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Application of Problem Based Learning Based E-LKPD on Digital Literacy and Critical Thinking Skills of High School Class X Students

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ABSTRACT

The digital literacy skills still need to be improved in order to support individuals in adapting to developments in information and communication technology. 60% of junior high and high school students have difficulty in solving questions based on reasoning and problem solving. This study aims to analyze the application of PBL-based ELKPD on the critical thinking skills and digital literacy of grade X high school students. This study uses a quasi-experimental method. The design of this study uses a nonequivalent control group design, using experimental and control groups. Using experimental groups and control groups that receive different treatments but receive the same material, namely air pollution. Critical thinking ability instruments in the form of multiple-choice question sheets. The research data were analyzed using N-Gain calculations and Mr. Excel. The results of the analysis of the N-Gain Score pretest value of 48.6 increased to 83.01 in the posttest Showing an average increase of 65.4%, falling into the moderate to high category. The control class that did not use PBL-based E-LKPD only experienced a much smaller increase, with an average N-Gain Score of 12%. the results of the student digital literacy questionnaire, there was a significant influence on the implementation of PBL-based ELKPD on students' digital literacy skills with the "Good" category (62-76%).

INTRODUCTION

The level of digital literacy in Indonesia is still in the medium category, as reflected in a survey conducted by the Ministry of Communication and Information of the Republic of Indonesia with the Katadata Insight Center in 2022. Despite the increase, digital literacy skills still need to be improved in order to support individuals in adapting to the development of information and communication technology. The rise of the use of digital platforms and social media, other challenges arise related to the ability to think critically in sorting out valid and trustworthy information. Many individuals still have difficulty distinguishing accurate information from hoaxes or fake news. Showing that digital literacy is not only related to the use of technology, but also to a critical and creative mindset in processing information in the context of education, the learning system must be able to adopt more innovative and adaptive models to improve digital literacy and critical thinking of students. thus demanding individuals to not only have the technical knowledge but also the critical thinking skills necessary to evaluate information effectively (Santoso et al., 2020).

Various studies show that the critical thinking ability of Indonesian people, especially among students, is still relatively low. The Programme for International Student Assessment (PISA) 2022 report shows that Indonesia is still ranked at the bottom in the literacy categories of reading, mathematics, and science. These three fields are very closely related to critical thinking skills, because they require students to understand concepts, analyze data, and make logical inferences. The average score of Indonesian students in solving complex problems only reaches 382 points, far below the average of OECD countries of 500 points (OECD, 2023). In addition to the PISA results, data from

the 2023 National Assessment (AN) conducted by the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) also shows that the majority of students in Indonesia still have difficulties in answering questions that require critical and analytical thinking. 60% of junior and senior high school students have difficulty solving reasoning-based and problem-solving problems. This low critical thinking skill can have an impact on various aspects of life, such as lack of innovation, low competitiveness of human resources, and the increasing spread of hoaxes among the community. More effective strategies are needed to improve critical thinking skills, both through educational curriculum, more interactive learning methods, and the use of technology in learning.

The change from a passive to active learning model is a must so that students can participate more effectively in the digital ecosystem. Further research is needed on how digital literacy can improve critical thinking skills as well as factors that affect the level of digital literacy in Indonesia. Digital literacy not only includes the ability to use technology, but also involves an in-depth understanding of the content consumed in the context of education. UNESCO (2022) defines digital literacy as the ability to access, analyze, evaluate, and create information using digital technology. Meanwhile, critical thinking in education refers to the ability of learners to ask questions, evaluate arguments, and make decisions based on valid and logical evidence to improve digital literacy skills and critical thinking in education, a variety of strategies are needed that include integration in the curriculum, innovative learning models, and support from various parties, including teachers, schools, and the government.

One effective model is problem-based learning (PBL), which focuses on solving real problems (Wardani, 2023). The Electronic Learner Worksheet (E-LKPD) is a digital version of the LKPD that utilizes technology to improve learning engagement and effectiveness. e-LKPD is a worksheet that is designed digitally so that it can attract the attention of students in completing their assignments. This e-LKPD usually contains a summary of the material that is equipped with learning pictures and videos, clear instructions for use, and tasks that refer to the learning objectives. The presence of these multimedia elements aims to help students learn in a more directed and interactive way. Problem-based learning shows a positive impact on critical thinking skills and digital literacy. PBL-based learning is effective in improving digital literacy and critical thinking skills of grade V elementary school students. Expert validation, observation, and t-test tests revealed significant differences between students' skills before and after the implementation of the device. PBL has been shown to significantly improve both of these skills (Machfiroh et al., 2020).

PBL challenges learners to solve problems related to real-life situations, so that they can see the relevance and practical application of the knowledge gained (Hasibuan et al., 2017). The problem-based learning model emphasizes learner-centered learning, where they are encouraged to seek solutions through investigation, discussion, and reflection, which in turn helps them develop critical and creative thinking skills (Barus, 2019). The problem-based learning model has the characteristic of using real-life problems as something that students must learn. The Problem-Based Learning model is a learning model that uses real problems as a focal point to develop new knowledge and understanding. In this model, learners are actively involved in solving problems introduced from the beginning of learning, allowing learners to develop critical and analytical thinking skills (Pelu, 2019).

The incorporation of e-LKPD in PBL supports interactive and collaborative learning, by utilizing digital technology to create a dynamic and inclusive learning environment. This model also involves the use of e-LKPD as a special tool to facilitate collaborative learning. The digital platform provides opportunities for students to share information, discuss, and work together in groups, which can improve communication and collaboration skills. So this aspect becomes very relevant. The use of electronic worksheets based on Problem-Based Learning as a strategy to strengthen the skills needed by learners in the digital age This model facilitates learners to be actively involved in relevant problem-solving, which simultaneously improves their critical thinking skills as well as strengthens their digital literacy. The use of e-LKPD on the issue of air pollution, chose this topic because it is relevant to daily life. The discussion of air pollution not only educates students about its impact on health and the environment, but also engages them in finding practical and sustainable solutions, deepening students' good understanding of science, technology, and social studies. which was held at

SMAN 1 Sekayu.

Critical thinking skills are an important aspect of 21st century education, as they assist students in analyzing information, solving problems, and making informed decisions. However, at SMAN 1 Sekayu, there are still challenges in developing this ability optimally. This can be seen from the results of research that show that most students have the ability to think critically in the category of less to sufficient, especially in subjects. On the other hand, digital literacy is becoming an increasingly important competency along with the development of information technology. SMAN 1 Sekayu has implemented the Media Literacy Movement as an effort to improve students' digital literacy. Programs such as reading corners, short stories, and wall magazines have been implemented to foster students' interest in reading and literacy skills.

MATERIALS AND METHODS

1. Research Time and Place

The research time was carried out on January 22-25 of the even semester of the 2025 academic year. was held at SMAN 1 Sekayu Jl Merdeka LK. III Sekayu District, Musi Banyuasin Regency

2. Research Methodology

This study uses *a quasi-experimental* (Maciejewski, 2020). Method the design of this study uses *a nonequivalent control group design*, using an experimental group and a control group that is directly selected (Sugiyono, 2022). Researchers used experimental groups and control groups that received different treatment but got the same material, namely air pollution)

3. Population and Sample

The population in this study is students in class X of SMAN 1 Sekayu. The sample of this study took 2 classes where the class had the average ability of students. The classes taken are classes X2 and X3

4. Research Procedure

This research consists of three stages of preparation, implementation, and completion. At the preparation stage, samples were determined, e-LKPD based on Problem-Based Learning (PBL), critical thinking instruments, and digital literacy questionnaires were prepared. At the implementation stage, pre-tests were carried out, learning with e-LKPD in the experimental class, conventional methods in the control class, and then post-tests. At the completion stage, the data is statistically analyzed to assess the effectiveness of the e-LKPD, a report is prepared, and conclusions are drawn

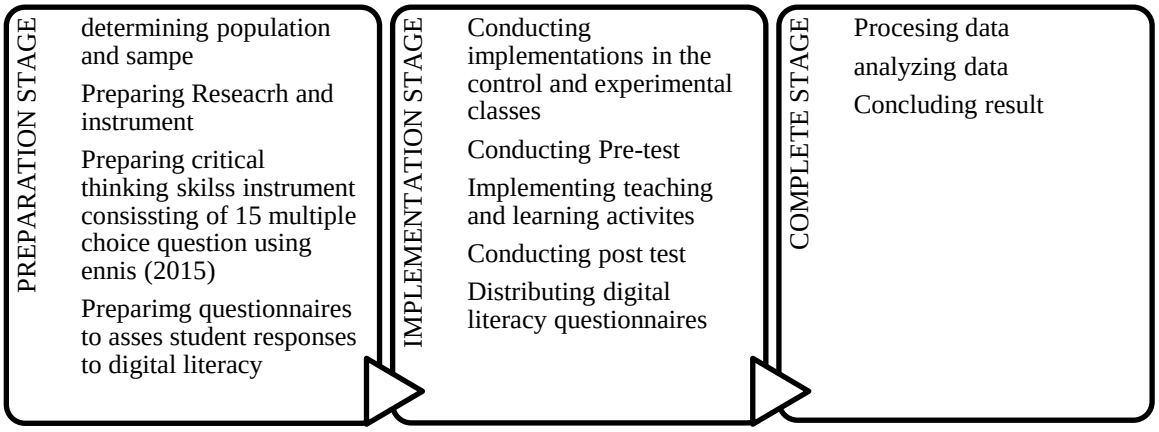

Figure 1. Stages of the research

5. Data Collection Techniques

The data collection technique used in this study uses the Interviews, Interviews, and Interviews

1. Test

   Critical thinking ability data was obtained through a test of 15 multiple-choice questions on Environmental Change material which is already known as a critical thinking indicator. Then the questions on critical thinking skills were disseminated through question sheet paper. Each question has a score of 1 if it is true and a score of 0 if it is false. The maximum score obtained if all question items are correct is 15
2. Questionnaire

   In digital literacy research, the author used a questionnaire with a handbook indicator question entitled Digital *Literacy across the curriculum* open through a google form, which has been provided with an answer but the respondent can still write his own answer if the answer is not in the choice that has been provided. This questionnaire technique is to obtain data on students' digital literacy

6. Data Analysis

Homogeneity is a statistical test that shows that the sample data group comes from a population that has the same characteristics and is not much different in diversity (Nuryadi, 2017). In order for the data obtained in this study to be accountable, it must first be tested for normality. N-Gain is the difference between post-test and pre-test scores that will show an increase in students' understanding or mastery of concepts from the learning given (Herlanti, 2014). The critical thinking ability test is given in the form of a description with a grading system (4-0). Pre-test and post-test data will be analyzed using Normalized Gain to measure changes in students' critical thinking skills with the formula:

$$N - Gain = \frac{Posttest - Pretest}{Skor\ Max - Pretest}$$

Table 1. N-Gain Score Assessment Category (Sundayana, 2014)

N-Gain	**Criteria**
$g \leq 0,30$	Tall
$0.30 \leq g \leq 0.70$	Keep
$g \geq 0,70$	Low

(Sugiono, 2017)

The questionnaire that will be analyzed is a response given to students in class X of SMAN 1 Sekayu to measure digital literacy. data processing of analysis results using the Ms. Excel application. Formula for calculating the percentage of student responses:

$$P = \frac{Total\ student\ score}{\text{Ideal score}}\ x\ 100\%$$

Table 2. Assessment of Learner Responses

Present (%)	**Information**
0- 20	Very Less
21- 40	Less
61 - 80	Good
80 - 100	Excellent

RESULTS AND DISCUSSION

Results of Students Critical Thinking Test

The critical thinking ability in this study was measured using a test instrument in the form of multiple-choice questions totaling 15 questions with air pollution material. *Prettest* was carried out before the implementation of PBL-based E-LKPD in experimental classes and lecture learning in control classes. *Posttest* is then given after the application of PBL-based E-KPD in the experimental class and lecture learning in the control class. The results of the pretest and posttest were carried out as follows.

Table 3. Kolmogorov-Smirnov Test Normality Test Results

Group	Variable	Sig.
Experiment	Pretest	0.100
	Posttest	0.156
Control	Pretest	0.158
	Posttest	0.055

Based on Table 3, the p-value (significance) in both the pre-test and post-test > 0.05. Based on the results of the normality test, it can be concluded that the data is distributed normally. In this test, the significance value (Sig. or p-value) is the main reference. If the Sig. value is greater than 0.05 (α = 5%), then the data is considered to be normally distributed. On the other hand, if it is less than 0.05, then the data is considered abnormal (Ghasemi & Zahediasl, 2012). Based on the results of the Kolmogorov-Smirnov test in Table 3, it can be concluded that all data from the experimental and control groups, both in the pretest and posttest stages, meet the assumption of normality. This shows that the data collection procedures and treatment provided are consistent and do not cause the data distribution to be distorted. Therefore, the results of advanced statistical analysis used in this study, such as the mean difference test (t-test), will have stronger validity because they are based on normally distributed data The critical thinking ability in this study was measured using a test instrument in the form of multiple-choice questions totaling 15 questions with air pollution material. *Prettest* was carried out before the implementation of PBL-based E-LKPD in experimental classes and lecture learning in control classes. *Posttest* is then given after the application of PBL-based E-KPD in the experimental class and lecture learning in the control class. The results of the pretest and posttest were carried out as follows. This finding is supported by research conducted by Rahmawati, Sari, and Prasetyo (2023) which states that the implementation of E-LKPD based on Problem-Based Learning (PBL) tends to produce a normal data distribution in measuring students' critical thinking skills. These results strengthen that PBL-based learning devices are able to provide an even learning experience for all students.

Table 4. Kolmogorov-Smirnov Test Normality Test Results

Group	Variable	Sig.
Experiment	Pretest	0.100
	Posttest	0.156
Control	Pretest	0.158
	Posttest	0.055

Based on Table 4, the p-value (significance) in both the pre-test and post-test > 0.05. Based on the results of the normality test, it can be concluded that the data is normally distributed.based on the test results, it is known that the significance value (p-value) for all data is above 0.05. In detail, in the experimental group the significance value for the pretest was 0.100 and for the posttest was 0.156. Meanwhile, in the control group, the significance value of the pretest was 0.158 and the posttest was 0.055. These significance values show that all data, both from pretest and posttest in both groups, are above the significance limit of 0.05. Therefore, it can be concluded that the data is distributed normally. This normal distribution is important because it is a requirement to perform parametric statistical tests at the next stage of analysis (sugiyono, 2019)

Table 5. Homogeneity Test Results

Variable	Live Test	
	F Calculate	Sig.
Posttest Experiment Posttest Control	0.655	0.421

Based on Table 5. that the p-value of the homogeneity test of the posttest value between the experimental and control classes was 0.421 which was greater than 0.05 which means that the data was homogeneous. Based on the results of the normality and homogeneity test, it can be concluded that the data is distributed normally and homogeneously. So that the data can be tested by parametic paired sample test (pretest – posttest) and free sample (posttest experiment – control). In addition, research by Nugroho and Kurniawan (2022) also showed that the pretest and posttest results of critical thinking in learning with the PBL model tended to meet the assumption of normality, indicated by the Sig. value > 0.05 in the Kolmogorov-Smirnov test. This shows that the learning process that involves active student involvement is able to facilitate an increase in critical thinking skills with homogeneous results among students.

Table 6. Experimental Group Paired Sample Test Results

Variable	Mean	Median	Std.Dev	Min-Max	P Value
Pretest Scores	48.6	46.6	11.69	26.67 – 66.67	0.000
Posttest Scores	83.01	86.6	10.72	60 – 100	

Based on table 6. The average answer sheet results for pretest students were 48.6 and posttest was 83.01. From the results of the mean value, it is known that the mean value of the respondents in the study has increased. Based on the table of paired sample test results above, with a value of sig. 0.000 < 0.05 in the increase in the value of student learning outcomes a model given to students has a significant effect on the application of PBL-based ELKPD on students' critical thinking skills study by Febriyanti and Wahyuni (2023) in the Indonesian Science Education Journal also proved that the use of PBL-based e-LKPD increased students' active participation and critical thinking skills in science material, as indicated by a significant increase in posttest results compared to the pretest.

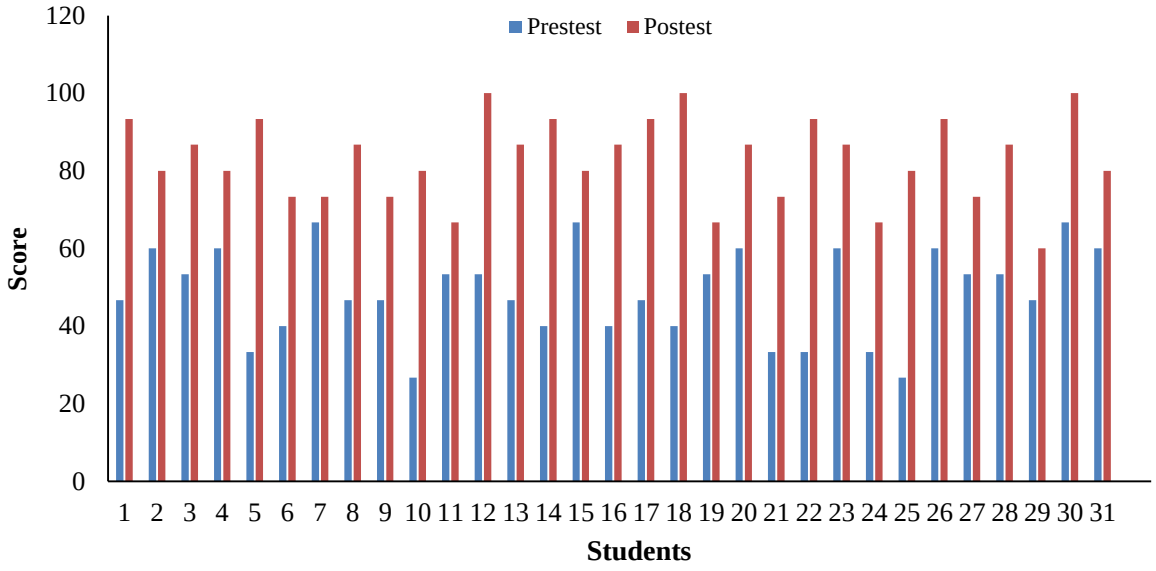

Figure 1. Shows the comparison of pretest and posttest scores in the experimental group.

Pretest scores are displayed in blue, while posttest scores are displayed in red. It can be seen that the posttest score is higher compared to the pretest score.

Table 7. Control Group Paired Sample Test Results

Variable	Mean	Median	Std.Dev	Min-Max	P Value
Pretest Scores	47.31	46.67	11.84	20 – 66.67	0.000
Posttest Scores	54.19	53.3	9.69	33.33 – 73.33	

Based on table 7. The average learning outcomes of pretest students were 47.31 and posttest was 54.19. Based on the table of the results of the paired sample test above, with a value of sig. 0.000 < 0.05. the results of the paired sample test on the control group for pretest and posttest scores. The variables analyzed were students' pretest and posttest scores. The average (mean) pretest score was 47.31 with a median of 46.67 and a standard deviation of 11.84. Meanwhile, the average posttest score increased to 54.19 with a median of 53.33 and a standard deviation of 9.69. The range of values (min-max) for the pretest was 20–66.67, while for the posttest it was 33.33–73.33. The significance value (P Value) of the paired sample test is 0.000, which indicates a significant difference between the pretest and posttest scores in the control group (p <0.05). Based on the table, it can be concluded that there was an increase in the average score from pretest to posttest in the control group, and the difference was statistically significant. research conducted by Pratiwi, Suniasih, and Dantes (2023) in the Indonesian Education Journal journal which stated that the implementation of PBL-based e-LKPD was able to significantly improve critical thinking skills and student learning outcomes. This happens because the PBL model encourages students to be active in solving problems and connecting concepts in learning

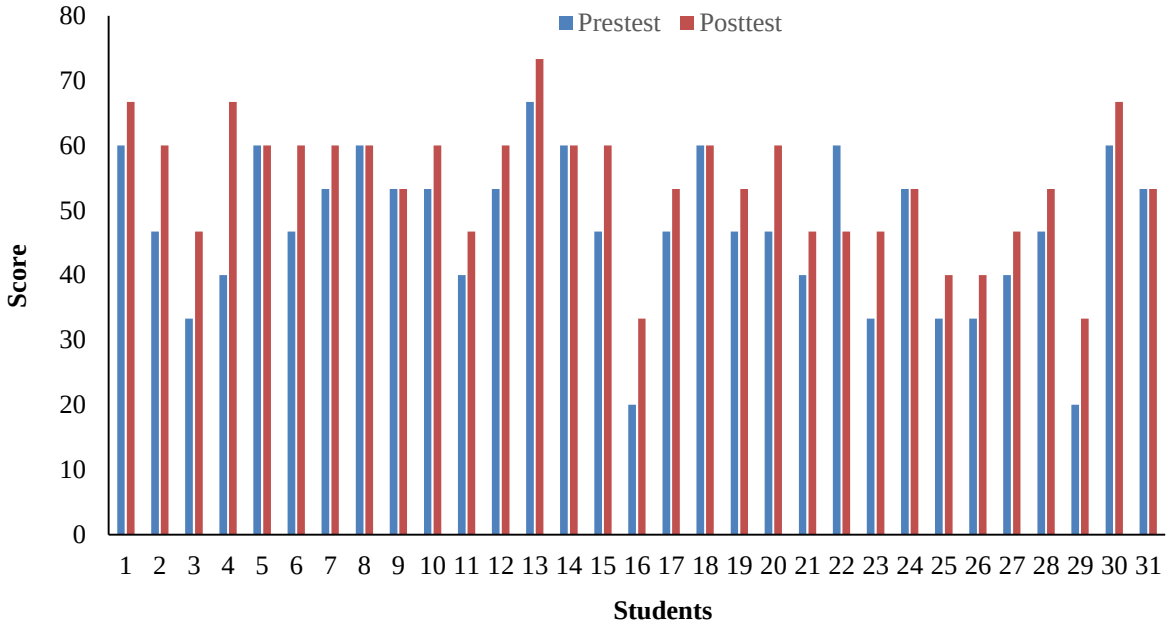

Figure 2. Shows the comparison of pretest and posttest scores in the control group.

Pretest scores are displayed in blue, while posttest scores are in red. There was an increase in posttest scores compared to pretests, although the increase was not very significant.

Table 8. Control Group Paired Sample Test Results

Variable	Mean	Median	Std.Dev	P Value
Experimental Posttest Scores	83.01	86.6	10.72	0.000
Control Posttest Scores	54.19	53.3	9.69	

Based on table 8. The average learning outcomes of posttest students in the experimental class were higher than those of the control class of 83.01 and the control class of 54.19. Based on the table of free sample t-test results, with a value of sig. of 0.000 < 0.05, it can be concluded that there is a significant difference in the average value of learning outcomes between students in the experimental and control classes, or it is interpreted that the model given to students, namely the application of PBL-based E-LKPD in the experimental class, on students' critical thinking skills, has a significant that with a problem-based approach, students become more trained in developing critical thinking skills, also

confirms that problem-based learning puts students in a more active learning situation, where they must identify, analyze, and find solutions to a problem, thereby improving their critical thinking skills (Shafira, 2024).

Results of the Digital Literacy Questionnaire for Students

The Digital Literacy Ability in this study was measured using an instrument with a total of 30 questions that had been validated. then measured in an experimental class to measure digital literacy after learning using PBL-free ELKPD

Table 9. Critical Thinking Skill Indicator Analysis

Indicators	Experimental Classes		Control Class	
	N-Gain	Category	N-Gain	Category
Provide a Simple Explanation	0.50	Keep	-0.12	Low
Building Basic Skills	0.64	Keep	0.18	Low
Drawing conclusions	0.76	Keep	0.12	Low
Making Further Explanations	0.70	Keep	0.32	Low
Creating Strategies and Tactics	1,07	Tall	0.24	Low

Based on Table 9, it is shown that the experimental class experienced a higher increase in critical thinking skills than the control class. In the experimental class, most of the indicators were in the "medium" category, with the highest N-Gain value in the "Making Strategies and Tactics" indicator (1.07) which was in the "high" category. Meanwhile, the control class only reached the "low" category for all indicators, there was even a decrease in the indicator "Providing a Simple Explanation" (N-Gain -0.12). This shows that the methods used in the experimental class have a significant influence on critical thinking skills compared to the control class. Previous studies conducted by Aulia & Widyatmoko (2024) also indicated that adequate technological infrastructure and training for teachers and students are essential to ensure the success of implementing PBL-based E-LKPD.

Table 10. Results of the Digital Literacy Questionnaire for Students in the Experiment class

No.	Aspects	Present (%)	Category
1	*Functional skills and beyond*	76	Good
2	*Creativity*	76	Good
3	*Critical Thinking and Evaluation*	75	Good
4	*Cultural and Social Understanding*	74	Good
5	*Collaboration*	62	Good
6	*The Ability to Find and Select Information*	73	Good
7	*Effective Communicatio*	71	Good
8	*E-Safety*	66	Good

Based on Table 10. The results of the participants' digital literacy questionnaire show eight aspects of digital literacy with the percentage of achievement and assessment categories. All aspects fall into the "Good" category with a percentage range between 62% to 76%. The aspect with the highest percentage is *Functional skills and beyond* and *Creativity* (76%), while the aspect with the lowest percentage is *Collaboration* (62%) and *E-Safety* (66%). Overall, students' digital literacy is in the good category (60-80%). Based on the results of the digital literacy questionnaire of students in the implementation of PBL-based ELKPD shown in Table 18, students' digital literacy in the implementation of PBL-based ELKPD is in the "Good" category with a percentage range of 62-76%. Some of the aspects with the highest scores are Functional Skills and Beyond and Creativity, each with a score of 76%. This shows that students have strong basic skills in using digital technology and are able to be creative in a digital environment. However, the Collaboration aspect has the lowest score, at 62%. This shows that even though learners are quite good at working together digitally, there is still room for improvement when it comes to sharing information, communicating, and working in teams

effectively through digital media. In addition, the E-Safety aspect has a score of 66%, which although still in the good category, shows the need to increase awareness of digital security, personal data protection, and ethics in using technology. Digital literacy refers to the ability to understand, use, and evaluate information from various digital sources (Kurnianingsih et al., 2017).

Table 11. Results of the Digital Literacy Questionnaire for Control Class Students

No.	Aspects	Present (%)	Category
1	*Functional skills and beyond*	58	Less
2	*Creativity*	65	Good
3	*Critical Thinking and Evaluation*	58	Less
4	*Cultural and Social Understanding*	76	Good
5	*Collaboration*	68	Good
6	*The Ability to Find and Select Information*	56	Less
7	*Effective Communicatio*	61	Good
8	*E-Safety*	58	Less

Based on Table 11. The results of the digital literacy questionnaire for control class students were based on eight aspects assessed. Three aspects are included in the "Less" category with a percentage of around 56–58%, namely Functional Skills and Beyond, Critical Thinking and Evaluation, The Ability to Find and Select Information, and E-Safety. The other five aspects are included in the "Good" category with a percentage of 61–76%, namely Creativity, Cultural and Social Understanding, Collaboration, and Effective Communication. These results show that several aspects of students' digital literacy still need to be improved, especially in functional skills, critical thinking, and digital security

Based on the results of the study, the implementation of E-LKPD is based on *Problem-Based Learning* (PBL) has been proven to have a significant influence on students' critical thinking skills. The results of the analysis showed that there was a fairly high increase in the average score of students in the experimental class. This increase is also supported by the results of the N-Gain Score test, which shows an average increase of 65.4%, in the medium to high category. Meanwhile, the control class that did not use PBL-based E-LKPD experienced only a smaller improvement, with an average N-Gain Score of 12%, which showed a significant influence compared to the problem-based learning model. which states that the PBL model is able to improve critical thinking skills through a problem-solving process that encourages students to think more analytically and reflectively based on research conducted by Machfiroh et al. (2020

The improvement that occurs is not only seen in test scores, but also in the way learners analyze, evaluate, and solve problems more systematically. Thus, it can be concluded that the use of digital technology in problem-based learning models is an effective strategy in critical thinking skills in today's digital era.Research on Problem-Based Learning (PBL) shows a positive impact on critical thinking skills and digital literacy. (Machfiroh et al., 2020) showed that PBL-based learning tools revealed significant differences between learners' skills before and after the implementation of the tool. There is a significant influence on the implementation of PBL-based ELKPD

CONCLUSION

Based on the results of the study, it can be concluded that there is a significant influence on the application of PBL-based ELKPD on students' critical thinking skills, showing that therecan be a fairly high increase in the average score of students in the experimental class, where the pretest score of 48.6 increased to 83.01 in the posttest. This increase is also supported by the results of the N-Gain Score test, showing an average increase of 65.4%, which is in the medium to high category. The control class that did not use PBL-based E-LKPD experienced only a much smaller increase, with an average N-Gain Score of 12%. Based on the results of the students' digital literacy questionnaire, there was a significant influence on the implementation of PBL-based ELKPD on students' digital literacy skills in the "Good" category (62-76%). The aspects of functional skills and beyond and creativity had the

highest score (76%), showing that students are able to use digital technology well and creatively in its use. The collaboration aspect has the lowest score (62%), indicating that online cooperation still needs to be improved. In addition, the E-Safety aspect with a score of 66% shows that awareness of digital security still needs to be strengthened.

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