

Designing STEM-based Learning Management System using Moodle as a Distance Learning Alternative in Basic Calculus Courses

Malik Ibrahim¹, Sunardi², Lalu Moh Yudha Isnaini³

^{1,2,3}Sistem Informasi, Universitas Nahdlatul Ulama NTB, Indonesia

malikedu.org@gmail.com¹, soenardhi.75@gmail.com², lalumohyudhaisnaini@gmail.com³

ABSTRACT

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This study aims to develop STEM-based Learning Management System using Moodle as an alternative to distance learning in a structured manner. ADDIE method deploy as the development model and outlined in the Moodle-assisted platform. Product quality Measurement using questionnaires, by looking at the percentage of user response. The study found that; (1) the expert validation of the STEM-based Learning Management System using Moodle is 3,76 which is converted to 94%, (2) the practicality of STEM-based Learning Management System is 3,83 which is converted to 95,75%, (3) STEM-based LMS gave positive result by easy to use and has a service menu that is served clearly to student with a total value of 3,84 converted to 96%. The STEM based LMS effectively used during the covid 19 pandemic as an alternative to distance learning, and has an impact on problem-solving capabilities.



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A. INTRODUCTION

The pandemic of Covid-19 that has been occurred for 2 years poses a serious threat to every institution of education. The face-to-face learning activities are not allowed to suppress the occurrence of covid-19 transmission. This provides a warning to each institution to respond quickly to the steps to be taken in accommodating the learning process. A research suggest to propose a scheme that utilize technology as a means of distance learning (Bojović et al., 2020). . Technology is present as a medium of learning and a means to help teachers/lecturers in delivering materials to students. Unfortunately, this opportunity has not been utilized to the maximum, not a few teachers/lecturers have not been able to use technology as a medium of learning in the classroom, which is below 50%(Mandailina et al., 2019). To bridge the use of technology in learning, an approach is needed that can integrate science with technology. One of the most complex approaches today is known as STEM (Science, Technology, Engineering, and Mathematics). STEM is well-known for its ability to train learners in problem-solving (Anggraini & Huzaifah, 2017). STEM also strengthen learning and foster creativity, critical thinking, and practice learners' skills (Alashwal, 2020). In addition, integrating mathematical learning would also hone students' creativity (Riana & Ibrahim, 2019). STEM design is very supportive in the implementation of the learning process. (Stohlmann, 2020).

Technology design becomes a core activity in STEM implementation in learning (Vossen et al., 2020). It requires a platform that is accessible remotely, easy to deploy, and openly self-learning. The platform that is widely used today in various institutions is Moodle (Mudiyanselage & Pan, 2020; Teo et al., 2019). Modular Object-Oriented Dynamic Learning Environment (Moodle) is a software package produced for internet-based learning activities and websites that uses the principles of social constructionist pedagogy. Moodle is one of the applications of educational and learning concepts and mechanisms that use information technology known as electronic learning or e-learning concepts. (Herbimo, 2020). A learning management system (LMS) enhances the learning process Online classroom environment (Bradley, 2020). A learning management system (LMS) is a widely used e-learning tool to improve a student's learning experience and gain a better understanding of a particular topic (Kasim & Khalid, 2016). Therefore, it is necessary to build a collaborative learning system such as STEM-based Learning Management System using Moodle so that it can be accessed by students during distance learning. Some researchs found that online learning during the pandemic becomes an alternative that can help the implementation of the learning process in various institutions and educational institutions (Mandailina et al., 2021). Research conducted by (Alturki & Aldraiweesh, 2021) the results showed that the student's desire to use LMS had a positive impact on learning as a sustainability effort during the COVID 19 pandemic. Moreover, Moodle LMS is the most advanced and popular e-learning system with a multilingual user interface (Zabolotniaia et al., 2020).

The development of online-based STEM learning using Moodle is essential to improve students' understanding and learning outcomes in Calculus. Moodle will facilitate students in remote area to conduct simulations independently. This product also help lecturers in delivering materials in the classroom, where students can be grouped or individually to learn independently not only in the classroom but also outside the classroom. In addition, Researchers hope that this is the first step in the development of STEM-based LMS to facilitate students in learning and can be developed on other materials.

B. METHODS

This research deploy ADDIE (Assessment/analysis, Design, Development, Implementation, and Evaluation) development model by (Molenda, 2015). The process of determining product outlines, problem analysis, product design, product implementation, evaluation based on expert validation results and user feedback. At the validation stage will be conducted validity tests to media experts (designs) and mathematical material experts, then field trials to see the practicality and effectiveness of using STEM-based LMS. The use of this model because the research team used this model to achieve the goals and external targets of the study. The ADDIE model in developing STEM-based LMS is depicted in the following figure.

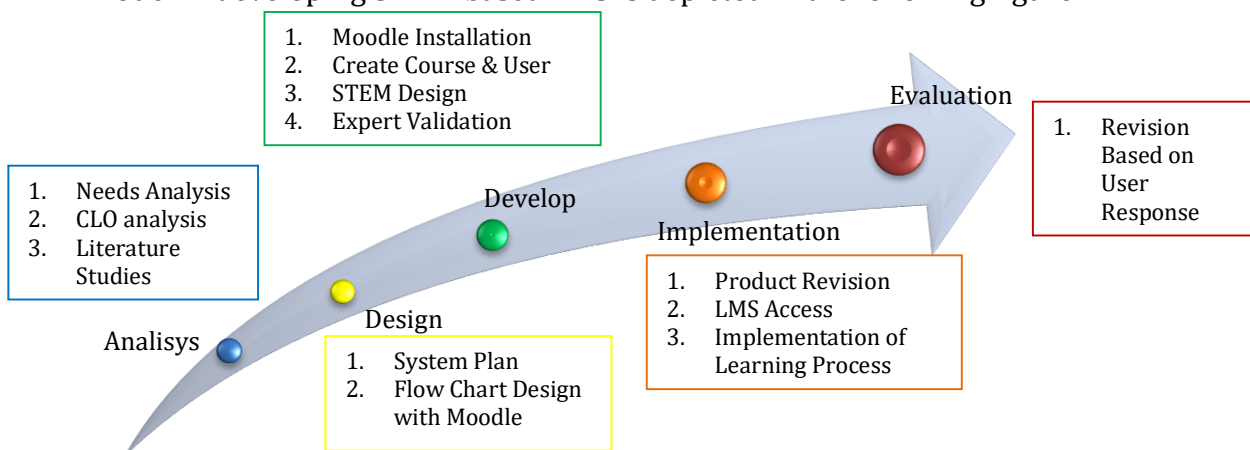


Figure 1. ADDIE Model Development Stage

1. Analisis

Before the product design stage, the first step is to analyze the needs to be developed. Needs analysis includes CLO analysis, material analysis, student analysis, and projects undertaken.

2. Design

The design stage is carried out based on the results of the needs analysis, so that the resulting product is in accordance with its usefulness. Student can do distance learning with the utilization of the internet and LMS, starting from the initial design to the moodle-based development stage.

3. Develop

This stage aims to design online-based learning media with the help of the Moodle platform. Media design consists of lms design stages and stages of compiling learning materials with STEM models. The LMS design phase begins with setting up moodle hosting and installation, then creating a Course and registering users on the LMS. While the stage of preparing STEM model learning begins by uploading materials, discussion forums, conferences, and projects produced. After the development process, the next stage is continued by conducting expert validation that includes aspects of display, aspects of use, and aspects of the material. The STEM design used can be seen in the following figure.

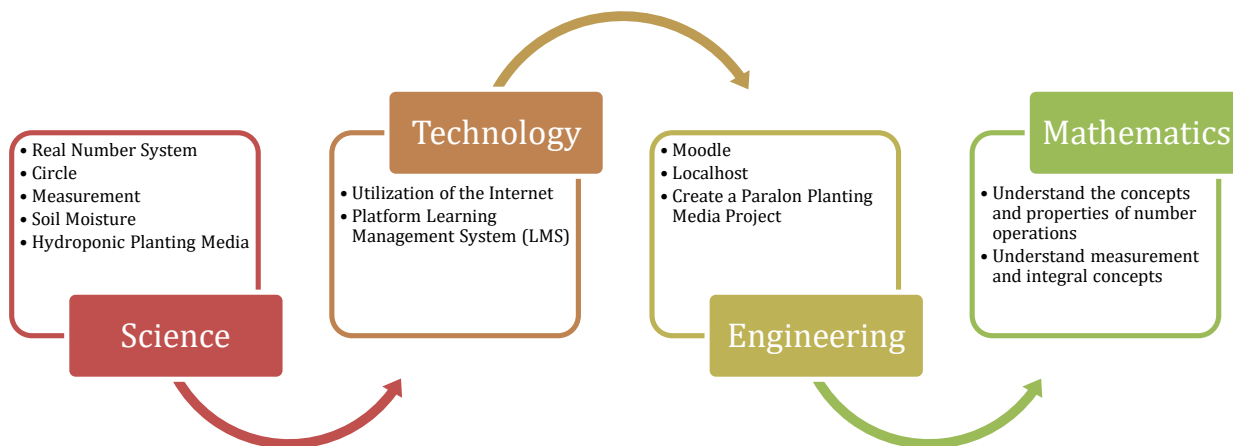


Figure 2. STEM Learning Design

Calculation of expert validation results using the following formulas.

$$\bar{X} = \frac{\sum_{i=1}^n S_i}{n} \tag{1}$$

with \bar{X} is the average value of validator assessment results, S_i is the average score of the i validator assessment result and n is the number of validators.

4. Implementation

At the implementation stage, the activities are carrying out learning and mentoring learners to complete projects and problem-solving that have been designed based on STEM learning. In addition, the user's response on the product developed is also measured. Projects in STEM-based Learning Management System showed on the Table 1.

Table 1. STEM Design Learning Mapping

No	Aspects	Details
1	Science	Includes the integration of the science used to solve project problems designed in learning.
2	Technology	Includes the use of technologies such as the internet and computers.
3	Engineering	Includes the use of tools and materials in completing projects.
4	Mathematics	Includes the competence of the material used to solve the problem.

5. Evaluation

This activity is the final part of the product development process with the ADDIE model. Product evaluation aims to correct deficiencies found based on expert and user input. User response is viewed based on the results of the questionnaire provided when using the developed product.

C. RESULT AND DISCUSSION

Learning with STEM design can provide good results to the creativity of learners (Hanif et al., 2019). In support of the results of research, the stages of development with this ADDIE model can be seen in the following details.

1. Analysis Stage

At this stage researchers analyze CLO and user needs to facilitate in designing learning with the help of Moodle. The results of the CLO analysis can be seen in the following table.

Table 2. Analysis of Course Learning Outcome (CLO)

No	CLO	Sub-CLO
1	Students are able to understand the concept of real number systems and apply them.	Students are able to explain real number systems including integers, numbers, rational numbers, and irrational by utilizing science and technology.
2	Students are able to learn and solve the problem of equality of absolute value.	Students are able to determine absolute value.
3	Students are able to have problem-solving skills through learning functions and limits.	Students are able to solve problem solving problems related to range, domain function.
4	Students are able to utilize science and technology in solving math problems.	Students are able to use technologi media in solving math problems.
5	Students are able to implement mathematical concepts in the creation of projects.	Students can complete a project to create paralon planting media in the field of engineering.

Based on the needs of users, learning in pandemic times can still be done without reducing the essence of material delivery and can be an interaction between educators and learners, who are able to integrate technology as a means of learning.

2. Design Stage

This stage is more of a STEM-based LMS including the installation of Moodle, (2) the creation of a Course, (3) registering users, (4) uploading materials, discussion forums, conferences, and project tasks.

3. Develop Stage

The purpose of this development stage is to be able to produce online-based learning media that have STEM learning design characteristics. Based on the previous stages, development activities begin with the display design.

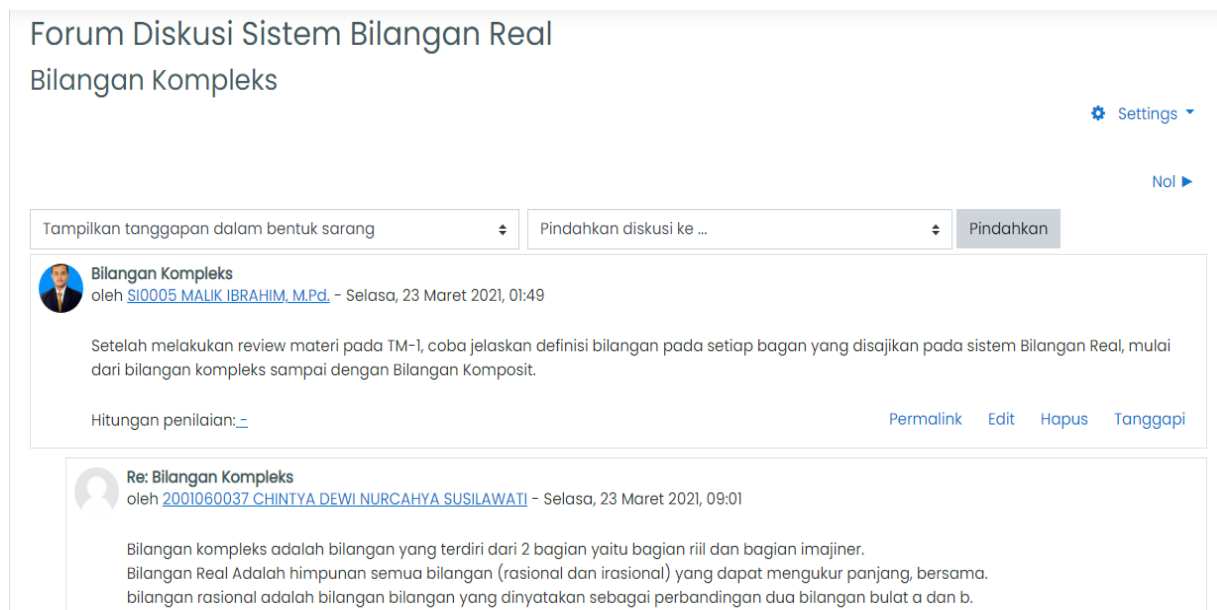


Figure 3. Discussion Forum Menu View

In Figure 3, there is a discussion forum menu that serves to conduct asynchronous interaction between students and lecturers. In addition, students can also interact with their colleagues.

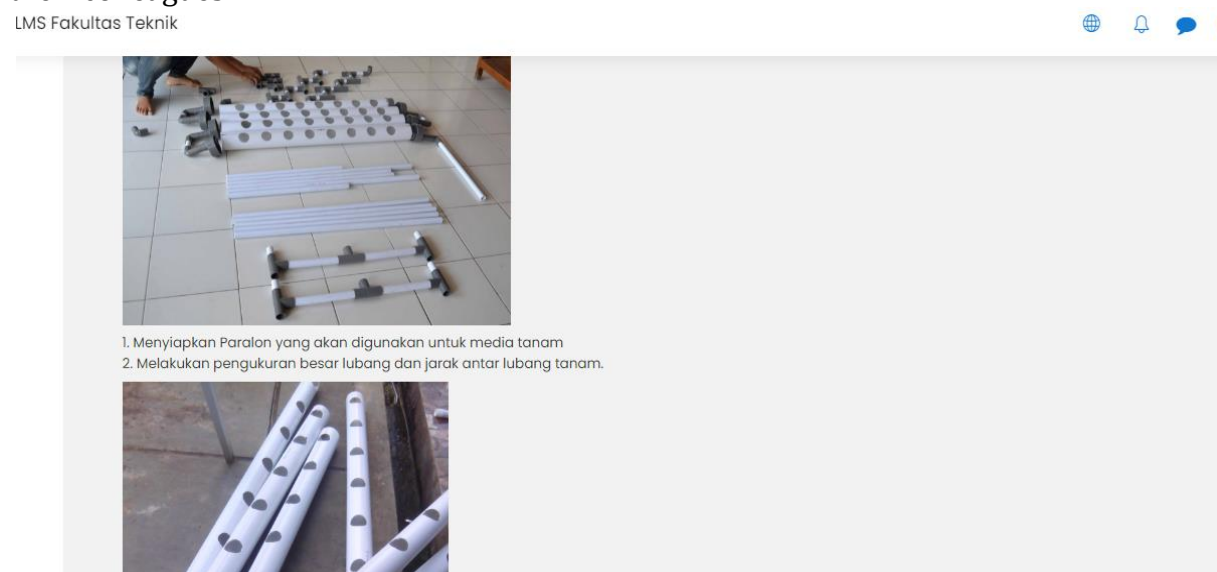


Figure 4. Project Task Activity View

Figure 4 shows a project-based assignment menu based on the material that has been studied. The project is completed with the guidance of teachers through conferences and

discussion forum menus that have been provided. Science aspect it means collecting literature and material concepts that can be used as the first knowledge to create projects. Technology aspect about the use of technology in conveying and interacting with learners who can help complete a project. Engineering Aspect can be describe like a knowledge to utilize or operate tools to help solve problems, and Mathematics Aspect is a connecting science that can be used in solving problems. The next activity is to perform expert validation to measured STEM-based LMS using Moodle. Expert validation includes media experts and material experts.

a. Expert Validation

Expert validation is conducted to determine the validity of media developed from the aspect of display and material aspects based on STEM design. The results of validation that has been done to the validator can be seen in the following Table 2.

Table 2. STEM Design Validation Results with Moodle

No	Assessment Aspects	Average Score
1	Design View Aspects	3,90
2	Aspects of Media Use	3,65
3	Aspects of Usefulness	3,75
	Total Score	3,76
	Percentage	94%

Based on the Table 2, it can be seen that the validation score is 3.76 or converted to 94%. This shows that the product developed is valid based on the appearance aspect, aspect of use, and aspect of media usefulness. Furthermore, the results of expert validation of material aspects can be seen in the following Table 3.

Table 3. Material Expert Validation Results

No	Assessment Aspects	Average Score
1	Material Aspects	3,85
2	STEM Design Aspects	3,70
3	Language Aspects	3,95
	Total Score	3,83
	Percentage	95,75%

The Table 3 can be seen that the validation score is 3.83 or converted to 95.75%. The scores indicate the validity of products developed based on material aspects, STEM Characteristic, and good and correct use of language. There are several improvements from validators including errors in writing stages in compiling STEM design projects. This repair will be completed at the next stage.

4. Implementation Stage

In the implementation phase, researchers use developed products to carry out the learning process to determine the user's response to the developed product and interact with participants related to a pre-designed project. This activity requires teachers/lecturers to innovate in determining the project designed (El Nagdi et al., 2018). In the stem learning stage known as project-based learning (Samsudin et al., 2020), so that the project task is completed in the form of making pipe planting media by making large planting holes according to the determination of diameter length and measuring the distance between holes. This is done to integrate the understanding of learners' concepts

to mathematical materials with environmental science. The activity in calculus learning can be make correlation with environmental engineering students which is related to the concept of real number systems in measurement activities.

5. Evaluation Stage

This evaluation stage is the last process carried out in developing STEM design with Moodle using the ADDIE model. This activity is done to perfect the shortcomings contained in the media. The improvements made can be seen in the following Table 4.

Table 4. Product Revisions List

No	Before Revision	After Revision
1	There are no instructions in working on the project.	Add technical instructions for completing a project.
2	Discussion forum menu view does not appear description.	Displays the discussion forum menu description as a clue in responding.

STEM-based LMS answers the problem of learning in pandemic times as an alternative to remote learning. This is in accordance with the user's response based on the questionnaire distributed. The results of user responses can be seen in the following Table 5.

Tabel 5. User Response Results

No	Assessment Aspects	Average Score
1	Manual User	3,95
2	Ease of Access	3,80
3	Readability of the language used	3,90
4	Clarity of projects being worked on	3,75
5	Discussion menu presented	3,80
	Total Score	3,84
	Percentage	96%

The Table 5 shows the results of user response to developed products, the average result of the questionnaire reaches a score of 3.84 or converted to 96%. These results give the conclusion that the product is very easy to use. Besides being easy to use, STEM models contained in e-learning media can also train learners in problem solving, this ability is trained through the integration of science with the skills possessed (Hallström & Schönborn, 2019).

D. CONCLUSION AND SUGGESTIONS

The product developed is STEM- based LMS as a means and alternative of distance learning activities in the Covid-19 pandemic. STEM-based LMS provides positive results based on the results of expert validation of the aspects of the appearance, use, and packaging of the materials presented. User response to the developed product reaches 96%, which shows the usefulness and ease of operating the product.

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