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Effect of Applying the Problem-Based Learning (PBL) Model with Powtoon Assessment Media on High School Students' Physics Learning Outcomes

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Abstract

Physics learning in senior high schools often faces challenges due to monotonous teaching methods and a lack of interesting media, resulting in low student interest and learning outcomes. This study aims to determine the effect of implementing the Problem-Based Learning (PBL) model supported by Powtoon-based assessment media on students' physics learning outcomes. Powtoon provides visual animations that can improve students' conceptual understanding. This study employed a quasi-experimental method with a post-test only control group design. The subjects were 72 eleventh-grade students at Arjasa State High School, randomly divided into 36 students in the experimental group and 36 students in the control group. The independent variable in this study was the PBL model with Powtoon media, the dependent variable was students' physics learning outcomes, and the control variables were the same topic and duration of instruction. The instrument used was a test consisting of essay questions. Data analysis was conducted using an independent sample t-test with a significance level of 0.05. The results of the study indicate a significant difference between the learning outcomes of students in the experimental group and the control group, with the experimental group achieving higher scores. Therefore, it can be concluded that the implementation of the PBL model with Powtoon as an assessment medium has a positive effect on students' physics learning outcomes. This approach can be used by teachers to enhance students' conceptual understanding and engagement in physics learning.

INTRODUCTION

High school physics is still often considered difficult by students. This is due to the many abstract concepts that require high-level thinking skills. The perception that physics is difficult to understand will affect students' ability to solve problems [1]. One of the causes is the use of monotonous learning methods or methods that are limited to lectures. Lectures usually do not engage students actively in the learning process. This problem is compounded by the fact that many schools have not implemented a scientific approach in constructing students' understanding of physics [2]. This statement is supported by previous research by [3], which mentioned that students were not involved in the learning process.

Based on the results of interviews conducted by the researcher at one of the state senior high schools in Jember, it was found that the learning methods used by the school only focused on Student Worksheets (LKS) using the lecture method. The learning methods used at the school were still limited, making students easily bored during class. This finding was also obtained from the research

by [4], thus necessitating a learning model to construct students' concept mastery accompanied by appropriate media.

One relevant learning model that provides students with the means to develop conceptual understanding is PBL. This model focuses on learner-centred learning, in which students play an active role during the learning process [5]. PBL involves students in solving real-world problems, requiring them to collaborate with classmates or assigned group members. This model also provides opportunities for students to express their ideas through discussions and presentations. The application of the PBL approach can help make learning more interesting and overcome problems related to monotonous instruction [6]. However, its effectiveness can be improved if accompanied by interesting assessment tools or media that support student participation and learning.

Students often feel that the assessments used in learning are not interesting. An interesting assessment uses technology applications so that it can increase students' technological literacy. One interactive technology-based media is the Powtoon application. Powtoon is an application that is used to create animated learning videos so that they can be used as learning media. The web-based application or platform Powtoon can not only be used as a learning medium, but it can also be used as an assessment medium in learning. How Powtoon works is that users can create animated video material according to their creativity. Powtoon is expected to help students during learning activities so that they do not become monotonous in following the lesson. The Powtoon media used by the researcher has been equipped with online video illustrations that have been provided. If researchers want to access more complete features, they need to upgrade to the premium application so that the facilities that can be used are more complete [7]. The Powtoon media will make it easier for teachers or students to create interesting learning videos [8].

The implementation of PBL supported by appropriate assessment media can have a positive impact on students' learning outcomes. A model accompanied by assessment media will enable students to learn better due to their more active involvement [9]. Combining the PBL model with appropriate assessment during learning will certainly increase students' motivation to learn [10]. The combination of the two will also influence the learning outcomes of the students involved. Several studies have examined the use of the PBL model and Powtoon media separately, but there have not been many studies that specifically test the integration of the two with a focus on physics learning, particularly temperature and heat. This became the consideration of the researchers to apply the PBL model assisted by the Powtoon assessment media.

Previous research by [11] explored the effectiveness of using Powtoon-based video media in online learning. Similarly, a study by [12] investigated how Powtoon audiovisual learning media influenced student motivation in mathematics classes. Unlike previous studies, this research integrates the PBL model with interactive Powtoon-based media and tests it in physics learning on the topic of temperature and heat. This approach is expected to not only improve students' learning outcomes but also foster their interest in physics learning.

RESEARCH METHODS

This study aims to determine the effect of implementing the Problem-Based Learning (PBL) model combined with Powtoon assessment media on students' learning outcomes in the subject of temperature and heat. The study was conducted at Arjasa State Senior High School located in Jember Regency, by implementing the Problem-Based Learning (PBL) model combined with Powtoon assessment media. Data collection was conducted in the second semester of the 2024/2025 academic year. The population of this study included all students in the 11th-grade MIPA class, consisting of 4 classes. The sample consisted of two classes, namely the experimental and control classes. The appropriate sample was determined using a homogeneity test. The sample was selected using the Cluster Random Sampling method.

The results showed that class XI MIPA 3 was used as the experimental class and class XI MIPA 4 was used as the control class. The number of students in each class was 36, with relatively equivalent academic backgrounds based on their previous semester report card scores. The research design applied was a quasi-experimental design with a post-test only design model.

The number of questions used in the post-test was 10 essay-type questions. The questions followed Bloom's taxonomy from C1 to C6. The topics on temperature and heat used were temperature and temperature scales, specific heat, heat capacity, Black's law, and heat transfer (conduction, convection, and radiation). The data collection techniques used included observation, interviews, tests (post-tests), questionnaires, and documentation. This study used two types of data, namely primary data and supporting data. The primary data was obtained from the post-tests of the students when they carried out learning using the PBL model, accompanied by the Powtoon assessment media. Meanwhile, supporting data was obtained from interviews with teachers and students as well as documentation during the research activities. Students in the experimental class group participated in learning using the PBL model combined with Powtoon assessment media. Powtoon media was presented in the form of interactive animations containing material on temperature and heat, as well as assessments as learning, for learning, and of learning.

Data analysis was conducted by first performing a normality test. If the data were normally distributed with a significance value > 0.05, data analysis was continued with a homogeneity test. If the data were homogeneous, it was continued with an independent sample t-test to see if there were significant differences between the control class and the experimental class. The research procedure carried out by the researcher during the study is shown in Figure 1 below:

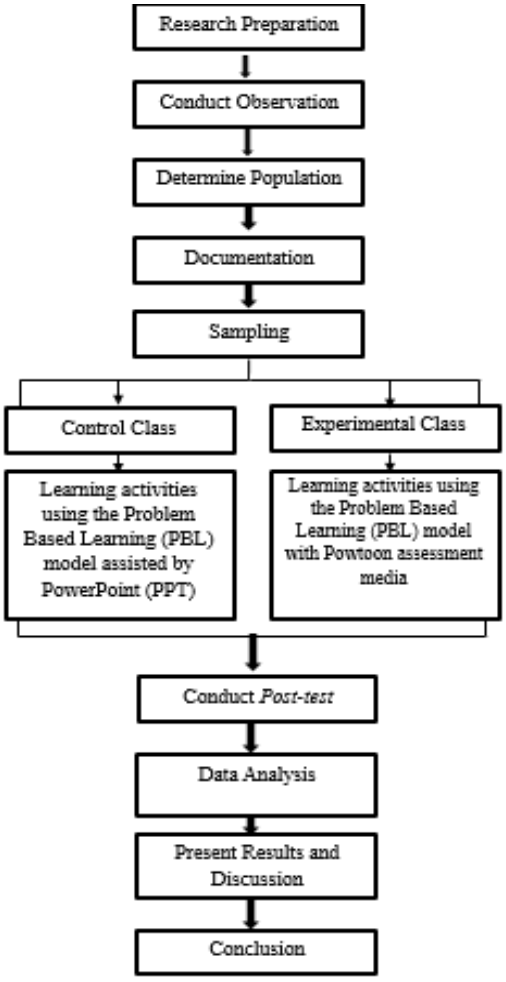

Figure 1. Research Procedure

RESULTS AND DISCUSSION

The study was conducted in two different classes, namely the experimental class and the control class. The treatment given to the experimental class was learning using the PBL model, accompanied by the Powtoon assessment media, while the study conducted in the control class only used the usual learning model used by teachers every day. The research using the PBL model, accompanied by Powtoon assessment at Arjasa State Senior High School, was carried out following the curriculum

used, namely the independent curriculum. In addition, learning using the PBL model accompanied by Powtoon assessment media aims to provide students with a deep understanding of temperature and heat so that it will affect their physics learning outcomes.

Data on students' physics learning outcomes were collected from final exam scores submitted at the end of the learning activity. The final exam was conducted for both the experimental and control groups before the study was considered complete, to evaluate physics learning outcomes after implementing the PBL model integrated with Powtoon assessment media on the topic of temperature and heat. Each class consisted of 36 students. The average post-test score for the experimental class was 78.47, while the average for the control class was 68.47. The next step was to conduct a normality test to check whether the data obtained were normally distributed. The test results are presented in the following table.

Table 1. Normality test of physics learning outcome data

Tests of Normality							
Learning outcomes	Class	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
	Posttest of experimental class	.129	36	.140	.940	36	.051
	Posttest of control class	.154	36	.031	.940	36	.051

Based on Table 1, the normality test conducted using the Shapiro-Wilk method shows that the experimental group obtained a significance value (Sig.) of 0.051, while the control group also recorded a Sig. Value of 0.051. Based on the test criteria, if the significance value is ≥ 0.05, it can be concluded that the data is normally distributed in both the experimental and control groups. As a result, the analysis was continued with an independent sample t-test, preceded by a homogeneity test. The results of the homogeneity test for students' physics learning outcomes are presented in the following table.

Table 2. Homogeneity test of physics learning outcomes data

	Test of Homogeneity of Variances				
Learning outcomes	Variances	Levene Statistic	df1	df2	Sig.
	Based on Mean	2.925	1	70	.092
	Based on Median	2.404	1	70	.126
	Based on Median and with adjusted df	2.404	1	67.260	.126
	Based on trimmed mean	2.991	1	70	.088

Based on Table 2, the data were classified as homogeneous because the significance value was 0.088, which was greater than 0.05. Next, an independent sample t-test was conducted to determine whether the use of the Problem-Based Learning (PBL) model combined with Powtoon-based assessment media had a significant effect on students' physics learning outcomes. The results of this test are shown in Table 3 as follows.

Table 3. Independent sample t-test of physics learning outcome data

	Group Statistics				
Learning outcomes	Class	N	Mean	Std. Deviation	Std. Error Mean
	Posttest of experimental class	36	78.47	10.269	1.712
	Posttest of control class	36	68.47	8.002	1.334

Table 4. Independent sample t-test of physics learning outcome data

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
	Variances	F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Learning outcomes	Equal variances assumed	2.925	.092	4.609	70	.000	10.000	2.170	5.673	14.327
	Equal variances not assumed.			4.609	66.053	.000	10.000	2.170	5.668	14.332

Based on Table 3 above, the Group Statistics Table shows that both groups, the experimental class and the control class, have a balanced sample size (N=36). The mean posttest score (Mean) of the experimental class that received the integrated PBL model treatment, Powtoon, was 78.47, while the control class that used the conventional learning method commonly used in schools had a mean score of 68.47. This indicates a difference in mean scores of 10, favouring the experimental class. The t-test results showed a Sig. Value (2-tailed) of 0.000 for the post-test scores of the experimental and control classes. This result indicates that the significance value is < 0.05, which meets the criteria for rejecting the null hypothesis (H_0) and accepting the alternative hypothesis (H_a). This proves that there is a statistically significant difference between the experimental and control classes. Thus, it can be concluded with confidence that there is a very significant statistical difference in physics learning outcomes between students in the experimental class and the control class. Therefore, the application of the PBL model integrated with Powtoon assessment has been proven to significantly influence and improve the physics learning outcomes of students at the senior high school level.

Effect of Applying the Problem-Based Learning (PBL) Model with Powtoon Assessment Media on High School Students' Physics Learning Outcomes

The purpose of this study was to examine the main effects of implementing a Problem-Based Learning (PBL) model integrated with Powtoon assessment media on students' physics learning outcomes. These effects were measured through a posttest consisting of questions with specific cognitive aspects, which were then described for each cognitive ability. Additionally, this study examines how the integration of Powtoon media as a visual aid and assessment tool can enhance the effectiveness of each stage of PBL and increase student engagement in the learning process. The students' scores in answering the questions based on the cognitive abilities of each question can be seen in Figure 2 as follows.

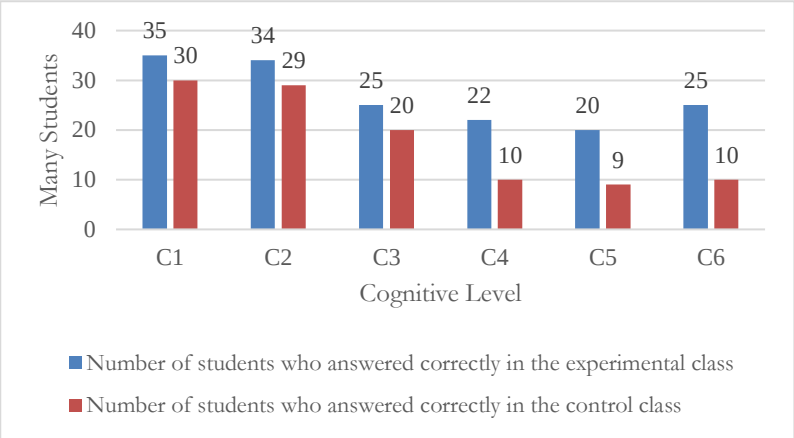

Figure 2. Graph showing details of students who answered the posttest questions correctly

Based on Figure 2, the cognitive abilities of students numbered 36 in each experimental and control class were compared based on each indicator. The data reflect students' achievement on six levels of Bloom's cognitive taxonomy: C1 (knowledge), C2 (understanding), C3 (application), C4 (analysis), C5 (evaluation), and C6 (creation). At C1, 35 students in the experimental class and 30 students in the control class answered the questions correctly. For C2, correct answers were given by 34 students in the experimental class and 29 students in the control class. For C3, 25 students in the experimental class and 20 students in the control class answered correctly. At C4, 22 students in the experimental class answered correctly, while only 10 students in the control class did so. For C5, 20 students in the experimental class and 9 students in the control class answered correctly. Finally, for C6, the number of students who answered correctly was 25 in the experimental class and 10 in the control class. These results, as shown in Figure 2, indicate consistently higher performance in the experimental class on all cognitive indicators. The average posttest scores for each group are then presented in Figure 3 to further clarify the differences in learning outcomes.

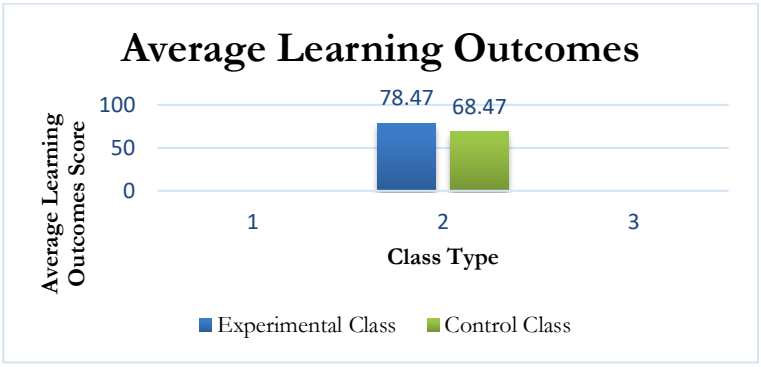

Figure 3. Graph of average learning outcomes

The experimental class achieved an average cognitive learning score of 78.47, while the control class obtained an average score of 68.47. The posttest results of 78.47 in the experimental group were categorized as good, while the score of 68.47 in the control group was categorized as fair. These findings indicate that students in the experimental class had better learning outcomes than those in the control class. As shown in Figure 2, there was a significant difference between the average learning outcomes of the two classes, with a difference of approximately 10 points. This difference in average scores reflects a clear imbalance in student performance between the experimental and control classes. The higher average score achieved by the experimental class shows that the application of the Problem-Based Learning (PBL) model integrated with Powtoon-based assessment media positively influenced students' physics learning outcomes. The use of the PBL model accompanied by the Powtoon assessment was the first learning method applied to students at the school where the research was conducted. The uniqueness of this approach sparked high enthusiasm among students to actively engage during the learning process. Positive responses from students contributed to the

overall effectiveness of the intervention. The significant differences in results between the two classes confirm the influence of the PBL approach, accompanied by the Powtoon assessment.

These findings are consistent with the results of [13], which also reported a significant increase in learning outcomes when the PBL model was applied in classroom teaching. The post-test results in the form of essay questions were given to both classes, as shown in Figures 1 and 2, and can be used as a reference to assess students' level of understanding based on Bloom's Taxonomy from level C1 to C6.

Based on Figure 4.1, the level of student understanding in both classes appears to be almost balanced, although there are some quite striking differences. In indicators C1 to C3, the understanding of students between the experimental and control classes was relatively equal. However, starting from indicators C4 to C6, the difference in understanding between the two classes was quite significant. This is reflected in the number of students who answered correctly on each indicator. On indicator C1 (remembering), 35 students in the experimental class and 30 students in the control class answered correctly. For indicator C2 (understanding), 34 students from the experimental class and 29 students from the control class answered correctly. On indicator C3 (applying), 25 students answered correctly in the experimental class, while in the control class, there were 20 students.

The difference was even more pronounced in the higher-order thinking indicators. In indicator C4 (analysing), 22 students in the experimental class answered correctly, while only 10 students in the control class did so. For indicator C5 (evaluating), there were 20 students from the experimental class, while 9 students from the control class answered correctly. Finally, on indicator C6 (creation), 25 students from the experimental class were able to answer correctly, compared to only 10 students from the control class. Although the difference in the number of students who answered correctly was small on indicators C1 to C3, there was a significant difference between the two classes on indicators C4 to C6. Based on this, it can be concluded that the majority of students in the experimental class demonstrated a better understanding of the material, supported by the learning model and media used by the researcher. However, in indicators C4 to C6, there were still several students who were unable to complete the questions correctly.

The average results of the experimental class were much higher than those of the control class. In the experimental class, the average learning outcome score was 78.47, which was classified as good. Meanwhile, the average learning outcome score in the control class was 68.47, which was classified as fair. These results show that the use of the Powtoon application, accompanied by an appropriate learning model such as PBL, will have a positive impact on classroom learning. The use of the PBL model accompanied by the use of ICT will also increase learning motivation and elicit positive responses from students [14]. Significant differences in learning outcomes indicate the superiority of the implemented model, with the experimental class recording an average score of 78.47 (category "good"), far exceeding the control class with a score of 68.47 (category "adequate"). These results confirm that the integration of the PBL model with Powtoon media has a positive impact, particularly in enhancing motivation and eliciting positive responses from students. In line with the research findings that the effectiveness of the Problem-Based Learning (PBL) model assisted by interactive media Powtoon can enhance attention and learning outcomes [15], [16]. Specifically, the advantages of Powtoon have been highlighted by those who emphasise its ease of use, flexibility, and ability to engage various sensory aspects, foster creativity, and motivate users.

Practically, Powtoon media was strategically integrated into the syntax phases of PBL: in phase 1 for problem orientation, phase 3 to support group investigation, and phase 5 for analysis and evaluation. The use of media in these key phases proved effective in helping teachers keep students active and focused during discussions, thereby making the learning process more orderly and effective. In addition to media support, this process is further strengthened by pedagogical strategies such as providing appreciation when students complete discussions. This practice can enhance students' self-confidence and engagement because they feel valued by the teacher, which ultimately has a positive impact on their learning outcomes [17], [18].

Student Responses to the Application of the Problem-Based Learning (PBL) Model with Powtoon Assessment Media on High School Students' Physics Learning Outcomes

Student responses to the application of the Problem-Based Learning (PBL) model integrated with Powtoon assessment media were reviewed from the perspective of students as learning subjects. Analysis of student responses was used to understand the affective and perceptual factors that contributed to the success of the media integrated into this model. Data on these responses were collected through the distribution of questionnaires to all students in the experimental class after the learning sequence was completed. In this section, the results of the student response questionnaire will be discussed in detail based on each measured indicator, namely interest in the media presentation in terms of motivational ability, student satisfaction, presentation satisfaction, and interest in the application as experienced by students during the learning process. The graphs of student responses for each measured indicator are presented in Figure 4 as follows.

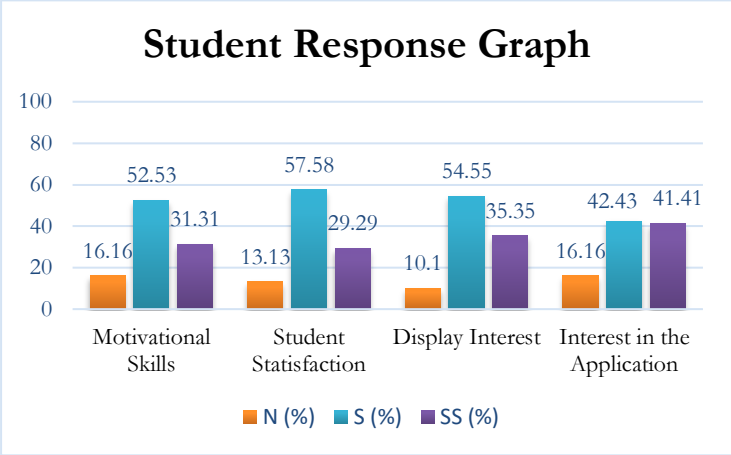

Figure 4. Student Response Graph

The response of students in the experimental class during learning can be seen from the results of the questionnaire completed by all students, as shown in Figure 4. Many students filled in the agree and strongly agree columns. There were a few students who checked the neutral column. This indicates that the majority of students gave positive responses to the use of the Powtoon assessment application. The first indicator is the ability to motivate students, which received the highest score in the Agree column, at around 52.53, with 16.16 choosing Neutral and 31.31 choosing Strongly Agree. The second indicator is the most influential indicator, which is student satisfaction with the application, where the highest result was in the Agree column at 57.58%, followed by Neutral at around 13.13%, and Strongly Agree at around 29.29%. These percentages show that the majority of students are satisfied with learning using the Powtoon assessment application because the application is easy to understand, interesting, and makes it easier for students to remember the material taught, one of which as temperature and heat.

The third indicator is the indicator of interest in the appearance of the Powtoon application. The results of the first indicator show that many students chose Agree with a percentage of 54.55, followed by Neutral at around 10.1, and Strongly Agree at 35.35. Thus, the highest percentage was students choosing the Agree option. The average percentage shows that students are interested in paying attention to the teacher when explaining the material through the attractive and interactive application display. In the last indicator, the most common answer was also 'Agree' with a percentage of around 52.53. The questionnaire results show that students are motivated to learn together and actively solve every problem or issue in learning through the Powtoon application. The next indicator is students' interest in the application, where the highest result in this indicator is the Agree column, with 42.43%, followed by those who answered in the Neutral column at 16.16% and those who chose the Strongly Agree column at around 41.41%. These percentages indicate that the material and questions presented in the Powtoon application are easy for students to understand and provide additional knowledge to students who participate in classroom learning. Figure 3 shows the students' response graph, where the dominant colours in each indicator represent 'Agree' and 'Strongly Agree.'

This indicates that the application successfully captured students' attention, motivated them to learn more enthusiastically, fostered their interest in learning, and provided satisfaction with the learning material on temperature and heat. Therefore, based on these statements, the Powtoon application is very effective as a learning medium in senior high schools with content that can be adapted to the teacher's needs. The results of the response questionnaire can be used to state that the Powtoon application is very popular among students during classroom learning, so that the learning process can be effective, efficient, and far from boring [19].

As a new learning approach first implemented at the research school, the integration of the PBL model with Powtoon assessment provided a unique learning experience for students. This novelty factor was proven to successfully trigger high enthusiasm and encourage active participation in every stage of learning. The engagement arising from this positive response is believed to be one of the key factors contributing to the overall effectiveness of the intervention, which was empirically proven through statistically significant differences in learning outcomes between the experimental and control classes.

These findings not only confirm the strong influence of the approach applied but are also in line with previous studies that also reported that the PBL model consistently improves learning outcomes [13]. Students' positive responses to Powtoon media can be analysed through several key interrelated aspects. The results show that the majority of students found Powtoon visually appealing. Powtoon has the advantage of interactive animation media appeal.

This visual appeal directly influences learning interest, as student interaction with animations can foster interest in the material. Ultimately, this interest sustains students' motivation to learn. The dynamic and non-monotonous nature of Powtoon media prevents students from becoming bored and motivates them to complete problems [20], [21]. This is reinforced by research that suggests that learning using Powtoon makes students more enthusiastic and interested [22].

Several obstacles or limitations experienced by the researcher during the learning process using the PBL model accompanied by Powtoon assessment were: 1) difficulty in conditioning students who were sometimes late for class when the lesson was about to start; 2) difficulty accessing media independently due to inadequate internet connection at school; and 3) limited time to deliver learning materials optimally, so that the researcher had to manage time as well as possible so that the implementation of the PBL model accompanied by Powtoon assessment could run as expected.

The Problem-Based Learning (PBL) model is a problem-based learning model that consists of a series of sequential activities, including: 1) directing students to a real problem related to temperature and heat; 2) organising students for learning and completing worksheets; 3) forming study groups; 4) presenting discussion outcomes; and 5) analysing and resolving problems. The implementation of this model has yielded positive outcomes, with students becoming more active in asking questions, discussing, and expressing their opinions verbally. This learning process is also supported by the Powtoon application, which serves as a learning and assessment tool, containing materials in the form of animated videos, example questions, formulas, and quizzes. The effectiveness of Powtoon was proven through a student response survey, with the majority of responses being 'Agree' and 'Strongly Agree,' indicating that the application successfully captured interest, motivated students, and provided learning satisfaction. The combination of PBL and Powtoon-assisted assessment creates a more interactive learning experience, leading to the conclusion that Powtoon is suitable for use as a medium to improve learning outcomes and student responses.

CONCLUSION

Based on the problem formulation and the results of the discussion, it can be concluded that the application of the Problem-Based Learning (PBL) model integrated with Powtoon media has a significant effect on the physics learning outcomes of high school students. This effect is evident from the statistically significant difference in post-test average scores, with the experimental class achieving an average of 78.47 (category "good"), while the control class obtained an average of 68.47 (category "fair"). The most prominent form of influence was on the development of cognitive thinking skills at Bloom's taxonomy levels, as seen from the significant performance gap between the two classes at cognitive levels C4 (analysis), C5 (evaluation), and C6 (creation). In addition to influencing learning outcomes, this study also concluded that the learning model with the applied media received a very

positive response from students. Survey data consistently showed that the total percentage of "Agree" and "Strongly Agree" responses was 51.77% and 34.34%, respectively, while the "Neutral" response was only 13.89% on average across all indicators, including motivation, learning satisfaction, visual appeal, and interest in the application. Therefore, it can be concluded that the implementation of the Problem-Based Learning (PBL) model integrated with Powtoon media successfully influenced the physics learning outcomes of high school students and elicited positive engagement and perceptions from students during the learning activities.

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