The Effect of Implementing Problem-Based Learning based e-Worksheets Assisted by Flip PDF Corporate on Higher Order Thinking Skills

Ulfa Epriga Mahyu, I Wayan Distrik, & Viyanti
Physics Education Study Program, University of Lampung, Indonesia
*Corresponding Author: wayandistrik8@gmail.com

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Abstract - *This study aims to describe the effect of implementing problem-based learning-based e-worksheet assisted by flip PDF corporate on students' higher-order thinking skills (HOTs). Higher-order thinking skills in this study are measured using seven indicators: targeted thinking skills, theory formation, hypothesis formation, reasoning, analysis/evaluation, elaboration, and problem-solving. This digital-based learning innovation emerges as a response to the demands of the 21st century, which emphasize the importance of critical, analytical, and creative thinking skills in addressing real-world problems in daily life. The e-worksheet used not only presents learning materials in an interactive and engaging manner but is also designed to encourage students to explore concepts, connect knowledge, and solve context-based problems relevant to daily life. Additionally, the use of flip PDF corporate enables the presentation of materials in a more dynamic and easily accessible format via digital devices, thereby supporting flexibility in the teaching and learning process. This research was conducted at SMA Negeri 1 Kalianda in the even semester of the 2024/2025 academic year. The research sample consisted of two classes, namely grade XI Merdeka 6 as the experimental group and XI Merdeka 5 as the control group. The research method used was quasi-experimental with a non-equivalent control group design. The results of the study indicate that there is an effect of the implementation of e-worksheet based on problem-based learning assisted by flip PDF corporate on students' higher-order thinking skills. This is indicated by the average N-gain score for the experimental class of 0.67 in the moderate category and the control class of 0.29 in the low category. The results of the independent sample t-test showed a sig. (2-tailed) value under the assumption of equal variance of 0.00 < 0.05. Additionally, the results of the Effect Size test calculation showed a value of 2.24, categorized as high. These findings confirm that the integration of digital technology in the form of e-worksheet based on problem-based learning is not only capable of creating more engaging and interactive learning but also capable of optimizing students' cognitive potential. Therefore, it can be concluded that e-worksheet based on problem-based learning assisted by flip PDF corporate has a high influence in enhancing students' higher-order thinking skills.*

Keywords*: e-worksheet*; *Flip PDF Corporate; Higher Order Thinking Skills*

INTRODUCTION

The development of the 21st century is marked by rapid advances in science and technology, bringing significant changes to various aspects of life. Creative and intelligent human resources are needed to compete in the 21st century (Mahrunnisya, 2023). One aspect of developing quality human resources is education. Education is carried out in accordance with the demands of the 21st century, as outlined in the new curriculum, known as the merdeka curriculum. The merdeka curriculum is one of the new policies of the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia aimed at fostering innovative learning processes that align with the needs of students (student-centered).

The 21st century learning model also requires students to achieve the 4C skills, namely critical thinking, communication, collaboration, and creativity (Indarta et al., 2022). In addition, digital literacy also plays an important role in today's world of education. Digital literacy refers to the

ability to access, understand, evaluate, and produce information by utilizing digital technology appropriately and responsibly. These skills not only support the development of the 4C skills but also equip students to actively participate in life in the digital age. However, there are still challenges in its implementation, such as infrastructure limitations, insufficient teacher training, and low parental awareness of the importance of digital literacy (Saputra et al., 2024).

This situation highlights the need for learning strategies that integrate digital literacy, 21st-century skills, and approaches that encourage students to actively construct knowledge and solve problems independently. Therefore, the use of technology-based interactive learning media is essential to improve the quality of learning, particularly in enhancing higher-order thinking skills.

Through the new learning system, students are expected to be creative and have higher-order thinking skills (Husna & Rigianti, 2023). However, in reality, the learning process tends to still be teacher-centered. This results in students becoming passive, monotonous, and bored (Lejiu et al., 2024). Based on interviews conducted by the researcher with physics teachers at SMAN 1 Kalianda, students still struggle with solving physics problems that require analytical skills. This is due to students' lack of understanding of the physics material being taught.

Although various studies have discussed the application of problem-based learning (PBL), there are still few studies that specifically examine the integration of PBL with interactive digital media such as e-worksheets supported by corporate flip PDFs in the context of physics learning. In particular, few studies have measured its impact on students' higher-order thinking skills using comprehensively measurable indicators. Additionally, the use of flip PDF corporate as an interactive learning medium supporting problem-based learning has not yet been widely adopted, particularly at the secondary education level in rural areas.

Therefore, an appropriate learning approach is needed, namely Problem Based Learning (PBL). This learning method involves students learning through problems related to everyday life. Students are expected to find solutions and draw conclusions in overcoming these problems. In addition to an appropriate learning approach, interesting learning media are also needed to support students in their learning. One medium that can be used is e-worksheet assisted by flip PDF corporate.

Flip PDF corporate is software for creating PDF files that can be opened like a book. This software can display multimedia illustrations, making it interactive teaching material (Ningsih & Suriani, 2024). Therefore, research has been conducted to determine the effect of implementing PBL-based e-worksheet assisted by flip PDF corporate on students' higher order thinking skills.

RESEARCH METHODS

This study was conducted during the 2024/2025 academic year at SMAN 1 Kalianda, South Lampung Regency. The study was conducted using two sample classes, namely class XI Merdeka 6 as the experimental class and class XI Merdeka 5 as the control class. The sampling technique used was purposive sampling. The research design used was Quasi-Experimental with a Non-Equivalent Control Group Design. The data collection technique used in this study was a test with ten essay questions. All students in the experimental and control classes were given a pretest at the beginning before the learning process began. After the

learning process, the students were given a posttest.

Before conducting the pretest and posttest, the validity and reliability of the test instruments were tested first. The criteria for validity testing according to Rosalina et al. (2023) are presented in Table 1.

Table 1. Validity Correlation Coefficient

Value Interval r	Description
0,80 – 1,00	Very High
0,60 – 0,80	High
0,40 – 0,60	Moderate
0,20 – 0,40	Low
0,00 – 0,20	Very Low

The results of the validity test of the higher order thinking skills test instrument for each item are presented in Table 2.

Table 2. Results of HOTs Instrument Validity Test

Question Number	*Pearson Correlation*	Description	Validity Category
1	0.42	Valid	Moderate
2	0.42	Valid	Moderate
3	0.47	Valid	Moderate
4	0.60	Valid	High
5	0.67	Valid	High
6	0.63	Valid	High
7	0.51	Valid	Moderate
8	0.50	Valid	Moderate
9	0.49	Valid	Moderate
10	0.73	Valid	High

The testing criteria were based on the Pearson Correlation value compared to the r Table value, which was 0.34. Based on the validity test results, it was found that all items were valid and could be used in the study with a Pearson Correlation value > 0.34. The interpretation of the reliability coefficient according to (Arikunto, 2013) is presented in Table 3.

Table 3. Reliability Category

Reliability Coefficient	Description
≤ 0,20	Very low
0,20 – 0,40	Low
0,40 – 0,70	Moderate
0,70 – 0,90	High
0,90 – 1,00	Very high

The reliability of the instruments in this study was obtained using Cronbach's Alpha formula with the help of SPSS version 24.0. The results are presented in Table 4.

Table 4. Instrument Reliability Test Results

Number of Questions (1)	*Cronbach's Alpha* (2)	Description (3)
10	0.73	High

Based on Table 4, a value of 0.73 was obtained, which means that the instrument is reliable for use because it is in the range of 0.70-0.90 with a high level of reliability.

RESULTS AND DISCUSSION

Results

The quantitative data obtained from this study is data on the higher order thinking skills of students before (pretest) and after (posttest) learning about static fluids in the experimental and control classes. The results of the pretest and posttest of the higher order thinking skills of students in the experimental and control classes are presented in Table 5.

Table 5. Recapitulation of Pretest and Posttest Scores

Statistical Parameters	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Sample Size (N)	35	35	35	35
Lowest	35	75	40	57.5
Highest	72.5	92.5	70	80
Maximum	100	100	100	100
Average	47.42	83.28	55.14	69.00
Standard Deviation	8.98	5.68	8.44	6.97

Table 5 shows that the average pretest and posttest scores for the experimental class were 47.42 and 83.28, respectively, while the average pretest and posttest scores for the control class were 55.14 and 69.00, respectively.

Based on the research data, N-Gain values are needed to determine the level of

improvement in higher order thinking skills of students in the experimental class and control class. The N-gain values for each class are presented in Table 6.

Table 6. N-Gain Scores for Each Grade

Class	N-Gain Score			Desc.
	Lowest	Highest	Average	
Experimental	0.33	0.88	0.67	Moderate
Control	0.17	0.58	0.29	Low

Table 6 shows that the average N-Gain score for the experimental class was 0.67, which is in the moderate category, meaning that there was a moderate improvement in the higher-order thinking skills of the students after they received the treatment. The average N-Gain score for the control class was 0.29, which is in the low category, meaning that there was an improvement in the higher-order thinking skills of the students, but only to a low degree.

This study used seven HOTs indicators according to (Pogrow, 2005) consisting of: indicator 1 targeted thinking skills, indicator 2 reasoning, indicator 3 forming hypotheses, indicator 4 problem solving, indicator 5 constructing theories, indicator 6 elaborating, and indicator 7 analyzing/evaluating. The N-gain scores for each HOTs indicator are presented in Table 7.

Table 7. N-Gain Scores for Each HOTs Indicator

HOTs Indicators	Experimental Class		Control Class	
	N-Gain	Desc.	*N-Gain*	Desc.
Indicator 1	0.5	Moderate	0.17	Low
Indicator 2	0.54	Moderate	0.42	Moderate
Indicator 3	0.53	Moderate	0.32	Moderate
Indicator 4	0.69	Moderate	0.36	Moderate
Indicator 5	0.62	Moderate	0.28	Low
Indicator 6	0.89	High	0.19	Low
Indicator 7	0.53	Moderate	0.33	Moderate

Table 7 shows that of the seven HOTs indicators in the experimental class, there was an increase in the moderate and high categories, while in the control class there was an increase in the low and moderate categories. Based on the data analysis, it can be seen that there was a higher increase in HOTs indicators in the experimental class compared to the control class.

The normality test results were taken from the Sig. value in the Kolmogorov Smirnov table using SPSS 24.0. The basis for deciding the normality test results was (1) if the sig. (2-tailed) > 0.05, then the data is normally distributed, (2) if the sig. value (2-tailed) ≤ 0.05, then the data is not normally distributed. The results of the normality test are presented in Table 8.

Table 8. Normality Test Results

HOTs	Kolmogorov Smirnov Sig			Interpretation
	Statistic	Df	Sig	
Experimental Pretest	0.13	35	0.18	Normal
Experimental Posttest	0.12	35	0.20	Normal
Control Pretest	0.09	35	0.20	Normal
Control Posttest	0.09	35	0.20	Normal

Based on Table 8, it can be seen that the research data from both classes, namely the experimental class and the control class, have a sig. value greater than 0.05, so the data obtained in the study is normally distributed.

Homogeneity testing was conducted based on pretest and posttest data in the experimental class and control class. The results of the homogeneity test are presented in Table 9.

Table 9. Homogeneity Test Results

Levene Statistic	*df1*	*df2*	*Sig.*	Interpretation
2.20	3	136	0.91	Homogeneous

Based on Table 9, the variance between the two different data sets was 2.20 with a sig. value of 0.91. Based on the hypothesis that if the sig. value is > 0.05, then H_0 is accepted, which means that the

higher order thinking skills of students in the experimental class and the control class have the same or homogeneous variance.

The hypothesis tests in this study were the independent sample t-test and the effect size test. The independent sample t-test was used to determine whether there was a significant difference between the experimental class and the control class. The results of the independent sample t-test are presented in Table 10.

Based on Table 10, the sig. (2-tailed) value for Equal variances assumed is 0.00 < 0.05, so it can be concluded that H_0 is rejected and H_1 is accepted. Thus, there is a significant effect between the application of PBL-based e-worksheet assisted by corporate flip PDF on students' higher order thinking skills.

Table 10. Independent Sample T-Test Results

	t-test for Equality of Means Sig. (2-tailed)
Equal variances assumed	0.00
Equal variances not assumed	0.00

The Effect Size value shows how significant the impact of the implementation of PBL-based e-worksheet assisted by Flip PDF Corporate is on students' higher order thinking skills. The Effect Size test results are presented in Table 11.

Table 11. Effect Size Test Results

Class	**N**	***Mean***	***S.d***	***Cohen's d***	**Interpretation**
Experimental	35	83.29	5.68	2.24	High
Control	35	69.00	6.97		

Based on Table 11, a value of 2.24 was obtained, which is categorized as high. Thus, it can be said that the application of PBL-based e-worksheet assisted by corporate flip PDF has a high influence in improving students' higher order thinking skills.

Discussion

This study aims to determine the effect of implementing problem-based learning e-worksheets assisted by corporate flip PDF on students' higher order thinking skills in static fluid material at SMA Negeri 1 Kalianda. The assessment of higher-order thinking skills (HOTs) in this study was conducted through tests at the beginning of learning (pretest) and at the end of learning (posttest). Then, students used e-worksheets in learning to help stimulate HOTs abilities.

The implementation of problem-based learning based e-worksheets assisted by corporate flip PDFs on static fluid material has a significant effect on students' HOTs abilities. This can be determined through the calculation of n-gain from the pretest and posttest results of the students. The learning process was conducted directly by the researcher to determine the improvement in students' HOTs using an HOTs test instrument in the form of essay questions. The test was conducted before and after learning using the PBL model.

The HOTs test used in this study consisted of ten essay questions covering seven HOTs indicators. The experimental class used e-worksheet, whose activities were adapted to Arends' PBL model so that each HOTs indicator could be trained, while the control class used a conventional learning model.

The average score of the experimental class before learning was 47.42. After learning using PBL-based e-worksheet assisted by flip PDF corporate, the average

score of the experimental class was 83.28. The difference between the average scores of the experimental class before and after learning was 35.86. Then, the average score of the control class before learning was 55.14, while after learning using the conventional model, the average score of the control class was 69.00. The difference in the average score of the control class before and after learning was 13.86. The analysis results show that there was an increase in both classes after the learning process. However, the increase in the average score in the experimental class was higher than that of the control class. Additionally, the increase in students' HOTs skills was assessed based on the n-gain results. The following graph shows the average n-gain scores of the experimental and control classes, as presented in Figure 1.

Figure 1. N-Gain Average Graph

Based on the graph in Figure 1, it shows that the n-gain value of HOTs abilities of students in the experimental class is higher than that of the control class. This makes the application of PBL-based e-worksheet assisted by flip PDF corporate more effective than conventional learning in improving students' HOTs abilities. The average n-gain score in the experimental class was 0.67, categorized as moderate, while the control class scored 0.29, categorized as low. These findings indicate that the use of PBL-based e-worksheet can facilitate students to be more active in the learning process, which requires critical, analytical, and creative thinking skills. Learning does not only take place passively, but encourages students to solve problems, formulate hypotheses, and draw conclusions based on their own understanding.

The learning syntax using the PBL model implemented in the experimental class, according to (Arends, 2014), involves orienting students toward problems, organizing students, guiding individual and group investigations, developing and presenting work outcomes, analyzing and evaluating the problem-solving process. This syntax encourages students to develop ideas, connect new information with prior knowledge, and communicate their findings in a more structured manner. This process makes learning more meaningful because it emphasizes active and collaborative engagement.

The statistical analysis results in this study indicate that the application of PBL-based e-worksheet assisted by corporate flip PDF in learning has a significant increase in students' HOTs compared to the conventional learning model. The results of this study are supported by research conducted by Santoso & Rahmatsyah (2020), which states that the PBL model is effective in improving students' HOTs compared to the conventional model.

Then, the difference in the average N-gain of students' HOTs abilities can be seen from the results of hypothesis testing using the independent sample t-test and effect size test. The results of the hypothesis test obtained a sig. (2-tailed) value of 0.00 < 0.05, assuming equal variances, so it can be concluded that H_0 is rejected and H_1 is accepted. Thus, there is a significant influence or difference between the application of PBL-based e-worksheet assisted by corporate flip PDF on students' higher order thinking skills. The results of

the study also show that the application of PBL-based e-worksheet assisted by corporate flip PDF has a high influence in improving students' higher order thinking skills, as seen from the effect size cohen's d value of 2.24 in the high category. Therefore, students' higher-order thinking skills improved more significantly in the experimental class than in the control class. The following is the average N-gain score for each HOTs indicator, presented in Figure 2.

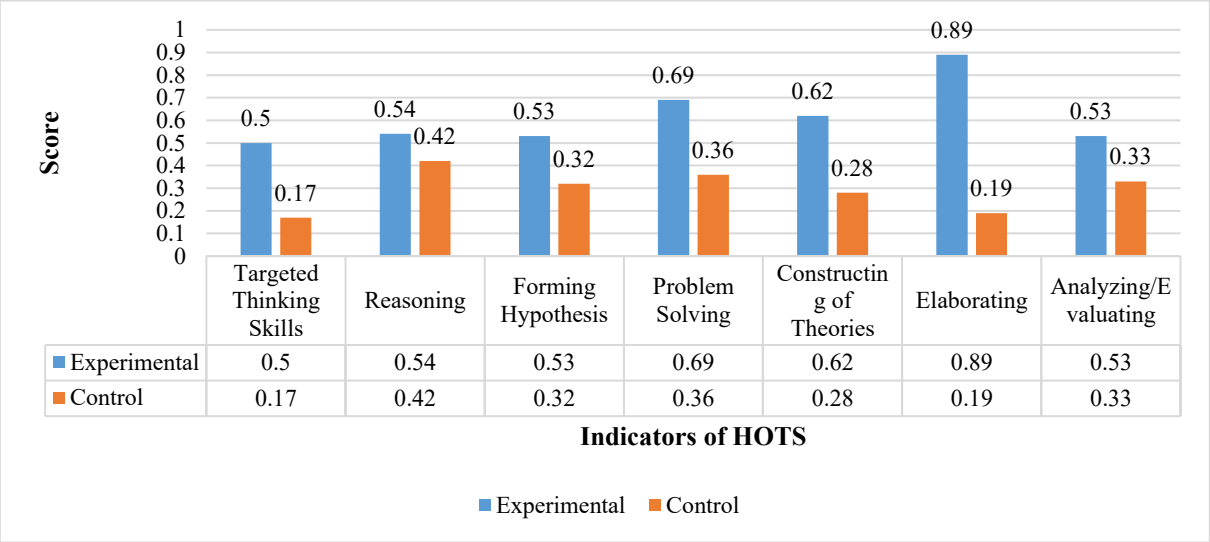

Figure 2. Average N-Gain Graph for Each Indicator

Based on the graph in Figure 2, the average N-gain results for each HOTs indicator in the experimental class were higher than those in the control class. The targeted thinking skills indicator in the experimental class obtained an N-gain value of 0.5 in the moderate category, while in the control class, it obtained an N-gain value of 0.17 in the low category. The reasoning indicator in the experimental class obtained an N-gain value of 0.54 in the moderate category, while the control class obtained an N-gain value of 0.42 in the moderate category. The forming hypothesis indicator in the experimental class obtained an N-gain value of 0.53 in the moderate category, while the control class obtained an N-gain value of 0.32 in the moderate category. The problem-solving indicator in the experimental class obtained an N-gain value of 0.69 in the moderate category, while in the control class, it obtained an N-gain value of 0.36 in the moderate category.

The constructing of theories indicator in the experimental class obtained an N-gain value of 0.62 in the moderate category, while in the control class, it obtained an N-gain value of 0.28 in the low category. The elaborating indicator in the experimental class obtained an N-gain value of 0.89 in the high category, while in the control class, it obtained an N-gain value of 0.19 in the low category. The analyzing/evaluating indicator in the experimental class obtained an N-gain value of 0.53 in the moderate category, while in the control class, it obtained an N-gain value of 0.33 in the moderate category.

Based on the results of the N-gain value calculations for each indicator in the experimental class, it can be seen that the elaborating indicator experienced the highest increase compared to other indicators. This indicates that the learning strategy used provides students with the opportunity to explore concepts, connect new information with existing knowledge, and communicate ideas in a more structured

manner. The development of elaborating skills suggests that students are not merely memorizing information but are also able to connect concepts and formulate solutions through small-group discussions. This aligns with research conducted by Sihaloho et al. (2017), which states that classes using PBL experience an increase in the average N gain for creative thinking and problem-solving skills, including moderate to high increases in elaboration, surpassing control classes using conventional methods.

The implementation of a problem-based learning e-worksheet assisted by Flip PDF Corporate has been one of the factors contributing to the improvement of students' higher-order thinking skills in the experimental class. In improving students' higher order thinking skills, educators can use problem-based e-worksheet products with the PBL model in teaching students. e-worksheet is a digital teaching material that can be used to improve students' cognition (Septiani & Amir, 2023). Learning with e-worksheet assisted by corporate flip PDF can facilitate learning because it only uses links, making it easy to open anywhere. However, the application also has disadvantages, namely that it requires an internet connection to access it, as well as a suitable laptop or mobile phone (Nisa et al., 2024).

The implementation of problem-based learning-based e-worksheet assisted by corporate flip PDF is in line with the activities applied in the learning process. The implementation of e-worksheet with the PBL model syntax not only enriches students' knowledge but also develops collaborative skills and practical abilities that can be applied in everyday situations (Abarang & Delviany, 2021).

CONCLUSION

Based on the results and discussions, it was concluded that the implementation of e-worksheet based on problem-based learning (PBL) assisted by flip PDF corporate significantly improved students' higher order thinking skills in static fluid material. This was seen from the hypothesis test results, which showed a significant difference in HOTs ability scores between the experimental class and the control class in the high category. The experimental class achieved a higher N-gain score compared to the control class, with a score of 0.67 in the moderate category and 0.29 in the low category. The research findings indicate that the implementation of e-worksheet based on problem-based learning assisted by flip PDF corporate enhances higher-order thinking skills (HOTs) across seven indicators: the targeted thinking skills indicator increased by 0.5 in the moderate category, the reasoning indicator increased by 0.54 in the moderate category, the forming hypothesis indicator increased by 0.53 in the moderate category, the problem-solving indicator increased by 0.69 in the moderate category, the constructing of theories indicator increased by 0.62 in the moderate category, the elaborating indicator increased by 0.89 in the high category, and the analyzing/evaluating indicator increased by 0.53 in the moderate category. Furthermore, the effect size calculation yielded a value of 2.24 in the high category. Therefore, it can be concluded that e-worksheet based on problem-based learning assisted by flip PDF corporate has a high impact on improving students' higher-order thinking skills.

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