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Development of Moodle's E-Learning as a Media in Mathematical Problem-Solving

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ABSTRACT

The aim of this research is how to design an e-learning application that can be used as a medium in solving mathematical problems for Mathematics Education students at the Islamic Institute of Muhammadiyah Sinjai. The purpose of this research is to produce a product in the form of an e-learning application Moodle as a medium in solving problems. This study was designed using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. To get a valid and effective application, the validity of the research instrument was tested and the validity of the developed application was tested. Applications that have been implemented are then assessed by research subjects to determine their effectiveness. The research results obtained are: the application of e-learning Moodle as a medium in solving mathematical problems was declared to meet the validity and effectiveness. These results were obtained after being tested for validity by experts, which consisted of validating problem-solving instruments in the form of materials and problem-solving questions, all of which were in the valid category, namely 3.36, where the material aspect was 3.40 and the aspects of problem-solving questions problem is 3.33. Meanwhile, for application validation that is in the very valid category, the average validator value is 3.50. This application was effectively used based on student assessments of the efficiency of the application, display, and use of language which are in the very effective category with an average student assessment of 3.61 with a percentage of 90% so that this application was suitable for problem-solving for Mathematics Education students at the Islamic Institute of Muhammadiyah Sinjai.

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A. INTRODUCTION

In general, mathematics is seen as a field of study that is rigid, symbolic and far from the reality of everyday life (Wahyuddin, 2017). This view assumes that to learn mathematics, a student must think seriously, abstractly, and always memorize formulas. Therefore, it is not uncommon for students to believe that mathematics is a complicated subject, difficult to understand, and tedious. Even for some students, mathematics is scary, so they tend to avoid the issue (Memnun et al., 2012). This phenomenon continues at every level, which makes students' sense of ignorance even greater and makes mathematics subjects meaningless in their eyes. This condition causes mathematics lessons to be increasingly disliked, ignored and even ignored. This has an impact on students' ability to understand mathematics lessons to be very minimal, resulting in low problem-solving abilities (Nurjannah, 2020; Shanti & Abadi, 2015).

According to the National Council of Teacher Mathematics, problem-solving occupies an important position in learning mathematics, and is at the core of the field of education from the lowest to the highest curriculum (Kurino, 2018). Indeed, for NCTM standards, problem-solving skills are indispensable in teaching mathematics. Problem-solving does have an essential role in learning mathematics because in learning mathematics, students are given problems and are required to be able to solve these problems so that inevitably students must have problem-solving skills to be able to solve the problems given (Culaste, 2011; Nurjannah, 2019).

Students must also possess this problem-solving ability at the higher education level, especially students in the mathematics education study program at the Islamic Institute of Muhammadiyah Sinjai. This is because, based on observations on several courses that have been given, most of their problem-solving abilities are still at the lower middle level. Therefore, it is necessary to improve problem-solving skills to master mathematics-related materials in the future.

Talking about problem-solving, Polya suggests four steps that must be taken, namely: (a) understanding the problem, (b) devising a plan, (c) carrying out the plan, and (d) looking back. Students can obtain optimal results and benefits from problem-solving when it is carried out through well-organized solving steps (Polya, 1965). Polya's strategy can solve mathematics problems (Nurkaeti, 2018; Upu, 2003). Many studies show that difficulties occur because students find it difficult to understand concepts that include problems and the relationship between those concepts when they solve problems(Nabiyev et al., 2013). One of the most important causes of these difficulties is that students do not perceive problem-solving as a gradual process (Polya, 1965).

Students' shared mathematical problem-solving ability is due to several things. First, the learning methods used by teachers are still conventional. Second, because the students themselves are less concerned about learning mathematics (Sajadi et al., 2013). Mathematics is considered boring and less attractive to most students. The teacher's learning process often asks students to sit, be quiet, listen, and take notes. Students are not asked to identify the known elements, develop mathematical models, and explain the results of the answers. So that in practice, students do not understand the intent or concept of the material they have heard and recorded, and many students are trying to get answers from other friends. For this reason, an appropriate solution is needed to overcome this problem so that it is expected to improve problem-solving skills and creativity in learning mathematics (Nurkaeti, 2018; Rahman et al., 2019; Tambunan, 2019).

Various ways have been taken to improve students' problem-solving abilities, such as by providing knowledge about the importance of problem-solving and problem-solving approaches during the teaching and learning process. In addition, the application of technology is also very influential on the learning process (Rahman et al., 2019). This is due to the rapid advancement of technology from time to time. The rapid advancement of information technology has encouraged changes in the paradigm of society in seeking and obtaining information. People are no longer fixated on newspapers, television, radio, and books but have also explored the virtual world (internet). The internet itself is one of the media sources of information whose reach is extensive and "actual" (Gamage et al., 2019).

The development of information technology has had a considerable impact on the world of education. If learning is a process of communication and data from educators to students containing learning information, which has elements of educators as data sources, media as facilities for presenting inspiration, ideas and teaching modules and students themselves. The internet as a source of learning has given birth to the concept of distance education (Dursun et al., 2011).

Distance learning is education by using a medium that allows interaction between teachers and learners. In distance education between teachers and students do not meet face-to-face; in other words, through distance education, it is possible for teachers and students to be in different places, let alone separated by great distances. So it makes the educational process very easy (Puspita Sari & Setiawan, 2018). An example of distance learning that uses the internet is better known as e-Learning. E-learning is an educational process that utilizes internet facilities and media in teaching education (Gunawan et al., 2019).

With e-learning, we can learn 24 hours a day, learn all kinds of knowledge and information from all corners of the world. Facing the sea of knowledge and news, we don't just see and recognize it and act as spectators. We have to be doers; we have to try to master and take advantage of it. E-learning is not just getting knowledge and information, but also analyzing, sorting, reorganizing, packaging, giving birth to new forms, using it for various purposes and solving problems (Nabiyev et al., 2013). With the application of e-learning mathematics, it is possible to use information technology in the learning process so that learning is not limited by time, place, and distance (Lin et al., 2017). Through web-based learning, students and teachers can quickly learn and deepen math material outside of school hours (Al-Ani, 2013).

E-learning mathematics will make it easier for students to understand abstract mathematics lessons and require a thorough understanding (Cady et al., 2011). Mathematical animation technology is the main element in e-learning and plays an essential role because by using animation, mathematics learning can be more engaging, directed, accessible and dynamic. In addition, through the internet, students can also exchange ideas with other students around the world. One of the software that can be used to build e-learning is Moodle (Ismail et al., 2020).

Moodle is a Course Management System (CMS), a software package designed to help educators create quality online courses easily without building from scratch but using software that Martin Dougiamas has developed (Gunawan et al., 2019). Moodle urges exploration and interaction between students and teachers. As a course designer and teacher, you will have a lot of tools that Moodle has provided. So that it can be used and make teaching and learning activities more interactive (Cady et al., 2011). Thus, e-learning, especially by using the Moodle application, is expected to stimulate and measure students' problem-solving abilities. Therefore, the researcher intends to develop an effective and efficient E-Learning Moodle to measure the mathematical problem-solving ability of students at Mathematics Educatoin, Islamic Institute of Muhammadiyah Sinjai. To develop the E-Learning Moodle, the

ADDIE model is used where the model is considered more rational and complete for developing products in learning activities (Mulyatiningsih, 2012).

B. METHODS

This study uses Research and Development (R&D) using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The subjects in this study were 25 (twenty-five) people who were fourth-semester students of the Mathematics Education Study Program at the Islamic Institute of Muhammadiyah Sinjai. The research flow plan based on the ADDIE development model can be seen through the following flow (Sugiyono, 2016), as shown in Figure 1.

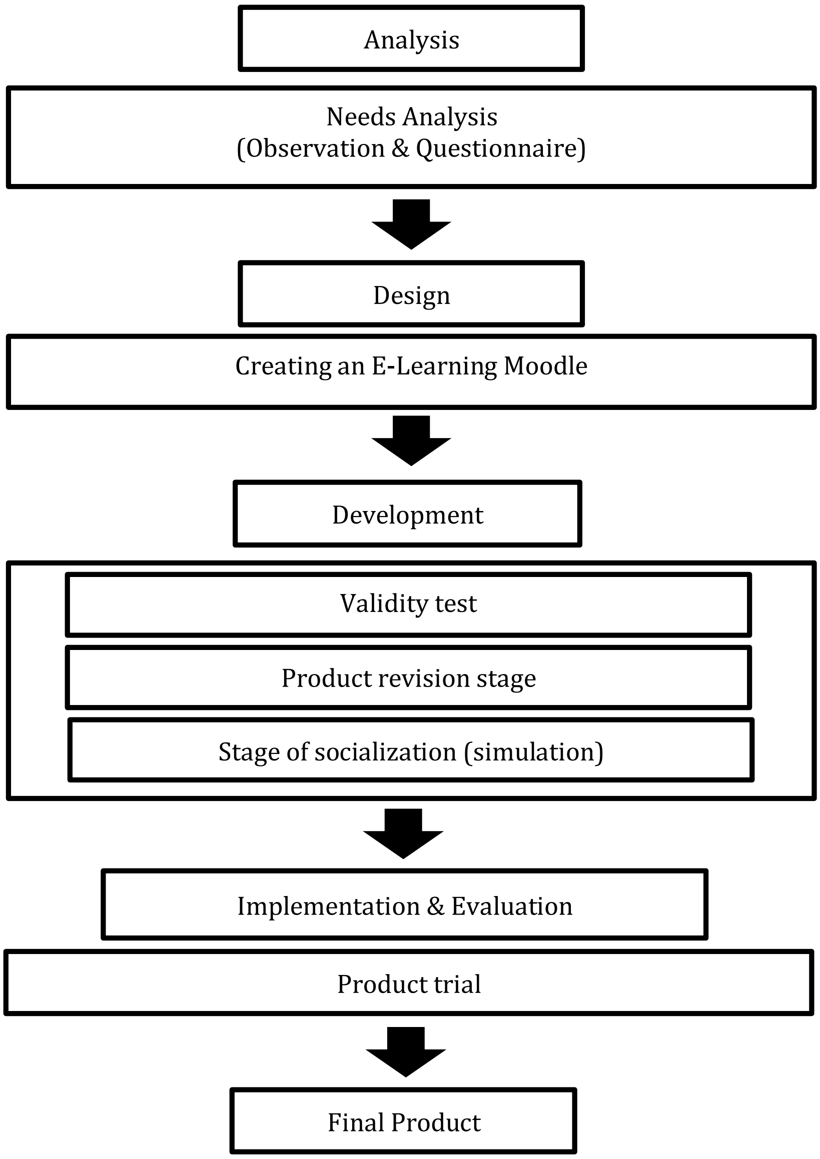

Figure 1. Steps to Develop Moodle E-Learning with ADDIE Model

1. Analysis Stage

In the analysis stage, the researcher conducts a needs assessment process and identifies problems (needs) through interviews, surveys/observations and literature analysis (relevant research results).

2. Design Stage

At the design stage, the researcher made a blueprint for the Moodle e-learning application as a tool for students' mathematics problem solving.

3. Development Stage

The stages carried out in the Moodle e-learning application as a tool for students' mathematics problem solving, namely:

a. Expert Team Assessment (Validity Test)

The initial product design (prototype product) contained in the application that has been designed is then submitted to an expert (validator) for assessment or content validation. Validator assessment is carried out to test the validity of the previously created product. The validator conducts a review and provides suggestions/feedback for product improvement. Inputs and suggestions from the validator are then used as material in revising the product. The formula for calculating the average validation results is as follows (Syaharuddin & Mandailina, 2017).

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

Where $\bar{X}$ is the total average, while $\bar{V}$ is the average of each validator, and n is the number of validators. The following categories are used for the expert validation test in Table 1.

Table 1. Validation Test Criteria

The Average	Criteria
$\mathbf{3,5 \leq \bar{X} \leq 4}$	Very valid
$\mathbf{2,5 \leq \bar{X} < 3,5}$	Valid
$\mathbf{1,5 \leq \bar{X} < 2,5}$	Quite Valid
$\mathbf{\bar{X} < 1,5}$	Not Valid

b. Product/Model Revision Stage

A product revision is carried out at this stage based on the assessment, input, and suggestions from the validators in the previous step. After the revision is carried out, the next stage is that the product is socialized (simulated) to the research object.

c. Stage of socialization (simulation)

At this stage, the product resulting from the first revision is then socialized (simulated) to students.

d. Implementation and Evaluation Stage

At this stage, a trial is conducted to see the practicality and effectiveness of the application. The results of the trial can be seen immediately after the subject answered all questions related to their mathematical problem solving. Quantitative and descriptive analysis was conducted to determine the data analysis techniques used by students to evaluate the application of this study. To analyze student response data, the following steps were taken:

1) Counting the number of students who gave positive answers based on aspects of the question

2) Calculate the percentage of the first step
3) Matching the percentage results with the standards that have been set determines the categories that students respond actively to.

Furthermore, the data were analyzed using the modified percentage formula as follows (Hobri, 2010).

$$\%Students\ Perception = \frac{Total\ score\ of\ data\ collection\ results}{Total\ Criteria\ Score} \times 100\%$$

To determine whether this application is effective or not, a conversion is carried out first. This conversion process is carried out by changing the percentage results' total score into the effectiveness criteria table (Hobri, 2010). The criteria for the effectiveness of teaching materials can be seen in the following Table 2.

Table 2. Moodle E-Learning Effectiveness Criteria Table

Percentage Interval	Criteria
85% - 100%	Very effective
70% - 84%	Effective
50% - 69%	Quite effective
0% - 49%	Not effective

C. RESULT AND DISCUSSION

The results obtained for each stage of research and development can be described as follows:

1. Needs Analysis

At the analysis stage, researchers seek to obtain data regarding student needs for the application to be developed. The implementation of this stage is carried out in January 2021 by conducting a needs analysis. At this stage, preliminary research was carried out, namely observation and giving a needs questionnaire to analyze the needs of students of the Mathematics Education Study Program at the Islamic Institute of Muhammadiyah Sinjai. This primary research includes observing activities during the teaching and learning process, distributing student response questionnaires. The purpose of this introduction is to obtain data on aspects of needs analysis.

After analyzing the needs questionnaire for students of the Mathematics Education Study Program, it was found that 85% of students stated that they needed the Moodle e-learning application because the learning process only used WhatsApp, which was considered less effective. The rest indicated that they did not need the application. This application is expected to make it easier for students to learn and does not require extensive data packages to ease students in online learning.

2. Design

At the design stage, the researchers made a blueprint for e-learning moodle as a medium in solving mathematical problems for students of Mathematics Education Study Program at the Islamic Institute of Muhammadiyah Sinjai. At this stage, researchers build designs that will later be used to create applications. However, before making the application in question, the researcher made indicators about the material that would later be inputted into the application to solve students' mathematical problems.

After making the design, the e-learning Moodle was created as a medium in solving mathematical problems by the researcher, a programmer who is an expert in his field. The plans are still in the early stages; no materials can later help students develop the problem-solving process. These materials were inputted after the initial draft of this design was completed. The following shows the initial display design of Moodle e-learning as a medium in solving mathematical problems, as shown in Figure 2.

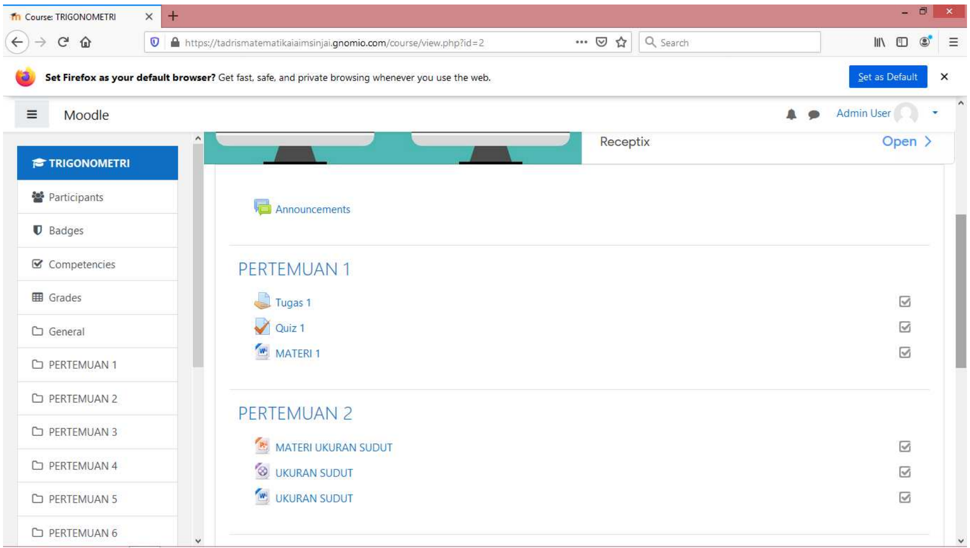

Figure 2. Initial Display of Moodle E-Learning as a Media in Solving Mathematical Problems

3. Development

After developing the model through the analysis and design stages, the next stage is the development stage, which includes several activities: validity testing by experts, model revision, socialization (model simulation), and empirical testing of instruments.

a. The Expert Validation Assessment Results

At the design stage, initial design models have been produced that are still empty or have not been inputted to instruments in the form of materials about solving mathematical problems. At this stage, before the design input at the design stage, it will be submitted to experts (experts) to assess whether the material and questions are following the indicators for solving the resulting problems that meet the valid criteria or not. The results of the experts' assessment (experts) will be used as the basis for making revisions. In addition to problem-solving validation, validation of the application is also carried out before testing the application. As for those who act as application validators in this stage, namely:

1) Problem Solving Instrument Validation Test Results

The process of validating the problem-solving instrument begins with submitting a validation sheet containing material and problem-solving questions related to trigonometry material to the validators to conduct a validity assessment following predetermined criteria. The results of the problem-solving instrument validation test can be summarized in Table 3 below. For a complete view, see the attachment.

Table 3. Summary of Problem-Solving Instrument Validation Results

No.	Rated Aspect	Average value ($\bar{X}$)	Percentage
1.	Material	3,40	Valid
2.	Problem Solving Questions	3,33	Valid
	Average	3,36	Valid

The results of the analysis from Table 4.3 can be clearly shown as follows:

a) The average value of the total validity of the indicators for the material aspect is $\bar{x}$ = 3.40. If the average value is converted to the instrument's validity criteria, it is included in the valid category (2.5-3.5). Thus, the questions for each indicator on the visual aspect were declared valid.

b) The average value of the total validity of the indicators for aspects of problem-solving questions is $\bar{x}$ = 3.33. If the average value is converted to the instrument's validity criteria, it is included in the correct category (2.5-3.5). Thus, the questions for each indicator on the auditory aspect are declared valid.

2) The Results of Applications' Validation

The application validation process begins by submitting a validation sheet containing the theory about aspects of the assessment in the form of design/display quality, button quality and application efficiency made to validators to conduct a validity assessment following predetermined criteria. The results of the application validation test can be summarized in Table 4. For a complete view, see the attachment.

Table 4. Summary of Application Validation Results

No.	Rated aspect	Average value ($\bar{X}$)	Percentage
1	Design/Display Quality	3,70	Very Valid
2	Button Quality	3,25	Valid
3	Efficiency	3,54	Very Valid
	Average	3,51	Very Valid

The results of the analysis from Table 4.4 can be clearly shown as follows:

a) The average value of the total validity of the application for the aspect of design/display quality is $\bar{x}$ = 3.70. If the average value is converted to the instrument validity criteria, it is included in the very good category (3.51 – 4). Thus, the quality of the design/appearance of the application that has been made is declared very valid.

b) The average value of the total validity of the application for the button quality aspect is $\bar{x}$ = 3.25. If the average value is converted to the instrument's validity criteria, it is included in the valid category (2.5 – 3.5). Thus, the quality of the application button design that has been made is declared valid.

c) The average value of the total validity of the application for the efficiency aspect of the application is $\bar{x}$ =3.54. If the average value is converted to the instrument validity criteria, it is included in the very valid category (3.51 – 4). Thus, the efficiency of the application that has been made is stated to be very valid.

b. Problem Solving Instrument Revision Stage

Based on the results of the validator's assessment of the problem-solving instruments that have been made, the instruments in the form of materials and questions regarding problem-solving in this study are overall declared valid. However, in particular, there are still certain aspects that, according to experts, still need to be improved. The input and suggestions for improvement from the validator are as follows, as shown in Table 5.

Table 5. Revision of Problem-Solving Instruments

Revised	Before Revision	After Revision
Material aspect	The material is too long, so it is difficult to understand	The material is more shortened but full of meaning
Question aspect	Conformity between indicators and questions	Questions are replaced with questions that match the problem-solving indicators

c. Application Revision Stage

Based on the validator's assessment of the applications that have been developed, the applications in this study are overall very valid. However, in particular, there are still certain aspects that, according to experts, still need to be improved. The input and suggestions for improvement from the validator are as follows, as shown in Table 6.

Table 6. Application Revision

Revised	Before Revision	After Revision
Display design quality	The background colour that has the same colour as the program display	The program display colour is changed so that it does not match the program.

The results of the revision at this stage are referred to as model 2 (two) revisions.

d. Socialization Stage (simulation)

The results of the validation and revision of the model were carried out in the previous stage. Before being implemented, socialization or model simulation was first carried out to several lecturers within the Faculty of Education and Teacher Training at the Islamic Institute of Muhammadiyah Sinjai. The purpose of this socialization is to equalize the perception of the application that will be implemented. Socialization of this product is done by registering early to get an account and then logging in according to the username and password registered at the time of registration. After that, materials and questions about trigonometry will appear at each meeting.

At this stage, the socialization and simulation were carried out twice, namely: first, together with female lecturers within the Faculty of Education and Teacher Training at the Islamic Institute of Muhammadiyah Sinjai.; second; with male lecturers within the

Faculty of Education and Teacher Training at the Islamic Institute of Muhammadiyah Sinjai. During the first socialization, the lecturers provided suggestions and input on the application to reduce material on the application. Suggestions and inputs from this stage are then used as material for the next model revision. The revision results at this stage are referred to as model 3 (three) revisions that are ready to be implemented.

e. Implementation

At this stage, the E-Learning Moodle application was introduced to students of Mathematics Education study program, which already contained input materials and questions about solving mathematical problems; in this case, trigonometry was chosen. Trigonometry was chosen because it is seen as a material that requires a good problem-solving process when answering the questions. At this stage, students are asked to register first, enter at the link https://tadrismatematikaiaimsinjai.gnomio.com, then click Log in. Furthermore, users can directly access all materials, collect assignments, etc.

f. Evaluation

The evaluation stage describes the effectiveness of the Moodle e-learning application as a medium in solving student math problems. The effectiveness of the application is primarily determined by the implementation of the model in the previous stage. Thus, the evaluation stage is the final stage which reveals whether the Moodle e-learning application is a medium in solving students' mathematical problems. To assess the effectiveness of the model, data collection instruments in the form of a questionnaire were used, namely:

The results of the analysis of student assessment of the application with the number of respondents as many as 25 (twenty-five) people of the Fourth semester Mathematics Education Study Program at the Islamic Institute of Muhammadiyah Sinjai. can be summarized in Table 7.

Table 7. Analysis of Student Assessment of Applications

No.	Rated aspect	Average value ($\bar{X}$)	Percentage	Information
1	Material/Question	3,68	92%	Very effective
2	Visual Communication	3,54	89%	Very effective
3	Software	3,61	90%	Very effective
	Average	3,61	90%	Very effective

Three aspects are assessed by students in e-learning Moodle as a medium in solving students' mathematical problems. Based on student assessment data from 25 (twenty-five) respondents of the Mathematics Education Study Program in the fourth semester of the Islamic Institute of Religion (IAI) Muhammadiyah Sinjai, there are 92% of respondents who rate the material/questions, 89% of respondents who rate visual communication, and 90 % of respondents who rate the software. Thus overall, the total average percentage for all aspects is 90%. If it is categorized, the student's assessment is in the very effective category. This shows that in terms of the assessment aspect, students meet the criteria for effectiveness.

D. CONCLUSION AND SUGGESTIONS

The preliminary study results at the analysis stage revealed that students needed the Moodle e-learning application as a medium in solving mathematical problems because the campus did not yet have a patent application for online learning. Moodle e-learning application as a medium in solving mathematical problems is declared to be valid and effective. These results were obtained after being tested for validity by experts, which consisted of validating problem-solving instruments in the form of materials and problem-solving questions, all of which were in the valid category, namely 3.36, where the material aspect was 3.40. The elements of problem-solving questions problem are 3.33. Meanwhile, for application validation that is in the very valid category, the average validator value is 3.50. This application is said to be effectively used based on student assessments of application efficiency, display and use of language which are in the very effective category with an average student assessment of 3.61 with a percentage of 90% so that this application is said to be suitable for problem solving for students of the mathematics education study program.

The advantage of the Moodle e-learning application as a medium in solving mathematical problems lies in the ease of accessing it. A hosting system has been implemented so that anyone and anywhere can access it free of charge. This application can be accessed via a computer or mobile phone as long as there is an internet connection. Users only need to register then the material, and problem-solving questions will appear to be solved.

The drawback of this application is that it does not always support existing web browsers, although it can be updated by downloading the latest Moodle application. In addition, there are still some parts in the e-Learning display that cannot be changed in the choice of language. Therefore, for other researchers who will later research Moodle, it is better to pay attention to the shortcomings in Moodle to get even better results.

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