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Effectiveness of Physics Learning with PBL Model Assisted by 3D Webbook Integrated with Environmental Learning in Improving Students' Critical Thinking Skills

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ABSTRACT

Objective: *This study aims to examine the effectiveness of applying the Problem Based Learning (PBL) model assisted by 3D Webbook integrated with Environmental Learning in improving students' critical thinking skills on global warming material.* ***Method:*** *This study used a pre-experiment method with a One-Group Pretest-Posttest design. The research subjects consisted of two classes (X-1 and X-2), each comprising 36 students, selected through purposive sampling technique. The instruments used included a critical thinking skills test in the form of descriptive questions and an observation sheet to assess the implementation of learning syntax. The validity of the device was assessed by experts using a five-point scale and the reliability test was carried out using SPSS with the Cronbach's Alpha formula.* ***Results:*** *(1) The average pretest scores of classes X-1 and X-2 were 35.61 and 33.11, respectively, increasing to 85.11 and 83.78 on the posttest. (2) N-gain scores in both classes were categorized as high. (3) Syntax implementation reached an average of 93%.* ***Novelty:*** *This research introduces an innovation by integrating the PBL model with digital technology through a 3D Webbook combined with Environmental Learning. This integration enables flexible access to materials without requiring large file downloads and contextualizes relevant environmental issues to support the development of 21st-century critical thinking skills.*

INTRODUCTION

Critical thinking skills are one of the important components of the four key skills (4Cs) that students must have in the 21st century (Mahrunnisya, 2023; Mantau & Talango, 2023). n the era of globalization and rapid technological advancement, these skills form the foundation for students to compete effectively and adapt to the demands of an evolving world. Particularly in the context of Society 5.0, which integrates technological innovation into all aspects of human life, mathematics and natural science education, including physics, play a pivotal role in preparing youth to be adaptive and capable of solving complex real-world problems (Haratua et al., 2025). Consequently, 21st-century education must equip students not only with content knowledge but also with higher-order thinking skills to develop into competent problem-solvers with global competitiveness (Haratua et al., 2025; Judijanto et al., 2025)

The integration of creativity, collaboration, and technology in today's physics education is urgently needed to develop a generation capable of addressing global challenges (Nursaya'bani et al., 2025). However, field observations indicate that high school students' critical thinking skills, particularly in physics topics related to environmental issues such as global warming, remain relatively low (Pratiwi et al., 2020;

Jufriadi & Budianto, 2023; Putri et al., 2023). This highlights the need for a learning model that not only emphasizes content mastery but also fosters analytical, evaluative, and reflective thinking throughout the learning process. Research also indicates a positive and significant relationship between learning motivation, critical thinking skills, and students' physics learning outcomes, underscoring the importance of learning strategies that can simultaneously and sustainably support both aspects (Syamsinar et al., 2023). Therefore, the development of an innovative learning model is essential to address these challenges.

Innovative learning models not only deliver material in a conventional manner but also foster student interest, enhance conceptual understanding, and actively develop critical thinking skills in a meaningful way. The Problem-Based Learning (PBL) model is one such approach that has been proven effective in improving students' critical thinking abilities. PBL emphasizes the resolution of real, contextual problems relevant to students' lives, thereby encouraging them to actively seek information, analyze data, and evaluate and draw conclusions independently and critically (Sari et al., 2022; Halimah et al., 2023). This model has also been shown to improve physics learning outcomes (Tanjung et al., 2023) and enhance higher-order thinking skills (Erlangga et al., 2023). Based on interviews and observations at SMA Wachid Hasyim 5 Surabaya with a physics teacher, it was found that the PBL model has been implemented in classroom learning. However, its application has not been optimal, as many students still struggle to understand the problems presented, which hinders the development of their critical thinking skills. Furthermore, limited interaction between teachers and students has been observed, despite its crucial role in supporting the effectiveness of problem-based learning. To address these challenges, one promising solution is the integration of interactive and engaging learning media, such as technology-based digital books.

Various studies have developed PBL-based learning integrated with digital media, such as e-books and flipbooks. The application of the PBL model assisted by a 3D digital book developed by Yusuf et al. (2022), as well as physics e-modules utilizing flipbook technology by Utari et al. (2023), effective in enhancing students' conceptual understanding and critical thinking skills. Similarly, research conducted by Prahani et al. (2022), Sari et al. (2022), and Musaad & Suparman (2023) demonstrates that the integration of digital media within PBL learning can significantly improve students' creative and critical thinking abilities. Furthermore, the use of PBL supported by digital books, as implemented by Qotrunnada & Prahani (2022) in dynamic fluid learning, has shown a notable improvement in students' problem-solving skills. Research by Neswary & Prahani (2022) also supports the conclusion that PBL combined with digital books can significantly foster students' critical thinking skills.

The use of interactive learning media such as 3D digital books or e-books equipped with 3D animation has also shown effectiveness in improving students' engagement and understanding of physics concepts. 3D digital books provide a more interesting and realistic visual display, thus helping students in visualizing abstract physics phenomena (Prahani et al., 2022; Yusuf et al., 2022). Physics e-books and flipbooks developed by Wulandari et al. (2022), and Hutabarat (2022) shows that this media not only increases motivation and interest in learning, but also student learning outcomes. In fact, the use of Augmented Reality (AR) based media as studied by Arzak & Prahani (2023) and Cai

et al. (2021) shows that this technology is able to increase student interaction with learning materials and provide student learning motivation.

The application of digital media-assisted problem-based learning models that bring environmental issues also has a positive impact on the development of conservation attitudes and 21st century skills. Halilah et al. (2023) shows that interactive e-books on the topic of global warming are effective in training critical thinking skills. Haqque et al. (2023) showed that digital books on the theme of environmental pollution can improve students' environmental awareness and learning outcomes. In addition, research by Afikah et al. (2024) and Lidiawati (2024) also showed that e-books and interactive digital flipbooks significantly improved students' engagement, motivation and 21st century skills. Therefore, the development of digital-based learning media that contains environmental content such as 3D digital books integrated with Environmental Learning is one of the relevant and effective innovations for learning physics today. The results of a study conducted by Kholiq (2020) also shows that innovative learning models that incorporate technology and real-world applications can contribute greatly to the development of critical thinking skills in physics education. This is reinforced by various findings showing that students have low critical thinking skills, especially in physics learning, and that the application of PBL models assisted by digital books or similar technologies can help improve these abilities effectively (Neswary & Prahani, 2022; Wardani, 2023).

In line with this research, global warming material is one of the topics in physics that is very potential to develop students' critical thinking skills. This topic contains various complex natural phenomena that are relevant to everyday life, such as the greenhouse effect, increasing earth temperature, extreme climate change, air pollution, and ecosystem damage that can be observed directly in local and global contexts. The existence of these issues allows teachers to present real problem-based learning, so that students are encouraged to link their prior knowledge with new scientific concepts that are more in-depth. In this process, students are trained to formulate questions, evaluate data, and draw logical conclusions through critical discussions guided by the teacher. In addition to improving cognitive abilities, the global warming material also has a strong affective dimension because it involves environmental awareness and social responsibility. Thus, learning does not only focus on the knowledge aspect, but also fosters caring attitudes and contextualization of physics science in real life, which ultimately strengthens the relevance of learning for students.

This study aims to measure the effectiveness of the application of Problem Based Learning model assisted by 3D Webbook which is a web-based 3D digital book integrated with Environmental Learning by raising environmental issues in improving students' critical thinking skills. The application was conducted in physics learning on global warming material in class X SMA Wachid Hasyim 5 Surabaya (class X1 and X2). The focus of the research is directed at improving students' critical thinking skills before and after the use of this model, as an effort to evaluate the impact of learning innovation on the development of 21st century competencies. The results are expected to contribute to the development of physics learning models that are relevant, contextual, and effective in improving students' critical thinking skills.

RESEARCH METHOD

Research Design

This research was conducted through three main stages: (1) Problem and needs analysis to develop learning tools based on 3D Webbook integrated with Environmental Learning; (2) Testing the effectiveness of learning tools that had been validated by experts and implemented in learning activities using the Problem Based Learning (PBL) model; and (3) Evaluating the implementation of learning based on the syntax of the PBL model. The method used in this research is Pre-Experimental Design with One Group Pretest-Posttest Design, which is applied repeatedly to two classes without involving a control class. This design aims to analyze the effect or effectiveness of certain treatments, namely the application of the PBL model assisted by 3D Webbook, on students' critical thinking skills. This design allows researchers to compare students' pretest and posttest results to determine skill improvements following the intervention. The structure of this design is described as follows (Sugiyono, 2022) in Figure 1.

$$O_1 \longrightarrow X \longrightarrow O_2$$

Figure 1. Research design.

Description:

O_1 = Tests given to students on learning materials tested before treatment (pretest).

X = The application of treatment to students is carried out during the learning process by using the PBL learning model supported by an integrated environmental learning 3D Webbook.

O_2 = Tests given to students on learning materials tested after treatment (posttest).

Sample

The population in this study were all grade X classes at SMA Wachid Hasyim 5 Surabaya in the even semester of the 2024/2025 school year, totaling six classes. The sample was selected using purposive sampling technique based on certain criteria (Sugiyono, 2022). Two classes were selected as research samples: class X-1 as the experimental class and class X-2 as the replication class, each consisting of 36 students.

Instrument and Procedures

In this study, the Problem Based Learning (PBL) learning model is used which is supported by a number of learning tools, namely lesson plans that are prepared based on the five syntaxes of PBL (orienting students to the problem, organizing students to learn, guiding investigations, developing and presenting results, and analyzing and evaluating the problem solving process), 3D Webbooks integrated with environmental learning, Learner Worksheets (LKPD), and critical thinking skills test instruments that are prepared based on Facione's (2015) critical thinking skills indicators, including interpretation, analysis, evaluation, inference, and explanation. In addition, all of these indicators are also reflected in the content and learning activities contained in the 3D Webbook, which aims to support the improvement of students' critical thinking skills.

The 3D webbook used in this study was developed in the form of a web-based page that can be accessed through various devices such as smartphones, tablets, laptops, and other gadgets. With the web-based format, learners can access the materials flexibly without having to download and install large applications. This aims to minimize network constraints that often occur during learning. This webbook has been equipped with 3D animation-based visual content and simple simulation guides that support the problem-solving process, although it still has limitations in terms of interactivity and full integration of practical simulations in Figure 2. After the pretest, this webbook was used as a treatment for the experimental class in PBL learning to support the improvement of students' critical thinking skills.

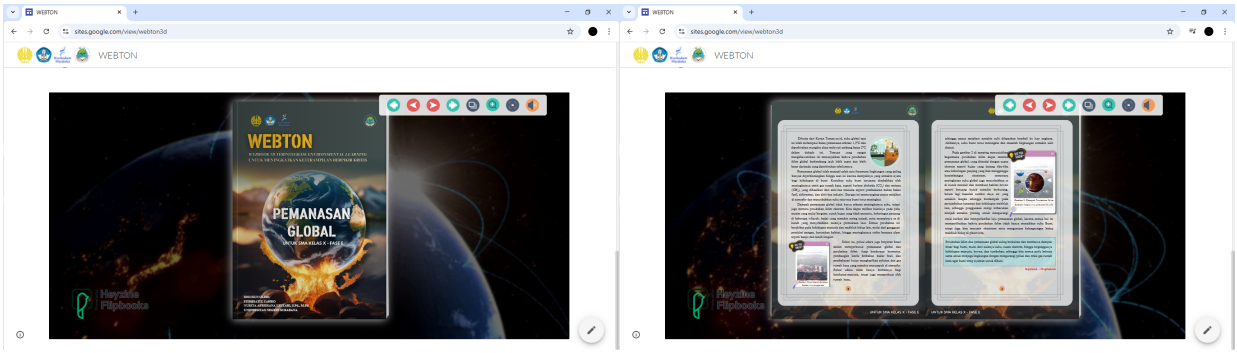

Figure 2. Display of 3D Webbook Integrated with Environmental Learning.

Data Analysis

In collecting data, appropriate, relevant, and appropriate techniques are used in accordance with the learning objectives. The techniques used include giving tests to students, as well as conducting observations during the teaching and learning process. The following presents some analysis of the results of research and trials of the learning process that has been carried out in this study:

(1) Validity and Reliability Analysis of Learning Tools

The validity of the learning tools was assessed by three experts using validation sheets prepared based on the aspects relevant to each type of tool. The number of items on the validation sheet is different for each device, adjusting the characteristics of the content and function of each device. However, a consistent 5-point scale was applied across all instruments, with the following categories: 1 = not good, 2 = less good, 3 = quite good, 4 = good, and 5 = very good. The scores from each validator were averaged and converted into a percentage. The interpretation of the validity level refers to the criteria established by Zetriuslita et al. (2022). The following table presents the criteria used to interpret average scores for assessing the validity of the learning device in Table 1.

Table 1. Criteria for Level of Validity.

Criteria	Categories	Description
85,01% - 100%	Very Valid	Can be used without revision
70,01% - 85 %	Fairly Valid	Usable but needs minor revisions
50% - 70%	Less Valid	Usable but needs much revision
01,00% - 50%	Invalid	Not to be used

(Zetriuslita et al. , 2022)

In addition to validity, reliability testing was also carried out on the critical thinking test instrument and PBL syntax implementation observation sheet. The reliability test was conducted using the Cronbach's Alpha method with the help of SPSS software, to determine the extent to which the instrument can produce consistent and stable data. The results of instrument reliability were analyzed descriptively and quantitatively and adjusted to the following criteria: (1) $0.90 \leq \alpha \leq 1.00$ (very high); (2) $0.70 \leq \alpha < 0.90$ (high); (3) $0.50 \leq \alpha < 0.70$ (medium); and (4) $\alpha < 0.50$ (low) (Jatmiko et al., 2018).

(2) Analysis of Critical Thinking Skills of Learners

This analysis aims to determine whether students have mastered these skills or not. The analysis process is carried out descriptively quantitatively using the formula

$$P = \frac{\Sigma score\ obtained}{\Sigma maximum\ score} x100\% \quad (1)$$

Students are said to have achieved mastery in critical thinking skills if they obtain results that show optimal mastery of the material according to the standards set by the school.

Before conducting statistical analysis to assess students' critical thinking skills after the application of the PBL model assisted by 3D Webbook integrated with Environmental Learning, prerequisite tests were first carried out in the form of normality test and homogeneity test. The normality test aims to determine whether the data is normally distributed, while the homogeneity test is used to determine the similarity of variance between groups. If the data is normally distributed and the variance between groups is homogeneous, then proceed with parametric tests. However, if the data is not normally distributed, then a non-parametric test is used.

a) Paired t-test

To determine the improvement of students' critical thinking skills in each class, paired sample t-test was used on pretest and posttest data with the hypothesis: H_0: There was no improvement in the critical thinking skills of students in both classes.

H_1: There was an increase in the critical thinking skills of students in both classes.

Based on the results of the paired t test, decision making on the hypothesis is based on the significance value (p-value). If the significance value (p-value) obtained is greater than 0.05, then H_0 is accepted, which means there is no significant difference between the pretest and posttest scores. Conversely, if the significance value (p-value) is less than or equal to 0.05, then H_0 is rejected, which indicates that there is a significant difference between the pretest and posttest scores.

b) *N-gain* calculation

To determine the improvement of students' critical thinking skills, N-gain analysis was used based on pretest and posttest results. This analysis aims to determine the difference in physics knowledge before and after students are given treatment.

$$< g >= \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \quad (2)$$

Description:

$< g >$ = *Gain* score

S_{post} = Posttest score

S_{pre} = Pretest score

S_{max} = Maximum score

The results of the N-gain analysis were interpreted descriptively and adjusted to the following criteria: (1) N-gain ≥ 0.7 (high); (2) 0.3 ≤ N-gain < 0.7 (medium); and (3) N-gain < 0.3 (low) (Hake, 1998; Adilla & Jatmiko, 2021).

sThrough the analysis of the data that has been obtained, a classification of the level of significant improvement in the learning process that has been applied can be determined.

RESULTS AND DISCUSSION

Results

The data presented in this study are the results of the implementation of research activities carried out on X1 and X2 class students at SMA Wachid Hasyim 5 Surabaya. This research applied Problem Based Learning (PBL) model assisted by learning media in the form of 3D Webbook integrated with Environmental Learning. Before the research process was carried out in the field, all learning tools used including lesson plans, 3D Webbooks integrated with environmental learning, student activity sheets, and assessment instruments had gone through the validation stage first to ensure their feasibility and effectiveness. This validation process was carried out by two expert lecturers (validators) and one physics teacher who also acted as a validator. All instruments are detailed in Table 2.

Table 2. Results of Validity Assessment of Learning Devices and Instruments by Experts.

Component	Validity and Reliability of Webbook 3D Terintegrasi Environmental Learning			
	Score	**Validity**	**α**	**Reliability**
Lesson plans	81.78%	Fairly Valid	0.968	Very High
3D Webbooks integrated with environmental learning	89.33%	Very Valid	0.807	High
Student activity sheets	89.78%	Very Valid	0.673	Medium
Test instruments	84.17%	Very Valid	0.976	Very High

α = Cronbach's Alpha

Based on the validators' assessment, the learning tools used in this study generally meet the established eligibility criteria. All aspects assessed were declared valid, and the reliability values of each instrument also indicated a high level of consistency, placing them in the reliable category. In addition, the reliability value of each instrument also shows that all of them are in the reliable category, so they are suitable for use in the physics learning process to support the achievement of students' critical thinking skills. After making revisions in accordance with the suggestions given, the PBL learning model assisted by 3D Webbook is declared feasible to be applied in physics learning on global warming material at SMA Wachid Hasyim 5 Surabaya. The learning instruments used in this study have novelty in the application of the PBL model assisted by 3D Webbook media. In contrast to the application of conventional PBL, the instrument in this study has been assisted by one media, namely a web-based digital book (Webbook 3D) integrated with environmental learning. This digital book contains all learning tools in full, including a simulation guide designed to assist students in critically analyzing an environmental problem associated with global warming material.

The physics learning process using the Problem Based Learning (PBL) model assisted by 3D Webbook can be considered effective if each learning stage is implemented properly and align with the syntax contained in the teaching module. Based on the results of the syntax implementation analysis, it is known that all phases of learning activities have been implemented well, as indicated by an average value of 4.63 and a percentage of implementation of 93% at all meetings. This shows that the learning process takes place optimally in accordance with the design that has been prepared. Good learning syntax implementation is reflected when the teacher is able to direct the learning process according to the stages in the PBL model. Through this context, the active involvement of students is very important, where they can link their prior knowledge with new information obtained during the learning of global warming material. Through teacher guidance and triggering questions, students are directed to explore, analyze, and find solutions to the problems given systematically. In line with the opinion of Afiati et al. (2025), PBL model provides space for students to explore, integrate, and analyze data

more comprehensively and coherently in answering contextual problems presented during the learning process.

Before the learning process using the PBL model assisted by Webbook 3D begins, students are first given an initial test (pretest) to measure the level of their critical thinking skills before getting the learning treatment. After the entire learning sequence is carried out in accordance with the PBL syntax, supported by the 3D Webbook integrated with Environmental Learning, students are administered a final test (posttest) to assess the improvement in their critical thinking skills. The pretest and posttest scores are then compared to determine the extent of skill enhancement resulting from the learning process.

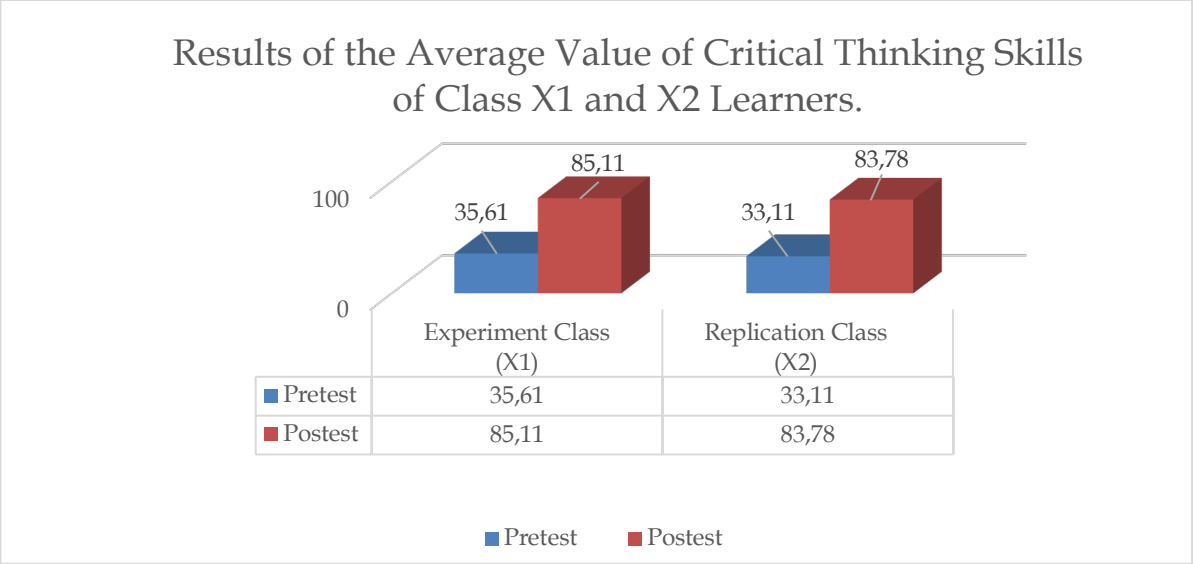

Figure 3. Results of the Average Value of Critical Thinking Skills of Students in Class X1 and X2.

Based on the results of data analysis obtained during the implementation of the study in Figure 3, it is known that before the implementation of learning using the Problem Based Learning (PBL) model assisted by 3D Webbook integrated with Environmental Learning, students' critical thinking skills were still relatively low and had not met the established achievement criteria. This condition is reflected in the results of the pretest given to students at the beginning of learning, where the average student pretest score in class X-1 was 35.61, while in class X-2 it was 33.11. This value shows that students' initial ability in critical thinking is still far below the expected minimum standard. This reflects that students have difficulty in analyzing problems, interpreting information, and drawing logical conclusions. However, after students followed the physics learning process by applying the PBL model assisted by 3D Webbook integrated with Environmental Learning, there was a significant increase in the posttest results. The average posttest score of students in class X-1 increased to 85.11 and in class X-2 to 83.78.

This increase shows that the application of the learning model is effective in improving students' critical thinking skills as a whole.

Table 3. The Test Results of Normality and Homogeneity.

Tests of Normality			
Group	**Test**	**sig.**	**Distribution**
X1	Pretest	0.061	Normal
	Posttest	0.083	Normal
Group	**Test**	**sig.**	**Distribution**
X2	Pretest	0.071	Normal
	Posttest	0.093	Normal
Test of Homogeneity of Variance			
Test	**Sample**	**sig.**	**Homogeneity**
Pretest	72	0.959	Homogenous
Posttest		0.279	Homogenous

The normality test results show that the data in both classes in Table 3, namely the experimental class (X-1) and the replication class (X-2), have a normal distribution. This is evidenced by the significance value of the Shapiro-Wilk test for the experimental class at pretest of 0.061 and posttest of 0.083, as well as the replication class with a pretest significance value of 0.959 and posttest of 0.279, all of which are greater than $\alpha = 0.05$. In addition, the homogeneity test results show that the data has a homogeneous variance. Based on the calculation results, the average value of N-gain in the experimental class (X1) was 0.78, while in the replication class (X2) it was 0.75. Both values are included in the high category, which indicates that there is a significant increase in students' critical thinking skills after the application of the PBL model assisted by Webbook 3D integrated environmental learning. Furthermore, because the assumptions of normality and homogeneity are met, then to determine the existence of an increase in the results of critical thinking skills in each class, a paired sample t-test is used with a significance level of 5% ($\alpha = 0.05$). This test was conducted to compare the pretest and posttest scores in each class separately, in order to determine the effectiveness of learning in each treatment.

Table 4. The Test Results of Paired Samples Test.

Paired Samples Test		
Group	Test	Sig. (2-tailed)
X1	Pretest -	0.000
X2	Posttest	0.000

Based on the results of the paired t-test conducted using SPSS in Table 4, the Sig. (2-tailed) of 0.000 in both classes, namely classes X1 and X2. Since the significance value is smaller than 0.05, it can be concluded that H_0 is rejected. That is, there is a significant

difference between the pretest and posttest results in the two classes after the application of the PBL model assisted by Webbook 3D integrated environmental learning.

Discussion

This research demonstrates that the learning tools, including the Teaching Module, 3D Webbook integrated with Environmental Learning, LKPD, and critical thinking skills test instrument, have been validated by experts and declared valid and reliable. The validation process and minor improvements carefully ensure that each learning component is able to represent the PBL syntax appropriately. The high syntax implementation (average 4.63; 93%) confirms that teachers are able to implement each PBL stage consistently, so that the learning environment becomes structured and supports active interaction between teachers and students. This finding is in line with the research of Afiati et al. (2025), which emphasizes the importance of teacher guidance in facilitating comprehensive exploration and analysis of data by students.

The pretest results showed that students' initial scores were below the standard, as well as a significant increase in the posttest, indicated that the 3D Webbook-assisted PBL model was effective in strengthening critical thinking skills. Sig. (2-tailed) of 0.000 in both classes strengthens the evidence that the difference between pretest and posttest does not occur by chance, but is a real result of the application of learning. The use of paired sample t-test is based on the fulfillment of the assumptions of normality and homogeneity of data, so that the conclusion regarding the effectiveness of learning has a valid statistical basis. This finding is in line with Kholiq (2020) who states that innovative learning models that integrate technology and real-world contexts can make a major contribution to the development of critical thinking skills in physics education. In addition, Neswary & Prahani (2022) and Wardani (2023) also revealed that the integration of interactive digital media in the PBL model can improve student learning outcomes.

The N-gain analysis averaged 0.78 in the experimental class and 0.75 in the replication class, both of which were in the high category indicating that the improvement in critical thinking skills was consistent across the two separate classes. Despite the slight difference, these two N-gain values confirm that the 3D Webbook integrated with Environmental Learning is not only effective in one context, but can also be replicated without losing the quality of improvement. This strengthens the argument of Halilah et al. (2023) and Haqque et al. (2023) that digital media with 3D animation provides a visual and interactive context that makes it easier for students to connect physics concepts with real environmental issues.

From a theoretical perspective, 3D Webbooks that can be accessed via smartphones, tablets, laptops and other gadgets break the technical barriers that have been limiting online or hybrid learning. This web-based application eliminates the need for large downloads and allows students to access learning resources anytime and anywhere. The simple simulation guide feature embedded within the Webbook provides the

opportunity to conduct virtual experiments, reinforcing the link between theory and practice. The accessibility of the 3D Webbook through browsers on smartphones, tablets, laptops and other devices without large installations is a major strength. Students can continue to explore the material even outside of class or when connections are limited, as the 3D content and simulation guides can be saved for access. This indicates that it not only enhances conceptual understanding, but also motivates students' cognitive curiosity and engagement. Literature support by Afikah et al. (2024) and Lidiawati (2024) shows that interactive e-books and digital flipbooks can increase learning interest, independence and other 21st century skills. Thus, the Environmental Learning integrated 3D Webbook not only fulfills the goal of improving critical thinking, but also supports the development of creativity, communication, and collaboration. Overall, the results of this study strengthen the evidence that that integrating the PBL model with innovative digital learning media has a significant positive impact on students' critical thinking skills. The practical implication is that schools and teachers can adopt a similar approach for other physics materials, as well as customize the digital content to be relevant to local environmental issues. Further research could explore the effectiveness of this model in more diverse populations and contexts, or add more complex virtual laboratory simulation features to deepen students' learning experience.

CONCLUSION

Fundamental Finding: Based on the research results, data analysis, and hypothesis testing, it can be concluded that the application of the Problem Based Learning (PBL) model assisted by 3D Webbook integrated with Environmental Learning is effective in improving the critical thinking skills of grade X students on global warming material. This is evidenced by the paired sample t-test with a significance value of 0.000 and an N-gain score of 0.78 in the experimental class and 0.75 in the replication class which is in the high category. The validity and reliability of the tools used also meet the eligibility criteria, and the implementation of PBL syntax reaches an average of 93%. **Implication**: The integration of PBL model with 3D Webbook interactive digital media supports more contextual and flexible physics learning. 3D visualization and web-based access make it easier for learners to understand abstract concepts and develop critical thinking skills relevant to the challenges of the 21st century. **Limitation**: This study was limited to one topic, global warming, and was conducted in a relatively short period of time. The measurement of critical thinking skills also still focuses on cognitive aspects through written tests, without exploring metacognitive or affective aspects. **Future Research**: Further research is recommended to develop and test the effectiveness of the PBL model assisted by 3D Webbook on other more complex physics materials. In addition, Webbook development can be improved by adding more interactive virtual simulation features and expanding the measurement of other 21st century skills.

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