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The Effectiveness of Problem-Based Learning-Based E-MFI to Spur the Solving Ability of PGSD UAD Students

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ABSTRACT

Problem-solving skills are an important component of higher-order thinking, which is essential for students to handle a variety of problems. It includes reasoning and applying mathematical concepts to solve problems in other areas. To train students' problem-solving skills, activities that provide opportunities to practice mathematical problem-solving skills by providing opportunities to use thinking skills to develop and find problem solutions. One effective option is to apply appropriate learning approaches, such as Problem Based Learning (PBL). A lecturer is expected to have the ability to create teaching materials based on goals and needs. Currently, Electronic-Student Worksheets (e-LKM) is one of the educational programs where it can be used for evaluation of learning through information and communication technology. The purpose of this study is to determine the effectiveness of the use of PBL-based e-LKM to improve students' problem-solving skills. This type of research is an experimental research with a pretest posttest control group design. The population in this study is 2nd semester students of PGSD UAD, while the sample is class D. The data collection technique uses interviews, observations, and pretest and posttest questions for student problem solving on SPLDV material. The results of this study show that the use of PBL-based e-LKM is proven to be effective in improving students' problem-solving skills with SPLDV materials. Therefore, this study concludes that the use of PBL-based e-LKM is effective in improving students' problem-solving skills.

Keywords: e-LKM; problem based learning; problem solving

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INTRODUCTION

In the development of the era in the 21st century, it is all digital. Digital technology is very petrified human activities in daily life, both in the world of work and in the world of education because it provides high efficiency. Problems are beginning to emerge related to inadequate infrastructure to support the learning process in the digital era (Mukmin et al., 2024). According to Fonna & Nufus, (2024) 21st Century Skills It consists of skills in critical thinking, problem solving, creative thinking, communication, and collaboration. Nowadays, problem-solving skills are a major concern in mathematics (Barham, 2020). Students must be trained in problem-solving during the educational process (Subekti & Jazuli, 2020).

As prospective educators, students must have good problem-solving skills (Sumarni et al., 2021). When students have good problem-solving skills, they also have good analytical skills, which they can apply to different situations (N. R. Dewi et al., 2020). Thus, mastery of problem-solving skills is important for students to have as prospective educators.

The low problem-solving ability is also seen in students of the Elementary School Teacher Education study program, based on the results of interviews with PGSD lecturers that students still have difficulties in solving problems, especially in the material of the two-variable linear equation system, these difficulties are difficulties in analyzing problems, solving

problems to evaluating problems and this is related to problem-solving indicators. Based on the results of interviews with students, the cause of low problem-solving skills is because they are still incapable of analyzing the given problems to be brought to the mathematical model. In other words, the process of analyzing problems to bring to mathematical models is part of the process of developing problem-solving skills, namely understanding the problem carefully and planning a strategy for solving it.

To train students' problem-solving skills, activities that provide opportunities to practice mathematical problem-solving skills by providing opportunities to use thinking skills to develop and find problem solutions (Siswanto & Ratiningsih, 2020). One effective option is to apply appropriate learning approaches, such as *Problem Based Learning* (PBL). PBL is a learning model that emphasizes the use of real-world problems as the foundation of mathematics learning, allowing students to acquire knowledge and core concepts from the material (Manurung & Marini, 2023). Type *Problem Based Learning* (PBL) will provide opportunities for students to develop their abilities in solving mathematical problems (Nisak & Istiana, 2017). Therefore, this study aims to find out the improvement of problem-solving skills. That way, *Problem Based Learning* suitable for developing student problem-solving skills. In addition to choosing the right learning model, the most important thing in achieving learning goals is the need for teaching materials (Daryanto et al., 2022).

Teaching materials are a collection of materials that are systematically created from several existing learning resources (D. R. Dewi, 2017). A lecturer is expected to have the ability to create teaching materials based on goals and needs (Ferdianto & Setiyani, 2018). Alternatively, teaching materials that are suitable for optimizing learning are student worksheets (Sari & Wulanda, 2019). Currently, Electronic-Student Worksheets (E-LKM) is one of the educational programs where it can be used for evaluation of learning through information and communication technology (Budiono et al., 2022). Therefore, it is important to create E-MFI for students based on the advantages of E-MFI. So, E-MFI is right to be used as a teaching material used today.

This research presents an innovation by integrating the use of Electronic-Student Worksheets (E-LKM) based on Problem Based Learning (PBL) as a learning medium on the material of the two-variable linear equation system. The novelty of this research lies in the unique combination of digital approaches and PBL methods, which have not been explored before in the context of improving the problem-solving skills of PGSD students. This approach not only utilizes information technology to facilitate the learning process, but also optimizes problem-solving strategies through real-world problem-solving that is relevant to the needs of the 21st century.

The purpose of this study is to determine the effectiveness of using E-MFI based on Problem Based Learning in improving students' problem-solving skills, especially in the material of the two-variable linear equation system. Thus, this research is expected to provide an overview of improving learning outcomes and present alternative learning strategies that are more adaptive and innovative in the digital era. This research is very useful for lecturers, and other researchers because with student e-worksheets it can help lecturers to measure students' mathematical comprehension skills in assessing students' cognitive abilities. Based on the background of the above problems, the purpose of this study is to determine the effectiveness of MFIs in improving the problem-solving ability of students who take the Two-Variable Linear

Equation System course, so that it can have a positive impact on the learning outcomes of these students.

METHOD

This study uses a quantitative descriptive method. The design of this study is One Group Pretest-Postest Design, which in the experimental research this model is depicted in Figure 1.

O1 x

Figure 1. Research Design

Information:
X = (Treatment) given
O1 = Pretest Value (before being treated)
O2 = Posttest Score (after being given the treatment)

This research site was carried out in the Class of 2023/2024 in the Elementary School Teacher Education Study Program which takes Advanced Mathematics courses. The time of this research was carried out in the even semester of the 2023/2024 Academic Year. The sampling technique uses Purporsive Sampling. Samples are taken using purposive techniques with certain considerations or criteria. The dependent variable in this study is the learning outcomes of students in the Advanced Mathematics course. The independent variable in this study is the use of Problem-Based Learning-Based E-LKM Student Worksheets to achieve problem-solving skills.

The research instrument used in this study is a test to measure the effectiveness of the use of E-MFI media on student mathematics learning outcomes. Data analysis technique from the results of learning about the effectiveness of E-MFIs using a two-way type t-test in formula (1), in (Rijal & Sofiarini, 2019):

$$x = \frac{Md}{\sqrt{\frac{\sum(x^2 d)}{N(N-1)}}}$$

The test results rejected H0 with the criterion, if tHit < −tα or tHit > tα, with a significance level of 0.05.

RESULTS AND DISCUSSION

The effectiveness of Electronic-Student Worksheets (E-LKM) based on *problem-based learning* improves problem-solving skills used to encourage the creation of independent, interactive, inspiring, challenging, and motivating students in the learning process and make learning more effective and efficient. So that it affects the learning outcomes obtained by students in the learning process. This can be seen based on the results of *the pre-test* and *post-test* obtained. *The pre-test* is carried out to determine the level of students' understanding of the material studied before using problem-based learning-based E-MFI to improve problem-solving skills. At the end, a *post-test was given* to find out the level of students' abilities with the existence of problem-based learning-based E-LKM to improve problem-solving skills in the SPLDV material for Advanced Mathematics courses in the 2nd semester of PGSD S1

students. The test questions given previously have been validated by the lecturer of the Advanced Mathematics course. The following are the results of *the pre-test* and *post-test* of students as seen in table 1.

Table 1. Test of Homogeneity of Variance

Test of Homogeneity of Variance					
		Levene Statistic	**df1**	**DF2**	**Sig.**
Learning Outcomes	Based on Mean	0.942	1	46	0.337
	Based on Median	1.104	1	46	0.299
	Based on Median and with adjusted df	1.104	1	42.622	0.299
	Based on trimmed mean	0.897	1	46	0.348

Based on the output above, it is known that the sig value *Based on Mean* for the variables of *Pres-Test* and *Post-Test* learning outcomes in SPLDV material is 0.337. Because the value of *sig.* 0.337 > 0.05, then it can be concluded that the variance of the *pres-test* and *post-test learning outcomes* data on SPLDV material in class D students is homogeneous.

Table 2. Tests of Normality

	Kolmogorov-Smirnov			**Shapiro-Wilk**		
Class	**Statistics**	**Df**	**Sig.**	**Statistics**	**Df**	**Sig.**
Pre-test learning outcomes	0.156	24	0.138	0.923	24	0.067
Post-test learning outcomes	0.149	24	0.182	0.927	24	0.083

Based on the output above, it is known that the *Kolmogoriv-Smirnov* sig value for the Pre-test *and* Post-test *learning outcome variables* in the SPLDV material is 0.067. Because the value of *sig.* 0.067 > 0.05, while it is known that the *Shapiro-Wilk* sig value for the variables of *pres-test* and *post-test* learning outcomes in SPLDV material is 0.083. Because the value of *sig.* 0.083 > 0.05, it can be concluded that the variance of the *pres-test* and *post-test learning outcomes* data in the SPLDV material in class D students is normally distributed.

Table 3. Paired Samples Statistics

	Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1 Pre-test	71.16	24	8.315	1.697
Post-test	82.08	24	6.114	1.248

Based on the table above, the average learning outcome score was 71.16, while the *Post-Test* score was obtained with an average learning outcome score of 82.08. The number of students used as a sample in this study was 24 students. The Std. Deviation value in the Pre-Test was 8.315 and the Post-Test was 6.114. Std.

The Error Mean (standard deviation of the mean value) for the Pre-Test was 1.697 and for the Post-Test was 1.248. Because the average score of E-MFI learning outcomes based on

problem-based learning improves students' problem-solving ability in the Pre-Test 71.16 is smaller than the Post-Test 82.08, there is a descriptive difference in the average score of student learning outcomes between the Pre-Test and the *Post-Test*. Furthermore, to prove whether the difference is significant or not, it is necessary to interpret the results of the paired sample t test contained in the table "Paired Samples Test".

Table 4. Paired Samples Correlations

	N	Correlation	Sig.
Pair 1 Pre-test & Post-test	24	0.307	0.145

The table above shows the results of the correlation test or relationship between *the Pre-Test* variable and the Post-Test *variable*. Based on the table above, it is known that the value of the correlation coefficient (*Correlation*) is 0.307 with a *significance* value (Sig.) of 0.145. Since the Sig. value of 0.145 is greater than the probability value (significance level) of 0.05, it can be said that there is no relationship between the Pre Test variable and *the Post-Test* variable.

Table 5. Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	Df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 Pre-test - Post-test	-10.921	8.680	1.772	-14.586	-7.256	-6.164	23	.000

Based on the "Paired Samples Test" table above, it is known that the value of Sig. (2-tailed) is 0.000 less than the probability value (significance level) of 0.05, so it is stated that H0 is rejected and H1 is accepted. It can be seen that there is a difference between the average learning outcomes of students based on *Pre-Test* and *Post-Test*, which means that there is a significant difference in learning outcomes after using problem-based E-MFM to improve problem-solving skills in the SPLDV material of Advanced Mathematics courses in 2nd semester students of PGSD S1. The table above also contains information about the "*Mean Paired Differences*" value, this value shows the difference between the average score of the *Pre Test* and *Post Test* learning outcomes of -10.921. The difference is between -14,586 to -7,256 (95% Confidence Interval of the Difference Lower and Upper). In the table "Paired Samples Test", it is known that the calculation has a negative value of -6.164, the calculation has a negative value because the average score of *the Pre-Test* learning outcome is lower than the average of *the Post Test* learning outcome. In this context, a negative tcal value can have a positive meaning. So that the calculation value is 6.164.

Next is the stage of finding the value of the table, where the table is searched based on the value *of df* (degree of freedom) and the value of significance (α/2). From the table above, it is known that *the df* value is 23 and the value of 0.05/2 is equal to 0.025. This value is used

as a reference in finding the ttable value in the statistical ttable value distribution. So a ttable value of 2.068 was obtained. Thus, the tcount value is 6.164 > ttable 2.068, so according to the basis of the above decision-making that H0 is rejected and H1 is accepted. So it can be proven that there is a significant difference in the average score of *Pre-Test* and *Post-Test learning outcomes*, which means that there is a significant change in learning outcomes after using problem-based E-MFM to improve problem-solving skills in the SPLDV material of Advanced Mathematics courses in 2nd semester students of PGSD S1.

Discussion

The results of the study show that the use of Electronic-Student Worksheets (e-LKM) based on Problem Based Learning (PBL) has proven to be effective in improving students' problem-solving skills in the material of the Two-Variable Linear Equation System (SPLDV). Based on the results of the statistical test, there is a significant difference between the pre-test and post-test scores of students, where the average post-test score is higher than the pre-test. This shows that PBL-based e-MFI makes a positive contribution to student learning outcomes.

This finding is in line with research conducted by Bahri et al., (2018), which states that problem-based learning can increase students' learning independence and problem-solving skills. The PBL model allows students to be more active in understanding mathematical concepts and applying them in real-life situations, thereby improving their analytical and problem-solving skills.

In addition, research from Fadhilah et al., (2024) also supports this result, where the application of PBL in mathematics learning has proven to be effective in developing students' creative thinking skills. As stated in this study, students who use PBL-based e-MFI have improved in understanding problems, designing solution strategies, and evaluating solution results.

Previous research by Nisak & Istiana (2017) also revealed that the PBL approach can significantly improve students' mathematical problem-solving skills. In this context, e-MFI provides additional support by providing more flexible and technology-based learning resources, thereby facilitating independent learning and increasing student interaction in the learning process.

From the perspective of using teaching materials, research by Santoso et al., (2021) shows that project-based student worksheets can improve students' creative thinking skills. In line with this study, the PBL-based e-MFI used in this study is proven to have a positive impact on student learning by increasing their involvement in the process of critical thinking and problem solving.

The results of this study also confirm the findings of Latiffah, (2023) which states that the development of problem-solving-based e-MFI can overcome misconceptions in science and mathematics learning. In this study, PGSD students initially experienced difficulties in analyzing and modeling SPLDV problems into mathematical form. However, after being given PBL-based e-MFIs, they showed an improvement in their ability to understand problems and determine the right solution strategy.

Thus, this study adds empirical evidence that the integration of e-MFI in PBL-based learning is an effective strategy to improve student problem solving in the field of mathematics. The implications of this study lead to the need for further development of adaptive digital teaching materials and the application of innovative learning models to

improve the quality of mathematics education in higher education.

CONCLUSION

This study discusses the learning outcomes of E-MFI based on *problem-based learning* to improve the problem-solving ability of PGSD S1 semester 2 students. Based on the analysis of the results of the research and discussion, it was concluded that problem-based E-LKM based on problem-based learning improves the problem-solving ability of students in the 2nd semester of PGSD S1 can improve problem-solving skills in the two-variable linear equation system material for advanced mathematics courses with an increase in the average score of student learning outcomes in problem-based E-LKMimproving problem-solving skills, the average score of the Post Test of 71.16 was greater than the Pre Test of 82.08. And the results of the analysis of the value of learning outcomes using the t-test showed a tcount value of 6.1 > a ttable of 2.068 with a significance level of $\alpha = 0.05$. Which means that there is a significant difference in learning outcomes after being used that problem-based learning-based E-MFI improves the problem-solving ability of PGSD S1 semester 2 students

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