribution.

Bivariate Correlations

Spearman correlations revealed that all variable pairs were weakly associated with non-significant associations. The connection between posttest scores and perceived LMS effectiveness was ρ = .191 (p = .341), and the association between the posttest scores and self-efficacy was ρ = .017 (p = .934). The association between LMS effectiveness and self-efficacy was ρ = .148 (p = .461). The finding indicated that neither perceived LMS effectiveness nor self-efficacy accounted for a significant variation in posttest score for this population.

Moderated Regression Analysis

The MRA model on three centered predictors (LMS_c, SE_c, LMS_c × SE_c) produced a multiple R of .078 and R^2 of .006 (Adjusted $R^2 = -.124$), meaning the model accounted for less than 1% of posttest score variance. Regression Coefficients are presented in Table 3.

Table 3. Moderated Regression Coefficients Predicting Posttest Scores

Predictor	B	SE	t	p	β	95% CI
Intercept	95.895	2.11	45.36	< .001	-	[91.57, 100.22]
LMS_c	-0.831	4.69	-0.18	.861	-.038	[−10.44, 8.78]
SE_c	-1.999	7.33	-0.27	.787	-.057	[−17.02, 13.02]
LMS_c × SE_c	2.878	14.01	0.21	.839	.044	[−25.83, 31.58]

The non-significant interaction signnifies that self-efficacy does not moderate the link between perceived LMS effectiveness and learning outcomes in this sample.

Discussion

The initial finding of this study indicates that the LMS-based e-module markedly enhanced student learning outcomes, as demonstrated by the substantial and statistically significant pretest-posttest difference (Cohen's d = 1.60). This finding aligns with the broader literature establishing the efficacy of LMS-based interventions in enhancing cognitive achievement. However, the second notable finding is that neither perceived LMS effectiveness nor self-efficacy demonstrated significant bivariate correlations with posttest scores. Several methodological and contextual factors may account for these null findings. First, the ceiling effect observed in posttest scores (mean = 96.0; maximum = 100) substantially limited variability, making it difficult for any predictor to account for meaningful variance. Range restriction is a well-documented methodological issue that attenuates correlation coefficients and regression estimates (Cohen et al., 2003). Second, the homogeneity of self-efficacy scores (SD = 0.294 on a 4-point scale) suggests that students in this purposively sampled classroom held relatively uniform self-efficacy beliefs, leaving insufficient between-subject variability for self-efficacy to differentiate learning outcomes. This finding is consistent with a recent study published in a high-

impact journal that found that self-efficacy did not directly determine learning outcomes when students had similar initial skill levels. However, it did interact with learning behaviors among lower-skilled students. Third, the measurement of LMS effectiveness relied on student perceptions rather than objective behavioral indicators. Research on learning analytics has demonstrated that self-reported engagement and actual platform usage often diverge significantly, and that objective measures such as login frequency, time-on-task, and interaction patterns may be more sensitive predictors of learning outcomes (Caspari-Sadeghi, 2022; Johar et al., 2023).

The final finding, indicating that self-efficacy did not mediate the connection between perceived LMS effectiveness and learning outcomes, is a sensitive one requiring careful interpretation. The next nonsignificant interaction term (B = 2.878, p = .839) and the near-zero R^2 (.006) suggested that perceived LMS effectiveness with self-efficacy together made a small predictive contribution. The findings confirm the role of self-efficacy in academic achievement in technology-mediated learning context. While meta-analytic evidence suggests that self-efficacy and academic performance are positively related on the aggregate level, according to (Suartini et al., 2023), the current study illustrates that circumstances associated with ceiling effects, narrow variance, or strongly supported learning environments can weaken this relationship.

CONCLUSION

The study provides evidence that learning modules using LMS can positively enhance cognitive outcomes in secondary students. However, the proposed moderating impact of self-efficacy was not validated, likely due to methodological limitations such as ceiling effects, limited variance, and a small, homogeneous sample. Although these findings do not lessen the theoretical relevance of self-efficacy in technology-mediated learning, they do provide some clarification on contextual parameters conditions that may muddle the self-efficacy's moderating role.

Subsequent study should broaden the methodological framework across many domains. Stronger statistics would come from larger and more diverse samples from several schools allowing one to estimate effects of student, classroom, and school at different level. Real engagement can also be easier to quantify with perception-based questionnaires by combining login frequency, interaction logs, and response-time data.

Hence, this study advances technology-enhanced learning by indicating that LMS-based e-modules possess significant cognitive benefits, noting also that the moderation of self-efficacy is not a universal occurrence but rather context-dependent. Educational practitioners should merge LMS adoption with instructional designs that explicitly encourage self-regulation. It is crucial for researchers to use more heterogeneous samples, more nuanced achievement measures, and more inclusive analytical strategies in order to fully explicate the psychological dynamics of digital learning.

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