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EFFECTIVENESS OF E-LKPD IN IMPROVING STUDENTS' MATHEMATICAL PROBLEM SOLVING

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Abstract: The development of digital learning media as problem-based E-LKPD (Electronic Student Worksheets) has become a significant trend in the education sector. This media utilizes information and communication technology to provide students with a more interactive, interesting and relevant learning experience. Nevertheless, it is important to determine the extent of the media's contribution to improving students' mathematical problem-solving abilities. Therefore, this research aimed to determine the effectiveness of PBL-based E-LKPD on flat-sided geometric material to improve the ability to solve mathematical problems. This research is a quasi-experimental research with a pretest-posttest design. The research subjects were class VIII students at SMP Negeri 3 Banjar Baru. Class VIII A is the experimental class and class VIII C is the control class. Each class has 30 students. The research instrument is questions in the form of essays on flat-sided geometric material that includes problem solving skills. The effectiveness of E-LKPD is measured using the N-Gain test. The research results show that the effectiveness of E-LKPD is in the high category.

Keywords: Aptitude for problem-solving, E-LKPD, PBL, digital learning

INTRODUCTION

Education is an intuitive movement between student and teacher for the development of full potential, leading to agreement on common learning goals (Sujarwo & Sutiarso, 2023). Mathematics is a basic science taught at all levels of education (Khasanah, 2021). Mathematical ability is not only about the ability to calculate. Mathematical abilities include the ability to reason logically and critically in solving problems. The problem solving carried out is not just problems in the form of questions but rather problems faced every day(Marni & Pasaribu, 2021).Students' failure to solve mathematics problems can cause them to be unable to complete mathematics learning activities (Jaswandi & Kartiani, 2022). Therefore, mathematical problem solving ability is one of the basic abilities that needs to be instilled and developed at all levels of education (Darma et al, 2020).

Mathematical problem solving ability is the skill of using the knowledge one already has to solve the mathematical problems faced (Davita & Pujiastuti, 2020). In solving problems, students need to apply a variety of knowledge and understanding which is then integrated in various different conditions (Hendriana et al, 2017). According to Polya,

there are four indicators in solving problems which include understanding the problem, planning to solve the problem, carrying out the plan that has been prepared and checking the results of the solution again (Hendriana et al., 2017). Problem solving can also be defined as a situation where students do not immediately easily find a solution to the problem. Students are expected to find their own way to solve a given problem. In this case the problem in question is a mathematics problem. Students who are used to facing problems will be trained to use the mindset of a problem solver who is able to solve problems in real life.

Realizing the importance of problem solving skills, teachers as facilitators must strive for effective learning. However, different from the expected goal, the pretest results showed that of the total class VIII students who were given the test, only 32% or around 29 students were able to pass the specified completion limit, while the remaining 68% (63 students) were not able to pass the specified limit. These results certainly illustrate that the achievement of mathematics learning objectives in eight grades has not met expectations and needs to be addressed. Not only Indonesia, but several other developing countries also have the same problem, one of which is Vietnam. From previous research it is known that Vietnamese students still have low problem-solving abilities. Only 33% of the 115 students that took the test were found to have met the requirements, and 57% of them gave the test in an inappropriate manner. Most of the solutions offered during the phase of identifying problems to carrying out calculations still contain many errors (Dung & Bao, 2021).

Through interviews with teachers, it is known that the use of student worksheets in school learning is still limited to textbooks, meaning that the questions used only come from textbooks and there is no technology integration. Therefore, the student worksheets used by teachers so far has not been as expected. The lack of application of real problems in student worksheets and the absence of technology integration in the current era are shortcomings of student worksheets used in the learning process. Even though there have been changes to the curriculum, the development of student worksheets designed by teachers does not seem to be in line with the characteristics and needs of students. Therefore, it is necessary to have a learning model that is appropriate to the mathematics learning material and students' lives.

One of the recommended learning models is Problem Based Learning. Problem Based Learningis a learning model that supports an active learning process that is student-centered (Noer & Gunowibowo, 2018). This model emphasizes the process, giving a problem is the beginning of the learning process followed by finding solutions through problem solving activities (Pratiwi & Setyaningtyas, 2020). By using problems from the real world as context or problems, the problem-based learning model helps students learn how to think critically and solve problems. This model also allows students to gain important concepts and knowledge from the subject matter (Istiqomah et al, 2023). The problem-based learning model makes learning more fun, more interactive, gives participants more opportunities to practice, and makes them more motivated to learn (Rani & Sutiarso, 2023).

This research aims to see the effectiveness of using PBL-based E-LKPD (Electronic Student Worksheets) in improving students' mathematical problem solving abilities. Problem-based E-LKPD is designed to increase student involvement in the learning process and includes mathematical problems related to the real world. Apart from that, the stages in the Problem Based Learning model apply a mathematics learning process that requires students not only to

understand mathematical concepts, but also to have the opportunity to think and reason by solving mathematical problems. E-LKPD combined with the Problem Based Learning model can improve students' mathematical problem solving abilities (Asrar et al, 2023).

Several studies have been carried out to improve students' problem solving abilities, including Sarman et al (2023) showing that the use of E-LKPD assisted by the Liveworkseet application grows students' mathematical problem solving abilities as expected (Sarman et al., 2023). Furthermore, research conducted by Khikmiyah (2021) found that PBL-based E-LKPD can increase students' learning activities and mathematical problem solving abilities.(Khikmiyah, 2021). Therefore, based on relevant previous research, this is the basis for the research to be carried out.

The novelty of this research lies in the application of PBL-based E-LKPD to flat-sided geometric material to improve students' mathematical problem solving abilities. The use of E-LKPD is currently becoming a significant trend in the education sector. The use of the internet as part of the learning process provides new learning experiences for students, so that the learning created becomes more interactive, interesting and relevant to students.

METHOD

The type of research used is quasi-experimental. This research was carried out at SMP Negeri 3 Banjar Baru in the 2023/2024 academic year with a population of class VIII students, on teaching material for building flat-sided spaces. The independent variable in this research is PBL-based E-LKPD, while the dependent variable refers to students' mathematical problem solving abilities. Subject selection used cluster random sampling technique. The research was conducted using a pre-post control group design. The samples obtained for the experimental class were class VIII A and control class VIII C. Each class consisted of 30 students. The research design can be seen in Figure 1.

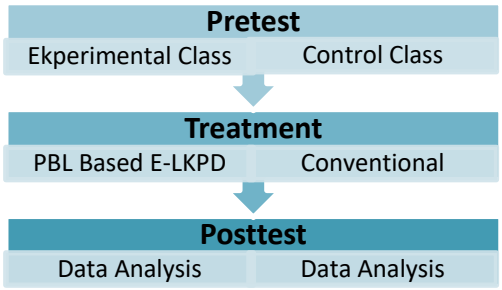

Figure 1 Research Design

The instrument used in this research was a 5-item essay question, which was used to determine the mathematical problem solving abilities achieved by students. After the data is collected, analysis is then carried out from the data obtained. The test used is the sample idependent t-test, and non-parametric Wilcokson test is the formula used if the data is not normal.

Before carrying out the t test, prerequisite tests are carried out, namely the normality test and homogeneity test. Apart from that, n-gain testing was also carried out to see whether there was an increase in students' problem solving ability scores. The n-gain coefficient obtained can be classified as follows.

Table 1 Interpretation of Average N-Gain Scores

N-gain value	Interpretation
$G > 0,7$	High
$0,3 \leq G \leq 0,7$	Currently
$G < 0,3$	Low

Table 2 Interpretation of N-Gain Effectiveness (%)

N-Gain (%)	Interpretation
< 40	Ineffective
$40 - 55$	Less effective
$56 - 75$	Effective enough
>76	Effective

The N-Gain classification will be a reference for comparing the increase in problem solving ability scores between the experimental and control groups. Both learning through the use of E-LKPD or conventional learning (without using E-LKPD). Thus, hypothesis raised in this research is

$H_0 =$ The average data on the mathematical problem-solving skills of students who use E-LKPD based on Problem Based Learning is equal to that of students who do not use E-LKPD based on Problem Based Learning is the hypothesis put forth in this study.

$H_1 =$ Students who utilize E-LKPD based on Problem Based Learning have higher average data on their mathematical problem solving skills than students who do not use E-LKPD.

After fulfilling the prerequisites, a hypothesis test will be carried out, namely an independent sample t-test to test the effectiveness of using PBL-based E-LKPD.

RESULTS AND DISCUSSION

Students' problem solving ability scores were obtained from the results of the pretest and posttest. Pretest and posttest results are presented in Table 3 below.

Table. 3 Distribution of Pretest and Posttest Data

Class	Pretest scores		Posttest scores	
	Max	Min	Max	Min
Experiment	48	10	94	66
Control	40	10	86	60

From Table 3 can be seen that the maximum student score on the pretest is below 50 out of 100. Most students get scores in the range of 25-30. The results of this pretest provide an illustration that some students lack mathematical problem solving abilities. Different from the posttest results. The posttest results show a higher range of student scores. Most students got scores in the range of 74 to 80. The students' highest scores were 94 and 86, while the lowest scores were 66 and 60. This posttest score shows that the majority of students have mathematical problem solving abilities.

However, the magnitude of the increase in pretest and posttest scores is not only determined based on the scores obtained. T and n-gain tests are needed to determine the magnitude of the increase. Next, a normality test was carried out from the pretest and posttest scores with a significance level of 0.05. The normality test results are shown in Table 4.

Table 4 Normality Test of Problem Solving Abilities

Class	Data	Sig.	Sig level.
Experimental	Pretest	0.670	0.05
Control	Pretest	0.979	0.05
Experimental	Posttest	0.084	0.05
Control	Posttest	0.642	0.05

The results of the normality test for mathematical problem solving abilities using the Shapiro Wilk method show the pretest and posttest probability values ore than 0.05. These results indicate that the pretest and posttest scores come from a normally distributed population. Next, a homogeneity test was carried out. The homogeneity test results are shown in Table 5 below.

Table 5 Test of Homogeneity of Problem Solving Abilities

Data	Sig.	Sig level.
Pretest	0.359	0.05
Posttest	0.152	0.05

The results of the homogeneity test of mathematical problem solving abilities using the Shapiro Wilk method show the pretest and posttest probability value and more than 0.05. These results indicate that the pretest and posttest scores come from a normally distributed population.

The results of the normality test and homogeneity test showed that the mathematical problem solving ability scores in the two research samples were normally and homogeneously distributed. After the prerequisite test is carried out, the hypothesis test is then carried out using a parametric test, namely the t-test. By using the SPSS version 25 program, the results obtained are shown in Table 6 below.

Table 6 T-test of Problem Solving Ability Pretest Scores

Independent Samples Test						
		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	T	Df	Sig. (2-tailed)
Pretest	Equal variances assumed	,854	,359	2,594	58	.012
	Equal variances not assumed			2,594	55,921	.012

Based on Table 6, the significance value (2-tailed) is 0.012, which is less than the 0.05 significance level. So it can be concluded that there is a difference in initial abilities (pretest) between the experimental class and the control class regarding students' problem solving abilities. Next, hypothesis testing was carried out on the final abilities (posttest) of students' mathematical problem solving abilities.

Table 7 Posttest Score T-test for Problem Solving Abilities

Independent Samples Test						
		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	T	Df	Sig. (2-tailed)
Posttest	Equal variances assumed	2,111	,152	3,644	58	,001
	Equal variances not assumed			3,644	53,415	,001

Based on Table 7, the significance value (2-tailed) is 0.001, which is less than the 0.05 significance level. So it can be concluded that there is a difference in the final ability (posttest) between the experimental class and the control class regarding students' problem solving abilities.

Table 8 T-test of N-Gain Score for Problem Solving Ability

Independent Samples Test						
		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	T	Df	Sig. (2-tailed)
N-gain	Equal variances assumed	3,671	,060	2,758	58	,008
	Equal variances not assumed			2,758	48,947	,008

Based on Table 8, the significance value (2-tailed) is 0.008, which is less than the significance level of 0.05. So it can be concluded that there is a difference in the average N-gain increase mathematical problem solving abilities groups of students who use E-LKPD based on Problem Based Learning and groups of students who do not use E-LKPD based on Problem Based Learning. Thus, the findings of this research show that PBL-based E-LKPD can improve students' mathematical problem solving abilities.

Several factors supporting success include the use of E-LKPD, the PBL model, and the choice of learning topics. The key factor is the use of E-LKPD. E-LKPD can bring students closer to adapting to digital technology. Different from printed LKPD, E-LKPD can be combined with interactive media or demonstrations (Saputri et al., 2022; Sari et al., 2023). The more senses involved, the more effective the learning process(Robbia & Fuadi, 2020). E-LKPD in this research utilizes the liveworkseet platform and interactive videos from YouTube. Through this media, students can gather information and determine solution options as an initial stage in decision making. Therefore, students can be actively involved in decision making throughout the learning experience.

The second key success factor is the implementation of the PBL model. This model uses real problems to guide students to learn independently according to each student's abilities (Afdillah et al., 2023; Nurdianti et al., 2022; Safitri & Endarini, 2020). Before students make a decision, they will look for information and try to understand and analyze examples of objects such as cubes, blocks, prisms and pyramids. Through E-LKPD, students are directed to carry out these activities. The PBL approach can train critical thinking skills (Noer & Gunowibowo, 2018). Critical thinking skills are the main provision in decision making. Critical thinking is a cognitive process that includes the ability to analyze, assess, draw conclusions, and solve a problem (Awaliya & Masriyah, 2022; Chotimah et al., 2023). Critical thinking skills support students in identifying various alternative solutions and evaluating available options (Cahyo & Murtiyasa, 2023; Nugroho et al., 2019). The third supporting factor is the choice of learning topics. In this research, the learning topic chosen was flat-sided space shapes. In this research, the focus of discussion lies in measuring the surface area and volume of cubes, blocks, prisms and pyramids. This topic is closely related to student life and is related to real problems faced by students. Real problems can make learning more meaningful.

This research shows that problem solving skills in mathematics learning can be trained through PBL-based electronic E-LKPD. E-LKPD as a form of digital learning media can be used to improve problem solving abilities. E-LKPD can also be developed to train 21st century life skills, such as critical and creative thinking skills. The results of this research can contribute to the development of digital learning in the 21st century. Apart from that, the existence of E-LKPD is needed to expand digital learning capabilities. This research is important to ensure that the E-LKPD developed is effective in achieving learning objectives. It is based on these capabilities that problem-based learning is proven to increase effectively.

CONCLUSIONS

The research results show that PBL-based E-LKPD on flat-sided geometric material has high effectiveness in improving students' mathematical problem solving abilities. E-LKPD is designed to train decision making skills from simple problems to complex problems, the ability to solve mathematical problems from simple ones, so that students' thinking patterns will form the same when solving more complex problems. It is hoped that the results of this research will provide benefits in integrating media into learning and training students' mathematical problem solving abilities as one of the skills needed to face the challenges of the 21st century. Especially in flat-sided building material, research findings can be used as a reference when developing curriculum and learning strategies.

Suggestions for future researchers are (1) pay more attention to internet facilities at the research site because carrying out learning requires sufficient internet, and (2) in choosing a learning platform, please be more careful, especially in learning mathematics, because not all platforms can write mathematical symbols or equations.

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