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Edlink LMS–Assisted Blended Learning: Its Impact on Students' Physics Conceptual Understanding and Self-Regulated Learning

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Abstract *- The rapid digitalization of higher education has created an urgent need for learning models that not only enhance students' conceptual understanding but also foster their capacity for independent learning, particularly in physics education. In this context, integrating blended learning with a Learning Management System (LMS) offers a promising strategy to support more interactive, flexible, and student-centered instruction. This study aimed to examine the effect of blended learning, assisted by the Edlink LMS, on students' conceptual understanding in physics and Self-Regulated Learning (SRL). The study employed a quantitative approach using a quasi-experimental design with a single-group pretest-posttest model. The participants were 32 students in the Physics Education Study Program at Universitas Flores. Data were collected using a four-tier diagnostic test to measure conceptual understanding and an expert-validated SRL questionnaire. The data were analyzed through descriptive statistics, normality and homogeneity tests, paired-sample t-test, and N-Gain analysis. The findings showed that students' average score in physics conceptual understanding increased from 49.65 to 82.27, while the average SRL score improved from 50.27 to 83.18. The paired-sample t-test indicated a statistically significant difference between pretest and posttest scores ($p < 0.05$), and the N-Gain values for conceptual understanding (0.65) and SRL (0.66) were both categorized as moderate. These results indicate that Edlink-assisted blended learning was effective in improving both cognitive achievement and learning independence. The novelty of this study lies in its focus on Edlink as a local LMS and in its simultaneous examination of conceptual understanding and SRL within physics education. In conclusion, integrating Edlink into blended learning provides an effective, contextually relevant approach to improving the quality of physics instruction. This study contributes to physics education by offering empirical evidence that local digital platforms can support the development of adaptive, independent, and conceptually competent future physics educators.*

Keywords: *blended learning; conceptual understanding; Edlink LMS; physics education; self-regulation learning*

I. INTRODUCTION

The rapid development of digital learning platforms, particularly Learning Management Systems (LMS), has significantly transformed physics education by enabling more interactive, flexible, and accessible learning environments (Iryani & Syam, 2025). In the context of the ongoing digitalization of higher education, the integration of technology into instructional practice is no longer optional; it has become an urgent necessity to improve teaching effectiveness and learning quality (Komljenovic et al., 2025). In disciplines such as physics, one of the major instructional challenges is helping students translate abstract principles into meaningful conceptual understanding and practical application (Bao & Koenig, 2019). Contemporary physics education, therefore, requires not only mastery of cognitive content but also the development of independent learning dispositions that enable students to adapt to rapidly evolving scientific and technological contexts (Diquito et al., 2025).

However, many students continue to experience difficulties in understanding physics concepts and in applying fundamental principles, largely because conventional teaching approaches still emphasize memorization over inquiry, reasoning, and exploration (Nasar et al., 2025). In many higher education settings, lecture-based instruction remains dominant, often resulting in limited student engagement and passive participation (Loughlin & Lindberg-Sand, 2023). This condition contributes to weak conceptual understanding, as students tend to memorize formulas without fully grasping the underlying physical meaning (Mohammadi et al., 2025). In addition, the limited availability of learning support beyond formal classroom sessions restricts students' opportunities to develop Self-Regulated Learning (SRL), making them more dependent on lecturer guidance than on their own initiative (Wong et al., 2019).

A growing body of research has shown that Blended Learning is an effective strategy for overcoming the spatial and temporal limitations of conventional instruction. By combining face-to-face and online learning, blended learning can enhance social interaction while providing flexible access to instructional materials (Singh et al., 2021). Research in digital education further indicates that blended learning environments can stimulate students' cognitive engagement through interactive multimedia and technology-supported instructional activities (Mohammadi et al., 2025). Within this framework, LMS serve as a crucial infrastructure for organizing content, facilitating asynchronous discussion, and providing timely feedback (Ashraf et al., 2021). In physics education specifically, LMS platforms are frequently used to deliver virtual simulations, digital modules, and structured exercises that support students in developing conceptual understanding independently (Mahzum et al., 2023).

The implementation of LMS platforms in physics education has been recognized as an effective alternative for improving students' understanding across multiple cognitive dimensions (Gunawan et al., 2021). One of the major strengths of LMS-based instruction lies in its capacity to integrate diverse learning theories, ranging from behaviorism to social constructivism, while simultaneously supporting personalized pedagogy and collaborative learning experiences (Ouadoud et al., 2018). The integration of virtual simulations within LMS environments has also been shown to improve students' reasoning abilities in complex areas of physics, including modern physics (Verawati et al., 2022). Similarly, the use of online learning modules at the university level has consistently contributed to better learning outcomes, particularly in conceptual reasoning and representational competence (Hill et al., 2015).

Moreover, LMS platforms that incorporate smart classroom functions, comprehensive assessment systems, and remedial learning mechanisms have been shown to strengthen students' conceptual understanding of physics significantly (Twahirwa & Ntivuguruzwa, 2024). Such platforms offer flexible access without spatial and temporal constraints, thereby enhancing lecturer–student interaction and facilitating more systematic organization of learning resources (Gunawan et al., 2019). Students' responses to these technologies have generally been positive, with many demonstrating openness toward using LMS platforms such as Moodle in science learning contexts (Psycharis et al., 2013). Overall, the use of LMS platforms has been associated with improved academic achievement and has created promising opportunities for more interactive and collaborative learning experiences in physics (Furqon et al., 2023; Amusa et al., 2024).

In higher education, LMS integration also plays a strategic role in fostering students' responsibility and engagement in learning complex subject matters (Shine & Heath, 2020). Through instructional structures such as the flipped classroom, LMS platforms can provide pre-class tasks, formative assessments, and continuous feedback that systematically encourage reflection and autonomy in choosing learning resources (Onodipe et al., 2020). Well-organized learning activities in digital environments have been shown to enhance self-directed learning and improve academic performance (Charoenwet & Christensen, 2016). This effectiveness is reinforced by students' positive perceptions of online learning environments that enable them to regulate both cognitive and behavioral aspects of their learning process (Araka et al., 2021).

Although LMS platforms offer substantial instructional potential, successful conceptual understanding also depends heavily on students' SRL skills, which include metacognitive, motivational, and affective dimensions (Alonso-Mencía et al., 2020). Because students often face challenges related to time management and independent problem solving (Arifin et al., 2025), it is important to develop learning systems that integrate course content with support for SRL strategies (Du et al., 2025). E-learning approaches that provide performance monitoring and direct instructional support can help bridge the gap between students' learning difficulties and the absence of structured guidance (Almoeather, 2020). Ultimately, the synergy between LMS features and students' learning independence contributes substantially to academic performance and deeper conceptual mastery (Araka et al., 2021).

Among the platforms currently used in Indonesian higher education, Edlink offers a comprehensive ecosystem for online and blended learning, integrating features that support efficient class management. The Home and Announcements menus allow users to monitor activities and access updated information, while the Classes and Materials menus facilitate the distribution of instructional resources such as documents and videos. Academic interaction is further supported through the Discussion, Messages, and Calendar features, which help maintain communication and scheduling. In addition, the Assignments, Quizzes, Attendance, and Grades menus support transparent evaluation processes. Together with personalized profile settings, these features form an integrated system that can enhance student engagement and instructional effectiveness in higher education contexts.

Despite the extensive literature on LMS implementation, most studies have focused on the general effectiveness of LMS platforms rather than examining the specific affordances of local platforms such as Edlink (Secaira et al., 2025). Edlink is distinct in that it integrates academic social-media-like interaction within an LMS framework that is relatively lightweight and familiar to Indonesian users (Evariani et al., 2023). However, a clear research gap remains regarding how Edlink specifically influences two important educational outcomes: students' conceptual understanding of physics and their SRL within an integrated instructional environment (Mintawati et al., 2024). Previous studies have also tended to examine cognitive outcomes and affective or behavioral outcomes separately. Research that investigates how Edlink's navigational efficiency and collaborative features may support both conceptual understanding and SRL among prospective physics teachers remains limited, even though some studies suggest that the platform performs well and is reasonably effective (Liat et al., 2025). This unresolved issue raises the question of whether a more user-friendly local platform, such as Edlink, can provide stronger learning benefits than conventional LMS-based or traditional instructional approaches in the context of complex physics content.

The urgency of this study stems from the growing need for instructional models that can simultaneously strengthen students' digital literacy and physics thinking skills (Pradana et al., 2024). Conceptual understanding is a central component of physics learning and remains one of the most persistent areas of difficulty for students (Irawan et al., 2025). Without structured blended learning interventions, inadequate conceptual understanding may continue to affect students' future performance, including their readiness to teach physics effectively in schools. At the same time, strengthening SRL through Edlink is highly relevant to lifelong learning, as students with stronger SRL are likely to be better prepared for future academic and professional challenges (Waheed et al., 2025). Delaying the investigation of local platforms such as Edlink would mean overlooking the opportunity to optimize technologies that are more closely aligned with the academic culture and digital infrastructure of contemporary higher education in Indonesia (Brugliera, 2024).

Based on these issues and identified gaps, this study aims to analyze the impact of implementing Blended Learning, supported by the Edlink LMS, on the conceptual understanding of physics among physics education students (Gingoyon, 2023). In addition, this study seeks to examine the extent to which using this platform improves students' SRL compared with conventional learning practices. By addressing these objectives, the study is expected to provide a comprehensive understanding of the synergy between Edlink LMS technology and blended learning strategies in improving the process and outcomes of physics learning. The findings are also expected to serve as an empirical reference for lecturers and curriculum developers in designing effective and interactive digital learning environments that foster independent learning among physics education students.

II. METHODS

This study employed a quantitative, quasi-experimental, single-group pretest-posttest design (Capili & Anastasi, 2025). This design was selected to examine the extent to which the blended learning intervention supported by the Edlink LMS influenced changes in the dependent variables. The study population comprised all students in the Physics Education Study Program at Universitas Flores. The sample consisted of 32 students from one intact class. This sample size was considered adequate for educational experimental research because it exceeded the minimum threshold of 30 generally required to support the assumptions of parametric statistical analysis based on the central limit theorem (Cohen et al., 2012).

The research procedure was conducted in three main stages: pretest, treatment, and posttest. In the initial stage, all 32 participants completed the instruments designed to measure their baseline levels of physics conceptual understanding and SRL. In the treatment stage, the learning process was conducted for one semester using a blended learning model that integrated face-to-face instruction with online learning activities via the Edlink LMS. These activities included access to digital modules, participation in asynchronous discussion forums, and completion of structured assignments. At the end of the intervention period, the participants completed the same instruments again during the posttest stage to determine the extent of improvement following their exposure to the blended learning environment.

The data collection instruments consisted of a conceptual understanding test in the form of a reasoned multiple-choice test, namely a four-tier diagnostic test, and an SRL questionnaire that had been validated by experts. Both instruments met the required reliability standards, with Cronbach's alpha values of 0.82 for the conceptual understanding test and 0.85 for the SRL questionnaire, indicating they were sufficiently reliable for use in this study. The collected data were analyzed using both descriptive and inferential statistics. As preliminary analyses, normality and homogeneity tests were conducted to ensure that the data met the assumptions for parametric testing. Subsequently, a paired-samples t-test was conducted to assess significant differences between pretest and posttest scores (Liang & Wang, 2026). The overall research procedure is illustrated in Figure 1.

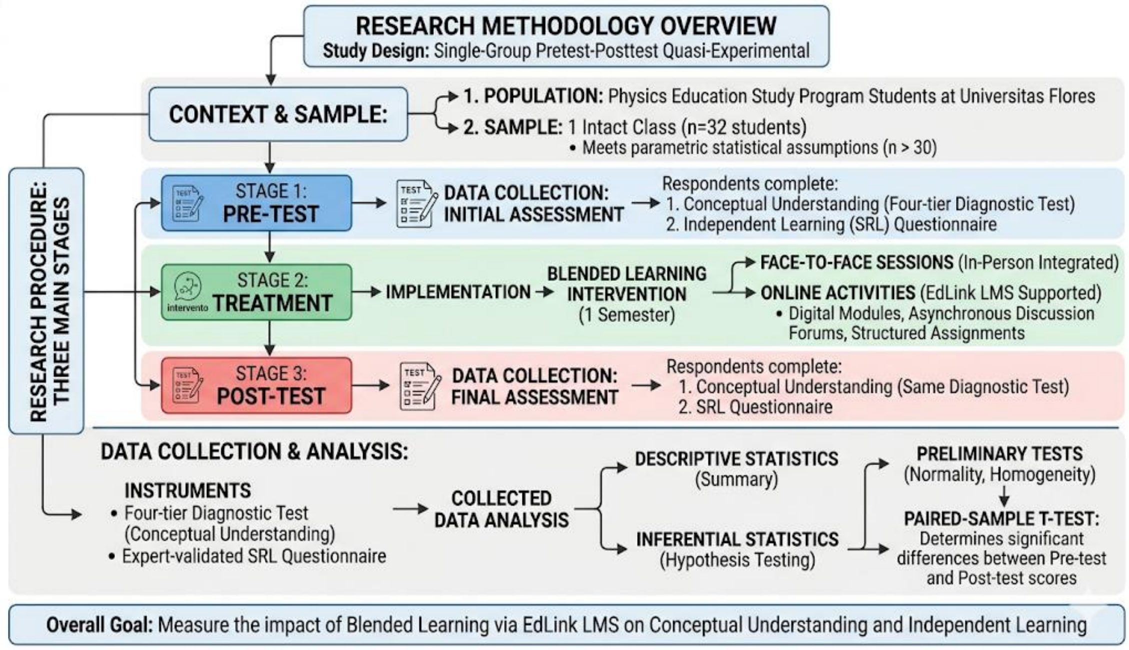

Figure 1. Flowchart of the research method

Furthermore, the N-Gain score was calculated to evaluate the effectiveness of the Edlink LMS-assisted blended learning intervention in improving students' conceptual understanding of physics and SRL categories (Meltzer, 2002).

Table 1. Category of gain score

Gain	Category
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Moderated
$g < 0.3$	Low

Source: (Meltzer, 2002)

III. RESULTS

The results of this study present the outcomes of the implementation of blended learning supported by the Edlink LMS, particularly in relation to students' physics conceptual understanding and self-regulated learning (SRL). Data were analyzed by comparing students' performance before and after the intervention using pretest and posttest scores. This comparison aims to provide an initial overview of the extent to which the learning intervention contributed to changes in both cognitive and self-regulatory aspects of learning. The descriptive results of these changes are summarized in Table 2, which displays the distribution of scores across different indicators of physics conceptual understanding and phases of SRL.

Table 2. Comparison of pretest and posttest scores of students' physics conceptual understanding and SRL

Physics conceptual understanding			SRL		
Aspect	Pretest	Posttest	Aspect	Pretest	Posttest
Apply	49.41	81.50	Forethought phase	51.03	84.28
Analyzing	49.59	83.16	Performance phase	50.34	82.91
Evaluating	50.09	81.94	Self-observation	50.28	82.59
Creating	49.5	82.5	Self-reflection	48.25	82.38
			Self-reaction	51.44	83.72
Average	49.65	82.27	Average	50.27	83.18

As shown in Table 2, all aspects of physics conceptual understanding increased substantially after the intervention. The average score rose from 49.65 in the pretest to 82.27 in the posttest. A similar pattern was observed for SRL, in which all measured aspects of forethought, performance, self-observation, self-reflection, and self-reaction showed improvement, with the average score increasing from 50.27 to 83.18. These findings indicate that the implemented learning process contributed positively to both students' cognitive achievement and their learning independence. Figure 2 illustrates the improvement in students' conceptual understanding of physics, as indicated by the pretest and posttest results.

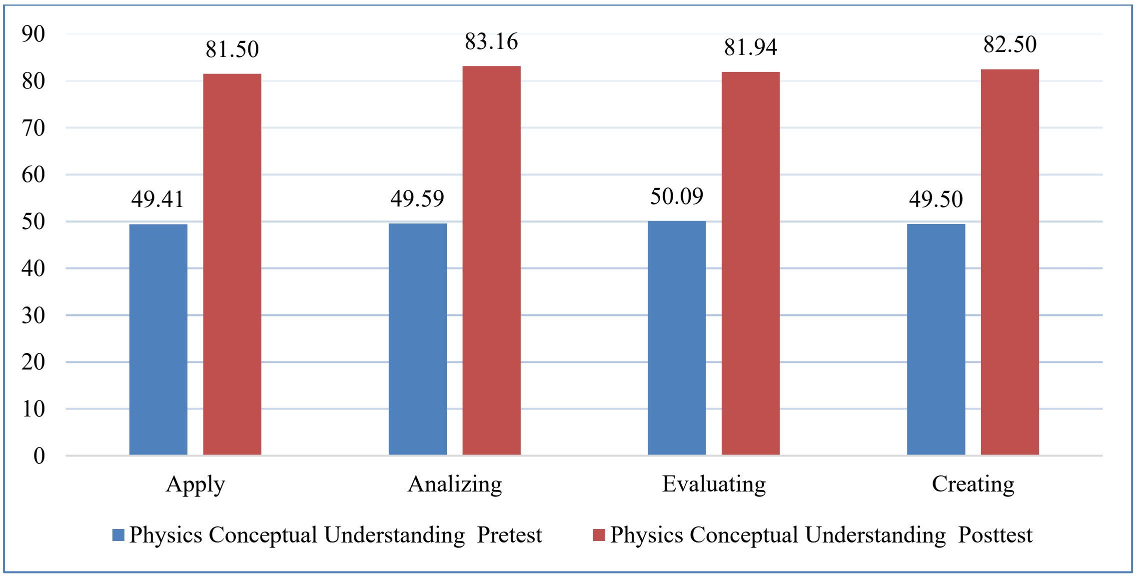

Figure 2. Improvement in students' physics conceptual understanding

The data presented in Figure 2 demonstrate a consistent increase across all indicators of physics conceptual understanding after the learning intervention. The posttest scores in each aspect were notably higher than the corresponding pretest scores, suggesting that the intervention had a positive effect on students' ability to apply, analyze, evaluate, and create physics concepts. Figure 3 presents the development of students' SRL before and after the learning intervention.

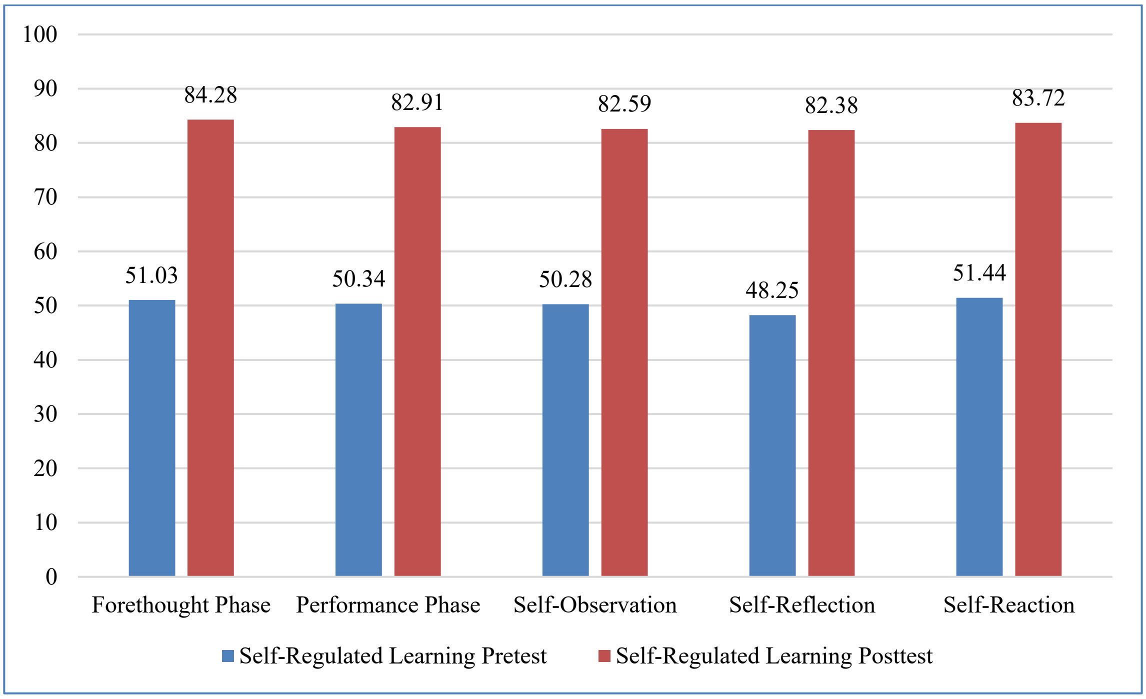

Figure 3. Improvement in students' SRL

The results shown in Figure 3 indicate clear improvement across all phases of SRL. Each indicator showed higher posttest scores than pretest scores, suggesting progress in students' planning, implementation of learning, self-monitoring, reflection, and responses to their own learning processes. Table 3 presents the results of the One-Sample Kolmogorov-Smirnov normality test.

Table 3. One-sample kolmogorov-smirnov test

		Physics conceptual understanding	SRL
N		32	32
Normal parameters[a,b]	Mean	82.2734375	83.1750000
	Std. deviation	4.59215904	2.03784632
Most extreme differences	Absolute	.196	.076
	Positive	.196	.076
	Negative	-.074	-.053
Kolmogorov-smirnov Z		1.108	.431
Asymp. Sig. (2-tailed)		.172	.992

a. Test distribution is Normal.
b. Calculated from data.

Based on Table 3, the significance value for physics conceptual understanding was 0.172, while that for SRL was 0.992. Since both values exceeded 0.05, the data for both variables can be considered normally distributed. Therefore, the data met the assumption required for further parametric statistical analysis. Table 4 presents the results of the homogeneity-of-variance test.

Table 4. Test of homogeneity of variances

	Levene statistic	**df1**	**df2**	**Sig.**
PCU	2.419	1	62	.125
SRL	2.402	1	62	.126

PCU = Physics conceptual understanding
SRL= Self-regulated learning

As shown in Table 4, the significance value for physics conceptual understanding was 0.125, and that for SRL was 0.126. Because both values exceeded 0.05, the data variances can be considered homogeneous. Thus, the homogeneity assumption for parametric testing was satisfied. Table 5 presents the results of the paired-sample t-test used to determine the mean difference between the pretest and posttest scores.

Table 5. Paired-sample t-test results

Paired samples test									
		Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference				
					Lower	Upper			
Pair 1	Post_PCU - pre_PCU	32.62500	2.14307	.37884	31.85234	33.39766	86.117	31	.000
Pair 2	Post_SRL - pre_SRL	32.90625	2.17789	.38500	32.12104	33.69146	85.471	31	.000

The paired-sample t-test results indicate that the significance values for both variables were 0.000, which is less than 0.05. This finding confirms a statistically significant difference between the pretest and posttest scores. Accordingly, the implemented learning intervention significantly improved students' conceptual understanding of physics and SRL. Table 6 presents the N-Gain scores used to determine the level of improvement in student learning outcomes.

Table 6. N-gain scores

	Pretest	**Postest**	**Gain**	**Category**
Physics conceptual understanding	49.65	82.27	0.65	Moderated
SRL	50.27	83.18	0.66	Moderated

The N-Gain score for physics conceptual understanding was 0.65, while the N-Gain score for SRL was 0.66. Both values fall within the moderate category. These results indicate that the intervention produced a meaningful improvement in both variables. Overall, the increase from pretest to posttest scores, together with the moderate N-Gain values, suggests that the blended learning intervention assisted by the Edlink LMS had a positive impact, although further improvement remains possible.

IV. DISCUSSION

The findings of this study indicate that blended learning, assisted by the Edlink LMS, had a significant positive effect on students' conceptual understanding of physics and SRL. This was reflected in increases in the average conceptual understanding score from 49.65 to 82.27 and in the average SRL score from 50.27 to 83.18. These improvements were further supported by the paired-sample t-test results, which showed a p-value < 0.05, and by the N-Gain values, which were categorized as moderate. Taken together, these results suggest that the implemented intervention was effective in enhancing both students' cognitive achievement and their capacity for independent learning.

The improvement occurred consistently across all measured dimensions. In terms of conceptual understanding, students showed progress in applying, analyzing, evaluating, and creating. Similarly, in terms of SRL, improvement was observed across the phases of planning, implementation, self-observation, reflection, and reaction. These patterns indicate that integrating face-to-face instruction with LMS-supported online learning created a more interactive and structured learning environment, which, in turn, supported students' active engagement and learning autonomy. In this context, Edlink appears to function not only as a medium for content delivery but also as a platform that facilitates more organized and self-directed learning experiences.

These findings are consistent with previous studies reporting that blended learning positively contributes to students' conceptual understanding and SRL. Research conducted by Hawi and Sudira (2019) and Chinwendu et al. (2020) similarly found that blended learning implementation was associated with improvement in students' understanding of physics concepts and their learning independence. The consistency between the present findings and previous studies strengthens the argument that blended learning environments supported by digital platforms can promote both conceptual mastery and independent learning behavior in physics education.

Nevertheless, several limitations of this study should be acknowledged. First, the study employed a single-group design without a control group, which limits the ability to attribute the observed improvements exclusively to the intervention. Second, the sample size was relatively small and limited to one study program, which reduces the generalizability of the findings. Third, the study's duration captured only short-term effects and did not reflect the intervention's long-term impact. These limitations suggest that the findings should be interpreted with caution.

Therefore, future studies are recommended to involve larger, more diverse samples, employ more rigorous experimental designs with control groups, and examine the long-term effects of blended learning interventions. Further research may also compare Edlink's effectiveness with that of other LMS platforms in supporting conceptual understanding and SRL in physics education. Despite these limitations, this study makes an important contribution to the field of physics education by providing empirical evidence that using a local LMS, such as Edlink, within a blended learning model is effective not only in improving students' understanding of physics concepts but also in fostering their SRL. These findings suggest that Edlink-assisted blended learning can support the development of future physics educators who are adaptive, independent, and better prepared to respond to the demands of learning in the digital era.

V. CONCLUSION AND SUGGESTION

The findings of this study demonstrate that implementing blended learning supported by the Edlink LMS had a positive and significant effect on students' conceptual understanding of physics and SRL. This was reflected in increases in the average score for physics conceptual understanding from 49.65 to 82.27 and in the average SRL score from 50.27 to 83.18. In addition, all cognitive aspects, namely applying, analyzing, evaluating, and creating, as well as all phases of SRL, showed consistent improvement after the intervention. These findings, supported by the paired-sample t-test results and moderate N-Gain scores, indicate that Edlink-assisted blended learning was effective in improving both students' conceptual mastery and their learning independence.

Despite these promising findings, this study has several limitations, including a single-group design without a control group, a relatively small sample drawn from only one study program, and a short-term intervention, which limits the generalizability of the results. Therefore, future research is recommended to involve larger, more diverse samples, employ more rigorous experimental designs with control groups, and examine the long-term effects of blended learning interventions, as well as compare Edlink with other LMS platforms. Nevertheless, this study contributes to the field of physics education by providing empirical evidence that a local LMS, such as Edlink, can effectively support improvements in both physics conceptual understanding and SRL. In this regard, the study offers a practical, contextual reference for developing technology-based learning innovations to prepare adaptive, independent future physics educators.

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