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The Effect of Seamless Learning on Learning Outcomes

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Abstract
This research investigates the effect of seamless learning on learning outcomes (problem-solving and procedural) in Basic Physics courses. LMS-assisted seamless learning strategy with zoom-assisted seamless learning strategy through a quasi-experimental research design with 2x2 factorial. This research involved 73 students at Akba Technology University Makassar as research subjects. They are students in the Basic Physics course in the first semester of the 2022/2023 academic year. Students are divided into two groups. The experimental group consisted of 37 students who carried out the learning process using a seamless learning strategy assisted by LMS, while the control group consisted of 36 students who carried out the learning process using a seamless learning strategy assisted by Zoom. This research uses test instruments in the form of multiple-choice and essays. Data analysis used Multivariate Analysis of Variance (MANOVA). The research results show that, firstly, there is a significant difference in problem-solving learning outcomes between students taught using seamless learning assisted by LMS and seamless learning assisted by Zoom. Second, there is a significant difference in procedural learning outcomes between students taught using seamless learning assisted by LMS and seamless learning assisted by Zoom.

Keywords: Seamless Learning; Learning Management System; Problem Solving; Procedural; Learning Outcomes; Basic Physics

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INTRODUCTION

Collaboration between the development of science and technology has helped humanity achieve ever-increasing levels of intelligence and prosperity. IT penetration has reduced human interaction and digital-based human activities in various industries. Many activities have moved online, including e-learning, e-government, e-commerce, and other activities that focus on online. The development of information technology creates opportunities to advance educational standards in line with technology to meet the demands of global growth, digital lifestyles, and economic understanding (Wong et al., 2015). The latest views on learning using technology offer the potential for a new phase in the continuous evolution of learning experiences in various learning situations. Seamless learning is the continuity of learning in a combination of location, time, technology, or social environment. This learning can be intentional, such as when learning activities begin in the classroom and continue through informal discussions with colleagues or online at home (Cross et al., 2019). Research on seamless learning has become a trending topic in the Scopus journal. The research results in Durak & Çankaya (2018) explained that as many as 58 studies had been surveyed to determine a list of concepts on the journal list, the most cited research, research methods and models, participants, data collection tools, and variables in this article. The research results show a considerable increase in the number of studies regarding seamless learning. Singapore is a leading country in seamless learning research. Virtanen et al. (2017) examined seven articles, five conducted on seamless learning from Taiwan and two from Japan.

Seamless learning encourages students to implement learning material learned in a formal environment into daily activities outside the classroom. The characteristics of seamless learning are that it 'bridges' multifaceted learning efforts in several spaces. Seamless learning allows students to learn in various settings and transition smoothly from one setting or context to another (informal and formal learning, personal and social) while using a private medium. Therefore, in seamless learning, students get the same learning experience, even in different locations (Amhag, 2017). Designing a learning environment suitable for seamless and distance learning is important (Yetik et al., 2019). A seamless learning environment is a space that can be accessed via mobile or stationary devices and is equipped with technology to meet learning needs. In seamless learning, learning tools are created to adapt learning content to suit the learner's context.

The learning objectives are achieved, as seen from the results of the learning evaluation. Evaluations carried out on students focus on academic achievement, behavior, and attitudes. Description of classroom behavior includes following instructions or directions, listening to lessons, working together with friends, and using study time wisely (Slavin, 2015). Efforts to solve every problem are a fundamental activity carried out by humans. Most of the human thinking is related to solving these problems. So, the result of learning problem-solving is that it becomes one of adult humans' most critical skills (Slavin, 2015). Mutmainnah et al. (2021) stated the steps in solving problems: 1) understanding the problem, 2) preparing a plan to solve the problem, 3) carrying out activities according to the plans made, and 4) re-evaluating the problem-solving and solution. Greenstein (2012) added a problem-solving stage, namely, Brainstorming all possible solutions (putting forward all possible solutions).

Procedural knowledge consists of three. The first is knowledge about skills in specific fields, such as algorithms that prioritize procedures or step-by-step rather than using one's abilities. Second, knowledge about techniques and methods in a particular field, namely knowledge that can show changing results. Such as knowledge of the techniques or methodologies researchers use to find solutions to problems. Third, knowing the criteria helps determine when to use appropriate procedures. Students are required to know how to use the procedures they have carried out. They can also show the relationship between the methods and techniques they have used or those used by others (Schunk & Greene, 2017). (Degeng, 2013) positions procedural type knowledge in third place, while (Wilson, 2016) places it in fourth place. Procedural knowledge explains how to do or make something (Wilson, 2016). This knowledge can also be defined as a cognitive ability that clearly explains the steps in carrying out actions within a procedural framework. (Rittle-Johnson & Star, 2009) explains that procedural knowledge is an effort to carry out work sequences in arranging objects and step-by-step arrangements to achieve a solution.

Based on the results of the study, it can be concluded that the limitless learning strategy assisted by the Learning Management System (LMS) can improve learning outcomes in problem solving and procedural. This study proves that this limitless learning strategy is innovative and can be applied to improve learning outcomes in problem solving and procedural. However, this study has limitations, namely it takes time to see student activities in detecting learning carried out informally by students. The internet network at their place of residence is also inadequate.This research uses a seamless learning strategy involving all learning spaces (social and individual, informal and formal, digital and physical) that utilize technological devices. This research will be applied in physics courses, considering that when students study physics courses, it does not rule out the possibility of learning in a formal environment; it also occurs in non-formal environments and is carried out continuously.

The research aims to investigate how seamless learning impacts learning outcomes, specifically in the areas of problem-solving and procedural knowledge. Seamless learning refers to an educational approach that integrates learning experiences across various contexts, technologies, and environments, allowing for a continuous and cohesive learning journey. The focus will be on understanding whether this integrative approach enhances students' abilities to solve problems and perform procedural tasks more effectively compared to traditional learning methods.

This research is urgent because of the rapid advancement of technology and the need for education systems to adapt. The increasing prevalence of digital learning platforms, as well as the COVID-19 pandemic, emphasizes the importance of flexible learning environments. By conducting this research, educators and policymakers can optimize learning strategies to meet the evolving needs of students and prepare them with essential skills for the future.

Understanding the impact of blended learning helps educators design curricula to enhance students' problem-solving skills, essential for academic and professional success. The findings provide insights for teachers and educational institutions into more effective teaching methods. Policymakers can use the research findings to develop guidelines to support the implementation of blended learning, in line with technological advances. Blended learning can also bridge the gap in access and quality of education, providing cohesive learning opportunities for all students, and preparing them for the demands of an evolving job market.

METHODS

The approach in this study is a combination of qualitative and quantitative (mixed methods). The quantitative approach will be used to measure student learning outcomes in problem solving and procedural learning, while the qualitative approach is used to explore student experiences in using seamless learning. This approach provides an overview of how seamless learning affects students' abilities in problem solving and procedural, and how the integration of technology and face-to-face learning can provide better results than traditional methods.

This research uses a quasi-experimental research design (quasi-experimental non-equivalent control group). The research method uses quasi-experiment because the subjects involved in the research were not chosen randomly. This is because the classes that will be research subjects are already structured and administratively. Researchers cannot randomize classes (Setyosari, 2016) —quasi-experimental research design with 2x2 factorial. Factorial design is used when researchers consider other variables, including the independent variable (Setyosari, 2016). In this research, there is an experimental class, namely a class given a seamless learning strategy assisted by the Learning Management System (LMS), and a control class, namely a class given a seamless learning strategy assisted by Zoom.

This research involved students enrolled in the Basic Physics course in the first semester of 2022/2023 at AKBA University of Technology Makassar. The participants in this research were 39 students who took classes taught using a seamless learning strategy assisted by LMS and 36 who took classes taught using a seamless learning strategy assisted by Zoom. Data was collected through problem-solving learning outcomes tests and procedural learning outcomes tests. Instruments used to measure students' problem-solving abilities. The test items are made according to indicators (Mutmainnah et al., 2021), namely: 1) understand the problem (understand the problem), 2) put forward all possible solutions (brainstorm all possible, 3) carry out the plan as a solution (carry out the plan), 4) look or check again (looking back). The test instrument used to measure procedural learning outcomes is in the form of multiple choice questions, which relate to Bloom's level of thinking in the cognitive domain.

This research consists of 2 stages: the experimental preparation and the experimental stages. The experimental preparation stage includes preliminary study activities regarding Basic Physics courses, SAP preparation, and testing the validity and reliability of the instrument. The second stage is experimentation, which consists of 4 activities. In the first activity, informal stage 1, students access and study lesson material offline and online. In this stage, students study in an informal environment and are expected to be involved in learning activities. The learning process uses the Learning Management System (LMS) at UNITAMA, called E-Macca.

LMS functions not only to accommodate student activities such as attendance and participation, but also as a platform to access open materials. Students use LMS to download learning materials in the form of e-books, open materials to be discussed, and questions to prepare for class discussions. In addition, students are also directed to watch learning videos as part of a multimodal learning method that combines text, video, and discussion.

Data collected from problem-solving and procedural learning outcomes tests were analyzed using inferential statistical analysis techniques, namely, the Multivariate Analysis of Variance (MANOVA). This analysis reveals the differences in problem-solving and procedural learning outcomes between the experimental and control groups.

RESULTS & DISCUSSION

Description of Learning Implementation with seamless learning strategy

In the informal stage 1, students learn the course materials offline and online through the E-Macca Learning Management System (LMS) at UNITAMA. They access e-books, teaching materials, and learning videos. Students are expected to understand the material before formal classes and can discuss in the forum. This stage includes the dimensions of seamless learning, including informal, personal, social, and digital learning, as well as access to knowledge from various sources. Students are expected to be able to explain the material being studied.

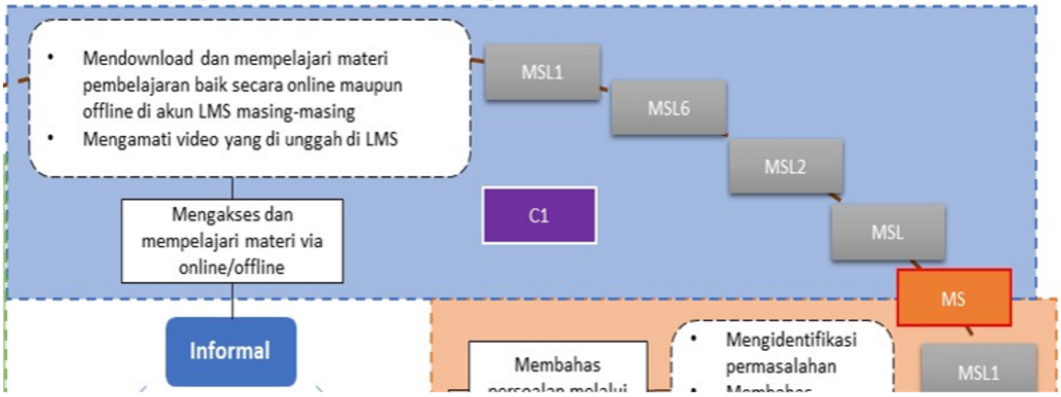

Figure 1. Informal Learning 1 in Seamless Learning

In formal stage 1, students discuss and create work steps to solve physics problems in groups. They identify problems, discuss solutions, and compile solution steps that are uploaded to the LMS. This process reflects the dimensions of seamless learning, including formal, data collection, analysis, communication, and knowledge synthesis. It is expected that students can understand and apply the concepts learned (C2 and C3).

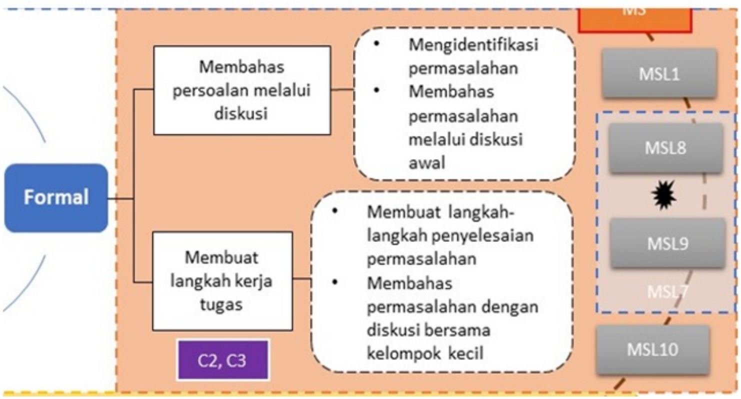

Figure 2. Formal Learning 1 in Seamless Learning

In the Informal Stage, students work in an informal environment through web browsing and discussions. They analyze physics problems, make observations, and search for literature for portfolios. The learning process includes the dimensions of seamless learning, namely MSL1, MSL2, MSL5, and MSL6, which involve access to knowledge from various sources and individual and social learning. Students are expected to be able to analyze, evaluate, and create (C4, C5, and C6).

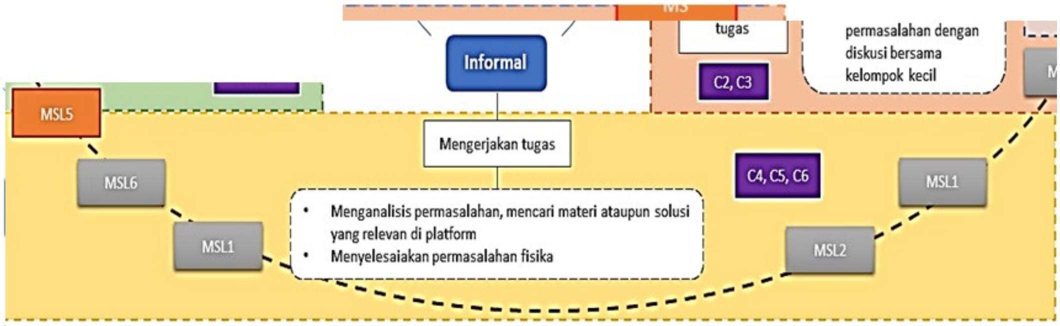

Figure 3. Informal Learning 2 in Seamless Learning

Formal stage 2 is the presentation of reports by each group in class, followed by a Q&A session and revision of the report. This process reflects several dimensions of seamless learning (MSL 1, 3, 4, 5, 7, 8, 9, and 10) involving formal dimensions, individual and social engagement, and access to knowledge from various sources. Students use various learning tools and learning strategies to analyze, evaluate, and create (C4, C5, C6).

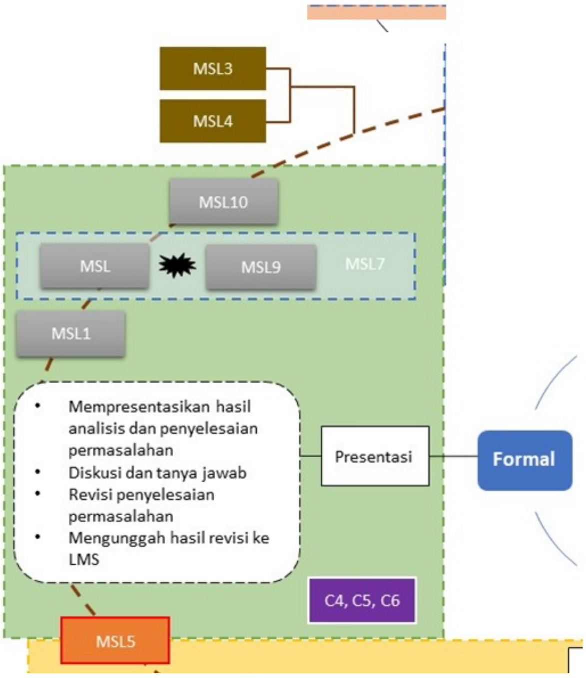

Figure 4. Formal Learning 2 in Seamless Learning

Learning Outcomes with seamless learning strategies

The post-test results on problem-solving learning outcomes between the experimental and control groups are as follows.

Table 1. Level of Problem-Solving Learning Outcomes for Experiment and Control Class for Post-Test

No	Criteria	Value	Experiment		Control	
			Total	%	Total	%
1	Very Good	86 – 100	10	27,03	3	8,33
2	Good	71 – 85	25	67,57	30	83,34
3	Enough	56 – 70	2	5,40	3	8,33

4	Less	41 – 55	0	0	0	0
5	Very Less	0 – 40	0	0	0	0
	Total		37	100,00	36	100,00

Table 1 illustrates the experimental class students' problem-solving learning outcomes. This was proven by 27.03% achieving a very good level, 67.57% good, and only 5.40 in enough category in the experimental class post-test score. There were no students in the inferior categories. On the other hand, in the control class, only 8.33% had a very good level. The dominant score was good; 83.34% of students achieved a good level, and 8.33% in the enough category.

Table 2. Level of Procedural Learning Results for Experiment and Control Class for Post-Test

No	Criteria	Value	Experiment		Control	
			Total	%	Total	%
1	Very Good	86 – 100	8	21,62	1	2,78
2	Good	71 – 85	19	51,35	16	44,44
3	Enough	56 – 70	10	27,03	15	41,67
4	Less	41 – 55	0	0	4	11,11
5	Very Less	0 – 40	0	0	0	0
	Total		37	100,00	36	100,00

Table 2 depicts the results of procedural learning in the experimental class post-test: 21.62%, which is very good, and good level dominates at 51.35%, but there are still students who have enough level at 27.03%, students who have less grades are still at control class, but the number was only 11.11%. Meanwhile, the inferior category for post-test scores in all classes no longer exists.

Analysis of the influence of learning strategies on problem-solving and procedural learning outcomes in Table 3 below.

Table 3. Effect Test Results

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Pemecahan_masalah	3896.432[a]	3	1298.811	10.091	.000	.305
	Prosedural	9440.915[b]	3	4805.305	24.161	.009	.153
Intercept	Pemecahan_masalah	438247.804	1	438247.804	3404.905	.000	.980
	Prosedural	516256.342	1	516256.342	4471.939	.000	.985
Strategi_Pembelajaran	Pemecahan_masalah	1822.131	1	1822.131	11.172	.002	.162
	Prosedural	987.714	1	987.714	9.626	.000	.223
Error	Pemecahan_masalah	8881.041	69	128.711			
	Prosedural	7965.602	69	115.444			
Total	Pemecahan_masalah	450536.500	73				
	Prosedural	528309.556	73				
Corrected Total	Pemecahan_masalah	12777.473	72				
	Prosedural	9406.518	72				

a. R Squared = 0.305 (Adjusted R Squared = 0.275)
b. R Squared = 0.153 (Adjusted R Squared = 0.116)

Table 3 shows the results of learning problem-solving for the experimental and control groups, F = 11.172 and significance 0.002 < 0.05. This means there is a significant difference between the problem-solving learning outcomes of the students taught with a seamless learning strategy assisted by LMS and those taught with a seamless learning strategy assisted by Zoom. Table 3 also shows the procedural results of the experimental and control groups, F = 9.626 and significance 0.000 < 0.05. It can be concluded that there is a significant difference between the problem-solving learning outcomes of the group of students who were taught with the seamless learning strategy assisted by LMS and those who were taught with the seamless learning strategy assisted by Zoom.

DISCUSSION

The implementation of the seamless learning strategy using LMS showed better problem-solving learning outcomes compared to the Zoom-assisted strategy. The average score for the class using LMS reached 81.36, while the control class was only 77.14. The Manova test showed a significant difference with a significance value of 0.002. In addition, the procedural learning outcomes of students using LMS were also higher (79.29) compared to Zoom (70.58). Although the difference was not too far, statistically, the Manova test showed a significant difference with a significance value of 0.000, confirming the positive influence of the LMS strategy on student learning outcomes.

Differences in problem-solving learning outcomes in students with high self-efficacy and low self-efficacy. The difference in terms of average is not too different where students with high self-efficacy have learning outcomes reaching 81.55 while students with low self-efficacy reach 77.14. The Manova test ensures that the difference obtained is very significant, namely 0.000 with a significance level of 95%. Based on the test results, it is concluded that there is a difference in problem-solving outcomes between students with high self-efficacy and students with low self-efficacy, where the learning outcomes of students with high self-efficacy are higher. Interaction of learning strategies and self-efficacy in influencing problem-solving learning outcomes in students. The existence of interaction is proven by the results of the Manova test, where in the test of between-subjects effects table the significance value is obtained at ,000. Judging from this value, it can be concluded that learning strategies and self-efficacy have an interaction in influencing problem-solving learning outcomes, and the contribution given reaches 30.5%.

Research findings show significant differences in problem-solving learning outcomes between LMS-assisted and Zoom-assisted seamless learning strategies. Students in classes that use seamless learning strategies assisted by LMS have higher learning outcomes than classes that use seamless learning strategies assisted by Zoom. This is consistent with the opinion of several studies that using seamless learning strategies can improve learning outcomes in problem-solving, but the effectiveness of seamless learning also depends on appropriate learning design and the use of appropriate technology. A study shows that a seamless learning strategy assisted by a learning management system (LMS) increases problem-solving abilities and strengthens collaborative skills (Purba et al., 2022). Using seamless learning strategies assisted by LMS and mobile devices can increase learning effectiveness and student satisfaction (Baharun et al., 2021). Using seamless learning strategies assisted by blended online learning and Zoom can increase student engagement and facilitate distance learning during the COVID-19 pandemic (Zainal et al., 2022). Efforts have been made to increase student engagement, learning quality, and collaborative skills during the COVID-19 pandemic in higher education by using seamless learning strategies assisted by LMS and Zoom (Gopinathan et al., 2022).

Furthermore, the findings show significant differences in procedural learning outcomes between seamless learning strategies assisted by LMS and seamless learning strategies assisted by Zoom. Students in classes that use seamless learning strategies assisted by LMS have higher learning outcomes than classes that use seamless learning strategies assisted by Zoom. Several previous studies in various fields support the results of this research. Research Ausi & Abdillah (2020) examined the differences in procedural learning outcomes using seamless learning strategies assisted by LMS and seamless learning strategies assisted by Zoom in higher education. The research results show that seamless learning strategies positively impact student learning achievement and motivation. The seamless learning strategy also positively impacts student satisfaction and interest in learning, although there is no significant difference in learning achievement (Hamid et al., 2019). A blended learning strategy, namely a combination of LMS and Zoom, can improve student achievement in seamless learning (Cao, 2023).

CONCLUSION

Based on the research results, it can be concluded that seamless learning strategies assisted by LMS can improve problem-solving and procedural learning outcomes. This research proves that the seamless learning strategy is innovative and can be applied to improve problem-solving and procedural learning outcomes. The limitation of this research is that it takes some time to see student activities in detecting learning carried out by students informally. The internet network is not yet adequate in the location where they live.

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