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# Implementation of Problem Based Learning Assisted by Learning Management System to Improve Students' Mathematical Communication Skills

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**Abstract**

*Learning is not limited to the transfer of knowledge, but rather needs to provide opportunities for students to communicate ideas clearly in order to develop more flexible and practical abilities. The aim of the research is to determine the implementation of Problem Based Learning assisted by a Learning Management System (LMS) to improve students' mathematical communication skills. The research method uses a quantitative type, with a sample of class 1F of 23 students as the experimental class and class 1G of 24 students as the control class for the 2022/2023 even semester academic year in the D4 Electronics Engineering study program at the Malang State Polytechnic. Data collection methods such as observation and tests, where instruments are provided with observation sheets and test questions. Data analysis used the normal test, homogeneous test, proportion test, comparison test (test) and the N-gain test. The research results show that the data is normally distributed and homogeneous. The research indicators meet 1) Students' ability to communicate mathematics which is influenced by the treatment given through Problem Based Learning with the help of LMS reaches the minimum standard in learning both (B) individual and classical, exceeds 75%, 2) Students' ability to communicate mathematics which is influenced by the treatment given through Problem Based Learning with LMS support is better than expository learning, 3) The increase in mathematical communication skills of students who take part in Problem Based Learning with LMS support is significantly higher than expository learning, namely 0.496 in the medium category.*

***Keywords**: pbl, lms, mathematical communication skills*

## INTRODUCTION

As time goes by, students are increasingly required to upgrade their mastery of science and technology, which includes the need for contributions from mathematics (La'ia & Harefa, 2021). Mathematics is not just about studying numbers and figures, but there are

many things that can be trained, such as solving problems, thinking critically about problems or communicating problems. (Anderha & Maskar, n.d. 2020). Communicating mathematics both written and verbally is needed to make it easier to understand. Communicating symbols, tables, graphs or other ideas to other people needs to be trained, which is the main thing in mathematical communication according to the Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 58 of 2014(Intan et al., 2021).

The results of observations of students while learning Mathematics at the beginning of the even semester lectures for the 2022/2023 academic year show that in the teaching and learning process students are rarely given training in developing critical thinking skills to solve problems independently. Students can only handle questions that are similar to the examples given by the lecturer, so they face difficulties when faced with problems that are different or have a higher level of difficulty. Students fully assume that learning resources only come from lecturers. This ability can be improved through learning methods where problems are presented in class, and students are asked to solve these problems using the knowledge and skills they have learned, especially mathematical communication skills. The tendency for students to have difficulty conveying ideas is because learning is still focused in one direction on the teacher. Then students still make mistakes when writing mathematical symbols, connecting pictures and tables with ideas are still confused.

The problem-based learning model changes the view of students from those who were initially considered as individuals who have no contribution to individuals who can act as partners, contributors, and sources of inspiration that support the continuity of the learning process(Berkala et al., 2023). For this reason, problem-based learning is an innovative change from conventional learning methods towards a more democratic, modern learning approach. One of the recommendations for learning methods that focus on students, namely the Problem Based Learning (PBL) method. This learning is referred to as innovation in education because it is considered a new approach that is different from previous learning models which tend to be conservative, conventional and based on roles. primary educator (Devanda dkk,2020). Learning no longer only functions as a transfer of knowledge, but is directed at actively exploring students' potential by using more flexible and practical abilities (Kusuma, 2020). As we know, conventional learning

often assumes that students do not yet have any knowledge, similar to empty bottles, so they need to be filled with various types of knowledge, depending on what the teacher deems appropriate for them. Therefore, conventional learning tends to treat students (Kusuma & Rakhman, 2018a).

The dynamic development of information and communication technology (ICT) in various fields, especially education, opens up new opportunities to improve access and quality of education at all levels. Learning during the Covid 19 pandemic at all universities utilized internet-based platforms, as did the Malang State Polytechnic (Polinema). The online learning used during the pandemic collaborates with Polinema's Learning Management System (LMS), as a form of e-learning where educators can inform or distribute syllabi, module materials, assignments and tests. Educators have responded positively to the existence of an LMS which is seen as more efficient, because they can access it anywhere and at any time. E-learning needs to be developed not only as just inputting material, but more holistic in approach, able to integrate learning systems that regulate the roles of lecturers, students, utilization of learning resources, management of learning, as well as systems for evaluating and monitoring learning. (Islamiyah et al., 2016). Mathematical communication skills are an important aspect for students, because studying mathematics is not just to learn to think, but as a tool to express ideas clearly. Based on several previous studies that have been carried out by other researchers, problem-based learning is a suitable method for training students to improve mathematical communication. With the support of an LMS, lecturers can monitor students' structured and independent task activities. From the description above, the indicators for mathematical communication skills include 1) The ability to demonstrate ideas through writing, orally, illustrating visually, 2) The ability to explain, interpret and assess mathematical concepts both in writing, orally, through demonstrations and visualization, 3 ) Ability to utilize notation, terminology, and mathematical structures to communicate ideas that illustrate relationships with situation models.

## METHODS

This type of quantitative research, with samples used in class 1G as a control group of 24 students and class 1F as an experimental group (trial) of 23 students for the 2022/2023 academic year, even semester, D4 Electronics Engineering study program, Malang State Polytechnic. Data collection techniques use observation, interviews and tests. The learning tool instruments include the Semester Learning Implementation Plan

(RPS), Modules, student Jobsheets and students' Mathematical Communication Skills Test (TKKM) questions on the Laplace Transformation material, totaling 3 essay questions. Processing research data using SPSS includes a) Testing the overall average achievement, b) Testing the comparison between two samples (t test), c) Testing proportions, and d) Testing the level of increase in N-Gain. The effectiveness of learning is measured using, namely: 1) Students' ability to communicate in mathematics which is influenced by the treatment given through Problem Based Learning with LMS support reaches minimum standards in learning well (B) individual and classical exceeding 75%, 2) Students' ability to communicate mathematics which is influenced by the treatment given through Problem Based Learning with LMS support is better than expository learning, 3) The increase in mathematical communication skills of students who take part in Problem Based Learning with LMS support is significantly higher than expository learning, The research instrument is validated by a validator called an expert validator, if the validation results are valid then proceed to trial the test questions on students. Testing test questions to evaluate validity, reliability (Cronbach's Alpha), differences between questions, and level of difficulty of questions.

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum \sigma_i^2}{\sigma_i^2}\right) \qquad (1)$$

Keterangan:

$r_{11}$ = reliability

$\sum \sigma_i^2$ = The amount of variance in the scores for each item

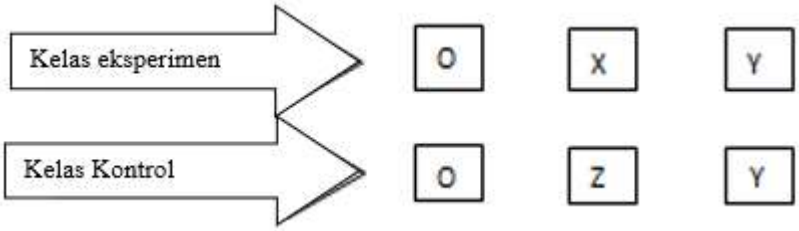
$\sigma_i^2$ = total variance

$n$ = number of questions in the test

Table 1. Learning Media

| Criteria | Information |
|---|---|
| $\mathbf{1,00 \leq P \leq 1,80}$ | Not adequate |
| $\mathbf{1,80 < P \leq 2,60}$ | Not enough Adequate |
| $\mathbf{2,60 < P \leq 3,40}$ | Enough adequate |
| $\mathbf{3,40 < P \leq 4,20}$ | adequate |
| $\mathbf{4,20 < P \leq 5,00}$ | Very adequate |

Each student in the control group and the experimental group received different learning treatment by providing questions and material regarding the same mathematical communication skills.




Picture 1 Research design

Explanation O describes the random selection of two groups. X refers to the group that accepts the Problem Based Learning approach with LMS support. Z refers to the group that took part in expository learning, and Y refers to the test of students' mathematical communication skills.

## RESULTS AND DISCUSSION

The research stages are grouped into three steps involved, namely the research planning stage, the research implementation stage, and the evaluation stage after the research is completed. In the research planning stage, the initial data formulated for the research problem is studied to obtain a solution. The observation data was collected, then a research instrument was created in the form of a learning tool including RPS, Modules, Student Jobsheets, and students' mathematical communication skills test questions (TKKM). After the research instrument was created, expert validation was carried out by two lecturers, from Harapan Bersama Polytechnic and UIN Malang. The validation results can be seen in the following table

Table 2. Expert validation of learning tools

| Instrument | Score | Predikat |
|---|---|---|
| RPS | 4,02 | adequate |
| Modul | 4,13 | adequate |
| Jobsheet S**tudent** | 4,21 | adequate |
| TKKM question | 4,11 | adequate |

The learning tool instrument was refined after receiving suggestions or input from the validator. For TKKM questions, after being declared valid, it is necessary to try them out in a class that has criteria with the experimental class. The results of testing TKKM questions in class 1B with 24 students are as follows

Table 3. Experimental results of TKKM Question Items

| No | Validity | Reliability | Difficulty level | Differentiating power | Information |
|---|---|---|---|---|---|
| 1 | Not Valid | | Easy | Very Good | Not used |
| 2 | Valid | very high | Hard | Good | Used |
| 3 | Valid | | currently | Good | Used |
| 4 | Valid | | currently | Good | Used |
| 5 | Valid | | currently | Good | Not Used |

The questions used took into account each of the test results obtained and the length of time the students worked so that 3 questions were used.

The stages of research implementation start from selecting the classes in which the research will be carried out, namely the experimental group and the control group. Based on the results of the last UAS scores and input from senior lecturers, these two classes have the same academic character, on average, not much different. The experimental group in class 1F was 23 students with the implementation of Problem Based Learning (PBL) learning assisted by the Learning Management System (LMS), the control group in class 1G was 24 students with expository learning in the even academic year 2022/2023. Validated learning instruments are used for experimental classes on the Laplace Transform material. The learning was carried out three times with the following details.

Table 4. Implementation of Learning

| Meeting to | Learning outcomes |
|---|---|
| 1 | Students are able to explain the Laplace transformation in problem solving |
| 2 | Students are able to explain the Laplace transformation in problem solving |
| 3 | Mathematical communication skills test |

In each student meeting, learning is carried out using blended learning using modules as learning companions. Students are given problems at the start of learning by distributing assignments via the Group Jobsheet which is provided in the LMS. The modules provided are used as initial reference material for students to study the material to help solve questions on the job sheet. The effectiveness of learning is determined by indicators, namely: 1) Students' ability to communicate in mathematics which is influenced by the treatment given through Problem Based Learning with LMS support reaches minimum standards in learning both (B) individual and classical exceeding 75%, 2) Students' abilities in communicating mathematics which is influenced by the treatment

given through Problem Based Learning with LMS support is better than expository learning, 3) The increase in mathematical communication skills of students who take part in Problem Based Learning with LMS support is significantly higher than expository learning. The results of the TKKM questions were then carried out by data analysis.

Table 5. Result Normalitas Test

| | Kolmogorov-Smirnov[a] | | |
|---|---|---|---|
| | **Statistic** | **Df** | **Sig.** |
| data_awal | .087 | 47 | .200* |
| a. Lilliefors Significance Correction | | | |

Kolmogorov Smirnov is used for the normal test, obtained sig = 0.200 = 20% > 5%, meaning the normal test is fulfilled, meaning the research sampling can represent the population.

Table 6. Independent Sample Test

| | | Levene's Test for Equality of Variances | |
|---|---|---|---|
| | | **F** | **Sig.** |
| Baseline Data | Equal variances assumed | 1.245 | .773 |
| | Equal variances not assumed | | |

The homogeneous test using the independent sample test - Levene's Test for Equality of *Variances* was found to be significant = 0.773 = 77.3% > 5%, meaning that the homogeneous test was fulfilled, meaning that the variances of the experimental group and the control group were the same.

The test was carried out using the calculation above, where t count ≥ t table (1-α) with a significance level of 5%, degrees of freedom (dk) = 22, and a t table value of 1.717. The calculation results show that the calculated t (7.055) is greater than the t table (1.717), so the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted. This means that the average TKKM (Mathematical Communication Ability) in the experimental group exceeds 68.

Learning completion in this research is defined as achieving a TKKM score above 68 and the number of students who achieve a score above 68 is 75%. This learning completeness refers to mathematical communication skills. The Z test was carried out with parameters n = 23, $\pi 0 = 0.75$, x = 22, and the calculation produced a Z value of 2.13,

which is greater than the table Z value (1.675) with a confidence level of 5%. Therefore, the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted. These results show that the proportion of students who achieve a score above 68 has exceeded 75%. The comparison test is intended to show that the implementation of learning outcomes in the experimental group is superior to that in the control group.

Table 7. Comparation Test

| | | F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
|---|---|---|---|---|---|---|---|---|
| Question | Equal variances assumed | .501 | .495 | 2.335 | 45 | .010 | 5.519 | 2.255 |
| | Equal variances not assumed | | | 2.335 | 52.918 | .010 | 5.519 | 2.252 |

From the distribution of t values, we can see that with degrees of freedom (dk) of 45 at a significance level of 5%, the t table value is 1.653. In conclusion, the calculated t value (2.335) is greater than the t table value (1.653). Therefore, the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted. This indicates that the mathematical communication skills of students who take part in PBL learning with LMS support are higher than students who take part in expository learning.

Evaluation of improving mathematical communication skills is carried out by calculating test scores at the beginning and end of learning. To measure this increase, a formula called Normality of Gain is used.

Table 8. Result N Gain

| Score | Initial evaluation | Final evaluation | Gain Score |
|---|---|---|---|
| Average | 63,65 | 81,7 | 0,496 |

The table shows that the level of increase in LMS-assisted PBL learning outcomes is 0.496 with a moderate predicate.

The results of mathematical communication skills in the experimental group or control group can be used as material for educators to improve other cognitive abilities.

In the development of education today, there are many new challenges and problems that need to be addressed carefully. The PBL approach utilizes the cognitive abilities of both individuals and groups to be completed in a relevant and contextual manner so that it is easy to understand (Tan, 2003). With the PBL model, it is hoped that students will be able to gain many things from exploring abilities, not just memorizing them. Learning on the Laplace Transformation material is carried out in 2 meetings where

students are given cases/problems on a job sheet adjusted to the course achievements. During class learning, students are grouped into small groups consisting of 4-6 students, to discuss job sheets. Modules and job sheets during the semester can be seen in the Learning Management System (LMS) which have been input by educators. This module was created so that learning is more focused in accordance with the learning model desired by educators. This module helps students as a learning resource at home(Safitri & Purbaningrum, 2020). Where this module has been prepared with instructions that are adapted to the Semester Learning Implementation Plan (RPS) (Kusuma & Rakhman, 2018b). Then the small group is given the opportunity to convey ideas regarding the problems provided by the job sheet, then the educator as facilitator directs if there are obstacles to the group's argument. An interactive climate that runs dynamically has a positive impact on students' understanding in communicating mathematics related to the problems they face (Ramadhani et al., 2019). Modules are one means of success in the teaching and learning process(Kusuma & Rakhman, 2018a). LMS provides a group chat feature where, in structured assignments, if students experience difficulties they can discuss with friends and educators.

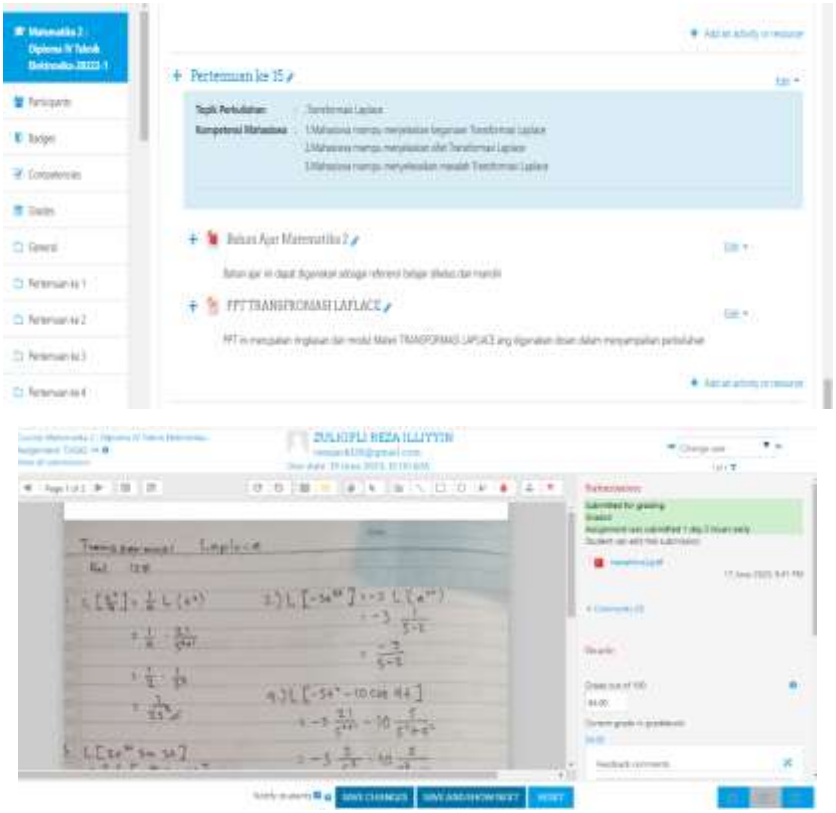


Figure 2. LMS Activity View

The role of educators with the existence of e-learning such as LMS makes learning not just a transmission of knowledge, but rather as a mentor whose function is to facilitate (facilitator) students (Muhammad, 2017). Learning by applying the PBL model does not only look at the final score of the questions that measure students' mathematical communication skills but there is an assessment of the learning process, where learning activities are observed by observers from peer lecturers who help students with active activities (Lidinillah, 2013). The evaluation was given at the last meeting with 3 mathematical communication skills test questions that had been tested. The questions are given for 60 minutes, the rest is used for feedback on the results of student work. The results of the recapitulation of students' mathematical communication skills (KKMM) for class 1F of 23 students are as follows.

Table 9. Result KKMM

| **Indicator** | **The number of students who answered correctly** | |
|---|---|---|
| Ability to express ideas through written, verbal, and visual representations. | 21 | 91,3% |
| Ability to understand, assess, and convey mathematical concepts both in writing, orally, by demonstration, and through visual representation | 19 | 82,6% |
| Ability to utilize notation, mathematical terms, and structures to communicate concepts that describe their relationship to situation models | 18 | 78,2% |

Based on table 9, the majority of students have met the indicators of students' mathematical communication skills, but there are still students who have difficulty communicating the indicators. The ability to use notation, mathematical terms and structures to communicate concepts that describe their relationship to situation models, this is because students in connecting real problems brought into abstract solutions are still not in sync.

In line with research (Kusuma & Junus, 2022) to obtain the development of online learning tools using the Problem-Based Learning (PBL) approach to improve students' ability to solve mathematical problems in a valid and effective way. Research (Ningrum, 2016.) that Problem Based Learning (PBL) learning can be used to help improve students' mathematical abilities, where this learning focuses on discussion activities, learning outcomes and presentations. Research (Yanti, 2017) explained that the problem-based

learning approach can improve communication skills in mathematics by 43% and problem-solving abilities by 58% when compared to conventional learning methods

## CONCLUSION

Indicators of the research results of Problem Based Learning (PBL) assisted by the Learning Management System (LMS) to improve students' mathematical communication skills can be seen: 1) Students' ability to communicate in mathematics which is influenced by the treatment given through Problem Based Learning assisted by LMS reaches the minimum standard in learning with both (B) individual and classical exceeding 75%, 2) Students' ability to communicate in mathematics which is influenced by the treatment given through Problem Based Learning with LMS support is better than expository learning, 3) Increased mathematical communication skills of students who take part in Problem Based learning Learning with LMS support is significantly higher than expository learning, namely 0.496 in the medium category. This research can be continued to find out in detail using qualitative methods each student's achievement of students' mathematical communication skills. The benefits that students get are that they are more confident in expressing ideas because they are given the opportunity to solve problems, then students feel accompanied even though the assignments are structured and independent in the LMS. For lecturers, students are more proactive in conveying their thoughts and ideas, learning goals are more easily achieved.

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