Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.14, No.23, 2023

Development of LMS as a Hybrid Learning Facility Assisted by Augmented Reality to Improve Students' Numerical Literacy and Critical Thinking Skills

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Abstract
The purpose of this study is to see the feasibility of LMS as a means of Hybird Learning in improving Student numerical Literacy and Critical Thinking Skills, to describe the practicality of LMS as a means of Hybird Learning in improving Student Numerical Literacy and Critical Thinking Skills, and to describe the effectiveness of LMS LMS as a means of Hybird Learning in improving Student Numerical Literacy and Critical Thinking Skills. The sample in this study was composed of Mathematics Department students who were taking Basic Mathematics courses at Medan State University, for a total of 37 people.The research stages carried out in this study refer to the ADDIE development model (Analysis, Design, Develop, Implement, and Evaluate) developed by Reiser and Mollend.The results of the study in terms of the feasibility of the material validation results show a value of 3.38 with very feasible criteria, and the media validation results show a value of 3.28 with feasible criteria. In terms of practicality, based on the results of the student response questionnaire, a score of 2.74 was obtained in the practical category. From the results of the response questionnaire analysis, 100% of students stated that the LMS was practical to use in learning basic mathematics, and 23 students strongly agreed that the LMS was easy to use (practical). The effectiveness of the LMS was seen from the results of learning mathematics, with a recapitulation of the average ability of students' mathematical literacy and critical thinking of 80.09 and a completeness level of 83.9% (31 of 37 students completed).
Keywords: Development, LMS, hybrid learning, numeracy literacy, critical thinking
DOI: 10.7176/JEP/14-23-01
Publication date: August 31st 2023

1. Introduction

Times have changed from time to time, and these changes require shifts in various aspects of life. One of the most influential changes is the advancement of technology. In the current conditions, digitization and automation are the main focus of almost all activities. This period is known as the Era of the Industrial Revolution 4.0. Professor Klaus Schwab describes the Industrial Revolution 4.0 as a fundamental shift in the way humans produce, consume, and interact with each other, which is driven by the convergence between physical and digital technology and humans themselves (Suherman, 2020). Currently, there is a shift towards the Super Smart Society Era (Society 5.0). The concept of Society 5.0 describes a society that focuses on humans and is supported by technology. However, there are concerns that this progress could threaten the human values that have been maintained so far. In the Era of Society 5.0, humans are faced with demands to be able to solve complex problems, think critically, and hone their creativity (Prayoga & Lajira, 2021).

This also applies to the world of education, where formal and informal educational institutions are required to be able to keep abreast of developments in the era of the industrial revolution (4.0) and society (5.0). Educators must have digital skills and think creatively. Therefore, there are three things that educators should take advantage of: the Internet of Things (IoT) in education, the use of virtual or augmented reality in learning, and the use of Artificial Intelligence (AI) to understand and identify student learning needs. One of the media that supports learning by utilizing IoT is the Learning Management System (LMS) (Farana, 2020), which functions as a flexible e-learning platform that allows educators and students to access it anytime and anywhere through various devices such as PCs, laptops, tablets, and smartphones (Subiyantoro, 2017).

The pandemic conditions that have been going on since 2019 have caused changes in the learning process that are usually done face-to-face to be limited by utilizing e-learning media. The conditions of learning at Medan State University are no exception. Since the beginning of the lockdown due to the spread of the Corona virus, Unimed has implemented online learning, or Learning from Home. After going through several stages of limiting community activities by the government and also handling large-scale vaccinations, learning activities slowly began to be carried out face-to-face with the enactment of certain rules. Following up on the government circular for learning in 2021–2022, Unimed issued circular letter no. 000119/UN33/KP2022 regarding the implementation of learning in the Unimed environment even in semester 2021–2022, carried out in a mixed manner, namely face-to-face and in the network (hybrid learning).

This hybrid learning method is still very foreign to ordinary people, especially parents of students. The

definition of hybrid learning is a combination of distance learning methods (PJJ) and face-to-face learning methods (PTM). So then, this hybrid learning method is a solution in anticipation of minimizing the psychosocial impact on students, but they can still learn like before the pandemic. Although this model is relatively new, its goal is similar to that of other educational innovations: "to help teachers" achieve what they strive for every day by understanding deeply and enabling every student they work with to achieve very high levels of educational mastery" (Tsai Augus, 2011). However, researchers say that the hybrid learning model has the potential to provide transformative experiences where new modes of education can challenge teachers to innovate to apply the best way to educate their students (Tseng et al., 2011).

Unimed, as a tertiary institution, has provided a Learning Management System called SIPDA as a facility for online learning. In addition, in a circular letter, Unimed also provides an opportunity to use other LMS besides SIPDA. This aims to face the challenges of the Industrial Revolution 4.0 and Society 5.0 eras, where lecturers as educators are allowed to prepare other LMS media as supports for hybrid learning.

In addition, one of the courses in the Mathematics Department of Medan State University is Basic Mathematics, which includes the Integral sub-section. Based on years of teaching experience, integral material is considered abstract and tends to be difficult for students to understand. It requires repetition, intense practice, and focus to master. Integral learning is not only about understanding the concept but also being able to apply it in other fields of science. Therefore, interesting learning strategies and media are needed so that students are interested and skilled in learning them.

In previous studies, researchers have developed learning media in the form of augmented Reality (AR) and assessment with the help of AR in Basic Differential Mathematics courses. According to students, the use of Augmented reality in learning is very interesting for students to learn with a positive response. (Elfitra, 2020). Assessments made with the help of AR are also able to increase average student learning outcomes and effectively improve students' 4C abilities.

Moving on from previous research and responding to the challenges of the era of society 5.0, lecturers as learning creators must be able to follow the developing paradigm and be able to utilize the right technology in innovating, especially in preparing students to be competitive. So the authors are interested in conducting research with the title "Development of a Learning Management System (LMS) as a Means of Implementing Hybrid Learning to Improve Numeracy, Literacy, and Critical Thinking Skills." It is said to be an LMS because it will be accessed using mobile devices (mobile phones, notebooks, smartphones, laptops, and PDAs). As for the LMS, assessments and books, which are assisted by AR types of markers, will be linked to the results of previous research and subsequent development.

The development of LMS as a hybrid learning tool with the help of AR is expected to improve students' numeracy, literacy, and critical thinking skills. With LMS, every student will be trained in study skills and skills in using technology so that they will have the life skills to work and contribute to society. The reality is that every graduate must face a future that is dynamic, full of challenges, competitiveness, and change, all of which are demands of 21st century life skills.

2. Reasearch Method

This research was conducted in the Mathematics Department of the Mathematics Education Study Program. The sample taken was one class with a total of 37 students taking basic Mathematics courses. The research method used in this research is the development of the ADDIE model (Analysis, Design, Develop, Implement, and Evaluate) developed by Reiser and Mollenda. Addie's model framework is a cyclical process that evolves over time and is continuous throughout the instructional planning and implementation process. Five stages comprise the framework, each with its own distinct purpose and function in the development of instructional design. In the ADDIE development design model, there are five stages of research implementation, namely as follows

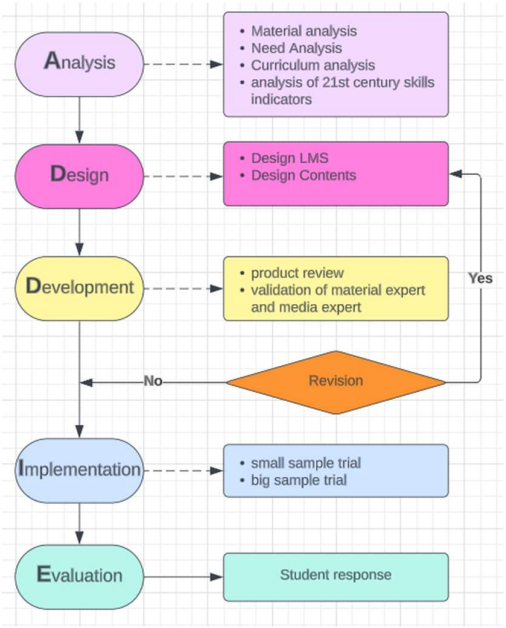

Figure 1. ADDIE Research Steps

3. Result and Discussion

The results of this study will be explained along with a series of stages of activities in development research using the ADDIE model

a.Stages of analysis

In the early stages of the research, when conducting a needs analysis, it was found that the use of a Learning Management System (LMS) was an important requirement for learning, both in face-to-face and online formats. Even though Unimed has provided an LMS called SIPDA, not all lecturers use it, and only a few lecturers have developed special LMS for certain subjects. In accordance with the Chancellor's decision to apply the hybrid learning method in the odd semester of 2022-2023, efforts were made to develop a special LMS for Basic Mathematics courses as a means of hybrid learning. In its development, LMS is designed with Augmented reality-assisted content, which is the result of previous research. At this stage, an analysis of the learning curriculum that applies at Medan State University is also carried out, which includes the application of the Case Method and Team-Based Project methods in the learning design as well as the application of a hybrid learning model. In addition, an analysis of the needs of the demands of the 21st century, where numeracy literacy and critical thinking skills are important for students, is also sought to be developed in the learning process taught by lecturers.

b. Design stage

The follow-up of the analysis stage is carried out by the design stage. The LMS design process requires a display design to help make the LMS. The LMS contains the homepage, Attendance, Material, quiz, and Reflection. LMS is built using Google Sites. The way to create a website with Google Sites is quite easy thanks to a simple menu and appearance.

The LMS is built with a choice of simple templates that match student characteristics so that they are interesting and not boring. Creating an LMS with Google Sites is an option because of the ease of management, which is enough to have an account. After entering the Google Sites Dashboard, several template options will be found at the top of the page. With a ready-to-use template, you can get a design instantly. However, if you want to create a website with a more attractive and unique design, then choose the Blank option to start the LMS website draft. Here's the finished LMS design.

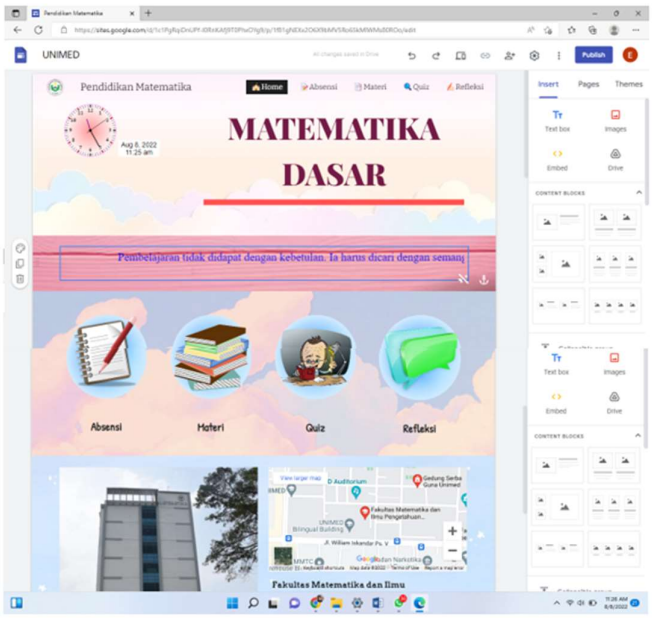

Figure 2. Basic Mathematics LMS Home Image

Figure 1 shows the LMS homepage display for basic mathematics that will be used in this study. Furthermore, several spaces are provided to be filled in accordance with the content of Basic Mathematics learning needs, including evaluation, attendance, materials, quizzes, discussion and reflection forums, and links for implementing hybrid learning

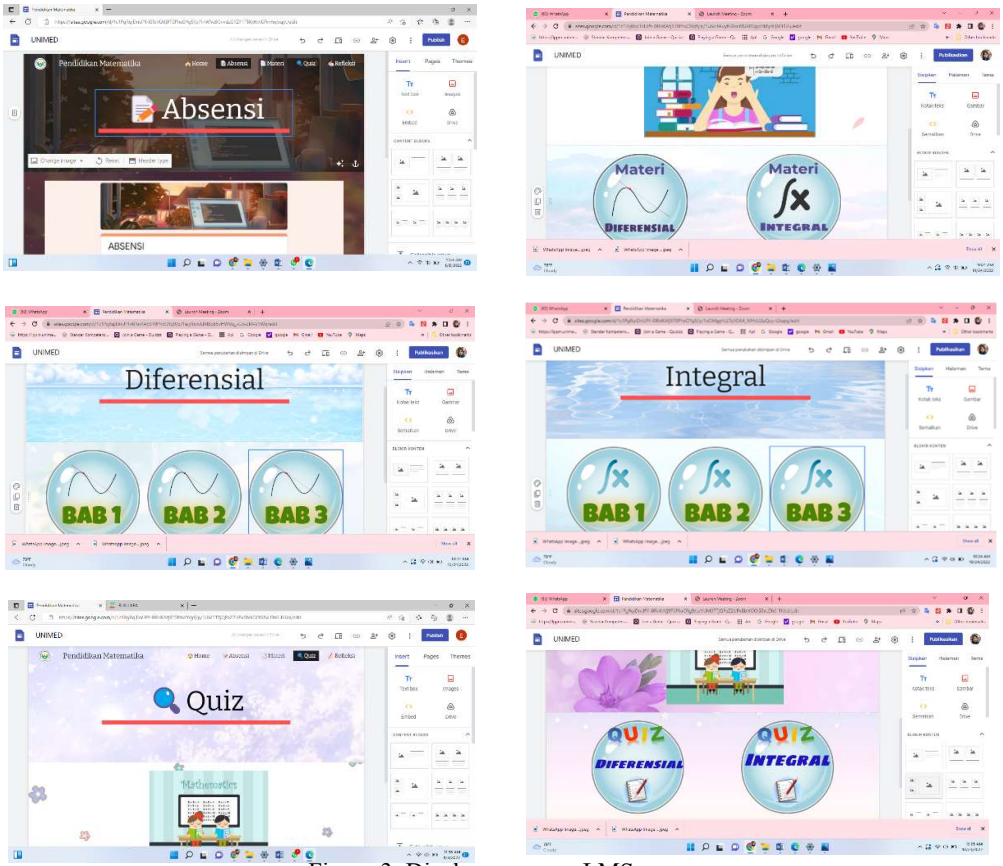

Figure 3. Display menu on LMS

At this stage, the content has also begun to be prepared to be included in the LMS, starting with teaching materials in the form of readings or explanatory videos, quizzes, and assessments of the results of previous AR-based research.

c. Stages of Development

(Development)Furthermore, after the LMS is filled with the required content, it will be validated by the Material Expert and Media Expert . Material validation assessment will be carried out based on learning aspects, the truth of the content, and the relationship with competence and research objectives. Media validation assessment is focused on the quality of LMS eligibility in visual communication aspects, software engineering aspects, aspects of independence, organization, adaptability, and ease of use.

Material Expert Validation

Material experts in the LMS validation process are two experts. Material validation is carried out as a feasibility assessment as well as providing suggestions and comments on the content of the material included in the LMS. The results of the validation carried out by material experts are as follows:

Table 1. Material Expert Validation Results

	Validator Assessment Results	
Assessment Aspect Indicator	**I**	**II**
Self Indicator	22	23
Self Contained	8	8
Self alone	7	8
Adaptive	3	3
User Friendly	3	3
Total	43	45
	3.31	3.46
Average	3.38	
	Very worth it	

Based on the table above, it can be seen that the relevance of the material from the validation results of two material experts with an average of 3.38 is included in the very feasible category. So that it can be said that overall, the material contained in the Learning Management System (LMS) that has been developed by the research team can be tested at the next stage,

As for suggestions from material experts, among others, separate the appearance of material for each chapter in teaching material so that it is easier to read and understand the material; the material in the video should not be repeated in material in the form of videos.

Media Expert Validation

Media experts validate microlearning objects in SMA Geometry material that has been developed by two experts. The validation carried out is related to the aspect of media display. Validation by media experts: Apart from conducting feasibility assessments, media experts also provide comments and suggestions for improving the media. The results of the validation carried out by media experts can be seen in the table 2.

Based on the table above, we can conclude that the feasibility aspect of the media obtained from media experts is 3.28 with a feasible category, so that as a whole the AR-assisted LMS developed by researchers can be tested at the next stage. The advice given by media experts is that some of the features for Augmented Reality are emphasized and added again to attract students' interest in learning

Table 2. Product validation results are seen from the media aspect.

Assessment Aspect Indicator	Validator Assessment Results	
	I	II
Content Eligibility Components		
The suitability of LMS media to make it easier for students.	4	4
Media suitability for individuals/groups	3	3
The effectiveness of the media used		
Effective and efficient in the development and use of LMS media	4	3
Creative in ideas and pouring ideas	4	3
Media Quality		
Maintainable (can be maintained and managed easily)	4	3
Usability (easy to use and simple to operate)	3	3
Compatibility (learning media can be installed)	4	3
Reusable (part/all of the learning media programs can be reused for the development of other learning media)	3	3
Communicative (on target and acceptable to target desires)	3	3
Total	31	28
Average	3.44	3.11
	3.28	
	Very Work it	

d. Implementation Stage

At this stage, all designs that have been developed and validated are revised based on input from the validator at the development stage. This implementation stage was carried out in two stages, namely the small group test stage and the large group test stage. Subjects were selected using a purposive sampling technique, namely determining the sample with certain considerations. In the small group test, six students were involved as subjects who were able to represent all samples taken from PSPM A for the 2022–2023 Academic Year. This group test was carried out by selecting students with high, medium, and low abilities, each of which consisted of two students. After the AR-based Mobile LMS was tried out in a small group test, students were asked to fill out a response questionnaire that had been provided.

e. Evaluation Stage

After carrying out small trials, large-scale trials or field trials are carried out. Where the tryout will be carried out in one class that takes basic mathematics, PSPM A, for the 2022–2023 academic year. Furthermore, to determine the level of effectiveness of AR-based Mobile LMS products, students are asked to follow the procedures for using the LMS during learning and fill out response sheets.

Table 3. Student response results

No	Statement	SS	S	KS	TS	Total
	Aspect of use					
1	Presence activity is easy to use	120	21			141
2	LMS is easy to use without having IT expertise	92	42			134
3	Matdas learning is more well structured	120	21			141
4	Using AR makes it easier for me to understand the material	104	24	6		134
5	reflection activity is difficult to use			6	34	40
6	The use of AR is difficult to access		18	46	8	72
7	Learning gets messed up with LMS				37	37
8	Access quiz is easy to use	124	18			142
	Average					2.84
	Presentation Aspect					
9	Modules, explanatory videos, easy questions to upload	100	39			139
10	LMS has forum facilities for discussion	148				148
11	LMS does not have complete facilities according to learning needs			6	34	40
12	The language used is easy to understand	148				148
13	Modules, explanatory videos and questions confuse students				37	37
	Rata rata					2.77
	Display Aspect					
14	Images and videos on the LMS are clear	148				148
15	The presentation of colors is attractive and not boring	124	18			142
16	The appearance of the website page is not attractive		6	12	29	47

No	Statement	SS	S	KS	TS	Total
17	The pictures and videos on the LMS are blurry			4	35	39
18	LMS design is not confusing	148				148
	Average					2.83
	Practicality Aspect					
20	LMS can be used in every learning meeting	148				148
21	LMS cannot be used in every learning meeting				37	37
	Average					2.51
	Overall Average					2.74

Worth 2.84 with the feasible category, the presentation aspect of the LMS was valued at 2.77 with the feasible category, the display aspect was valued at 2.83 with the feasible category, and the implementation aspect was valued at 2.51 with the feasible category. Overall, student responses to the use of LMS averaged 2.74 in the proper category, which means it can be used again without revision.

From the analysis of the results of the response questionnaire given to students majoring in mathematics education in basic mathematics learning, it was found that the LMS was something that was practical to use; this can be seen from 100% of students answering that the LMS could be used in every learning meeting. And also 23 people out of 37 students strongly agree with the use of LMS in easy-to-use learning. The practicality of using LMS is also answered by student learning outcomes, with a recapitulation of the average mathematical literacy ability and students' critical thinking of 80.09. With the number of students who completed as many as 31 people, or 83.8%, and who did not complete as many as 6 people, or 16.2%.

Therefore, learning using an AR-assisted LMS is considered effective for increasing students' mathematical literacy skills and critical thinking. An analysis of student grade data is given as a comparison of the scores of students who use the LMS and those who do not use the LMS.

4. Conclusion

Based on the results of the research into Mobile LMS Development as a hybrid Learning Facility assisted by Augmented Reality to Improve Numeracy Literacy and Student Critical Thinking Skills, it was found that students became more interested in learning basic mathematics because the learning material presented in the LMS was more interesting, supported by some Augmented Reality content, teaching materials, explanatory videos, and interactive quizzes where the results can be seen immediately. This LMS is also equipped with links for online learning activities if needed.In terms of feasibility based on the validation results in the development process, the LMS that was developed met the eligibility criteria in terms of material with an average of 3.38 (very feasible) and media with an average of 3.28 (very feasible). In terms of practicality, based on the results of student responses, as many as 100% of students stated that LMS was practically used in learning basic mathematics. It is said to be effective and is also supported by learning outcomes during basic mathematics learning using LMS, which is also better with a completeness level of 83.9% (31 out of 37 students) and an average score of 80.09.

The suggestion in this study is for students to practice more questions to improve numeracy literacy, which is indeed a basic requirement in learning basic mathematics, and to continue to develop themselves in various kinds of learning media that support the Education 4.0 revolution. and also supports learning both online and offline. In addition, for LMS to be used in hybrid learning, adequate facilities and infrastructure are needed in the classroom so that online learning can run smoothly together with face-to-face learning

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