



Effect of PBL with Prezi on critical thinking skills at SMAN 4 Pekanbaru

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ABSTRACT

This study aims to investigate the impact of Problem-Based Learning (PBL) supplemented by interactive Prezi media on students' critical thinking skills. The study was conducted in Class X of SMA Negeri 4 Pekanbaru in the second semester of April-June 2022/2023, using a quasi-experimental design with a pre-test-post-test control group. The parameter used was critical thinking ability, measured through five indicators, namely analysing, synthesising, identifying and solving problems, concluding, and evaluating. The post-test results showed an average score of 65.84 (fairly critical) in the control class, compared to 80.42 (critical) in the experimental class. The highest critical thinking performance was found in the analysis indicator, with a score of 66.67 (fairly critical) in the control class and 82.64 (critical) in the experimental class. The lowest performance was found in the evaluation indicator, with a score of 61.81 (less critical) in the control class and 77.08 (fairly critical) in the experimental class. The hypothesis test indicates that PBL supported by Prezi significantly influenced the critical thinking skills of Grade X students at SMAN 4 Pekanbaru.

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh Pembelajaran Berbasis Masalah (PBL) yang didukung media Prezi interaktif terhadap keterampilan berpikir kritis peserta didik. Penelitian dilakukan di Kelas X SMA Negeri 4 Pekanbaru pada semester dua April-Juni 2022/2023, menggunakan desain eksperimen semu dengan kelompok kontrol pretes-postes. Parameter yang digunakan adalah kemampuan berpikir kritis, diukur melalui lima indikator yaitu menganalisis, mensintesis, mengidentifikasi dan memecahkan masalah, menyimpulkan, dan mengevaluasi. Hasil postes menunjukkan skor rata-rata 65,84 (cukup kritis) pada kelas kontrol, dibandingkan dengan 80,42 (kritis) pada kelas eksperimen. Kinerja berpikir kritis tertinggi ditemukan pada indikator analisis, dengan skor 66,67 (cukup kritis) pada kelas kontrol dan 82,64 (kritis) pada kelas eksperimen. Kinerja terendah ditemukan pada indikator evaluasi, dengan skor 61,81 (kurang kritis) di kelas kontrol dan 77,08 (cukup kritis) di kelas eksperimen. Uji hipotesis menunjukkan bahwa PBL berbantuan Prezi secara signifikan memengaruhi keterampilan berpikir kritis peserta didik Kelas X di SMAN 4 Pekanbaru.

Kata Kunci: berpikir kritis; media interaktif; pembelajaran berbasis masalah; Prezi

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INTRODUCTION

A curriculum is an ideal plan designed to achieve specific educational goals. Curricula are continually updated to enhance the quality of education. The curriculum used in Indonesia is the Kurikulum Merdeka. The Kurikulum Merdeka was introduced in response to the fierce competition for human resources in the 21st century. 21st-century education is education that integrates knowledge, skills, and attitudes. There are four 21st-century skills: communication, collaboration, creativity, and critical thinking (Erdogan, 2019). One of the essential skills in the 21st century is higher-order thinking, which enables students to address global challenges (Zakaria, 2021).

Mastery of biological concepts is important for students to possess, as it forms the foundation for development in daily life. However, in reality, many students remain disengaged in learning activities, resulting in suboptimal critical thinking skills. Therefore, it is essential to develop students' critical thinking skills through learning activities. Critical thinking can be defined as a thinking process that begins with solving problems or answering questions, a skill essential for students and teachers in the current era (Nuri et al., 2021). Critical thinking is the ability to make informed decisions, analyze problems, and overcome challenges (Ristanto et al., 2020). There are five indicators of critical thinking, including analysing, synthesising, identifying and solving problems, drawing conclusions, and evaluating and assessing (Angelo, 1995).

Indonesia ranks 74th out of 79 countries in terms of critical thinking skills, according to the 2018 PISA survey, highlighting the urgent need to enhance these skills among Indonesian students (Hewi & Shaleh, 2020). Furthermore, the average initial score for critical thinking skills was 56.89%, indicating a "less critical" category, which underscores the necessity for improved teaching strategies (Apryani & Suryanto, 2021). Based on interviews with biology teachers at SMAN 4 Pekanbaru, it was found that students' critical thinking skills were still not optimal. This is evident from test results, which show critical thinking scores ranging from low to very low. These results were obtained because teachers employed the Discovery Learning model, which has been deemed ineffective in training students to think critically, and the media used to support learning activities consisted of a simple PowerPoint presentation, indicating suboptimal learning.

Based on these issues, efforts are needed to improve students' critical thinking skills through a learning model that provides opportunities and encouragement for students to solve problems and increases student engagement in learning, namely the Problem-Based Learning (PBL) model. The PBL model is a framework that trains students in problem-solving and gathering information to address specific issues (Liu & Pasztor, 2022). The advantages of the PBL model include the development of real-world knowledge, fostering communicative attitudes, and encouraging students to seek complex information from their environment and learning media. This can serve as a benchmark for assessing students' quality through problem-solving that trains critical thinking skills.

Learning media also contributes to students' mastery of the material. Therefore, learning media that can transform abstract material into concrete concepts, clarify information presentation, and enhance students' thinking abilities are needed, such as the interactive

Prezi platform. Interactive media can transform passive learning into active learning, where teachers no longer act as the centre of information but as facilitators guiding students in acquiring knowledge. Prezi is a digital presentation tool that enables the creation and presentation of text, images, animations, and videos. Prezi media is attractive and can make learning more alluring, thereby enhancing student learning motivation. Studies have shown that using Prezi can significantly increase student engagement and motivation (Ningsih et al., 2023). Furthermore, the combination of Prezi media and PBL has been found to influence critical thinking skills (Swandari et al., 2025). Research has demonstrated the positive impact of the PBL model, assisted by Prezi media, on both learning outcomes and critical thinking skills of students (Aisyah & Wulandari, 2024).

Recent research continues to support the integration of Prezi media with the PBL (PBL) model, enhancing higher-order thinking skills. Prezi media based on the PBL model have been developed to enhance learning effectiveness, indicating ongoing academic interest in this approach (Pratama, 2024). The PBL model, assisted by Prezi media, has been found to positively impact students' critical thinking skills and learning outcomes (Kristiantari, 2022). This is further supported by research indicating that learning materials presented through Prezi leave a stronger impression on students' memories compared to conventional media such as PowerPoint. In the context of PBL implementation, Prezi serves as a tool that supports the exploration and problem-solving process, enabling students to construct knowledge rather than passively receiving information. Therefore, the integration of Prezi with PBL is highly relevant for developing critical thinking skills, particularly in topics closely related to daily life, such as environmental change and conservation.

Biology material is often encountered in real life in relation to humans and their environment. However, many students struggle with these skills, especially when discussing issues related to environmental change and conservation, because they require assistance in analyzing, evaluating, summarizing, and explaining sustainability concepts that involve complex environmental problems (Aisyah et al., 2024). Therefore, this study aims to determine the effect of the PBL model assisted by interactive Prezi media on the critical thinking skills of tenth-grade students at SMAN 4 Pekanbaru.

LITERATURE REVIEW

Problem-Based Learning (PBL) Model

The Problem-Based Learning (PBL) model is an innovative learning approach that places students in real-life PBL situations. In this model, students are encouraged to directly address authentic problems that require in-depth investigation, thereby transforming the learning process from a passive to an active and contextual one. This contextual learning model is very useful in academic contexts (Kusasih & Satria, 2024). PBL is designed to help students acquire foundational knowledge while developing critical thinking and problem-solving skills in real-world contexts.

PBL is a learning model in which students develop critical thinking and problem-solving skills through relevant situations, enabling them to understand concepts in depth (Nurkhin & Pramusinto, 2020). The role of the teacher in this learning process is that of a facilitator, who provides encouragement, teaching materials, and guidance to students as they work to

find solutions to the given problems. PBL encourages students to recognise their own learning styles and work together in groups to solve the problems given (Maryati & Monica, 2021; Rambe et al., 2020).

According to the book "*Model-Model Pembelajaran IPA dan Implementasinya*" issued by the Kementerian dan Kebudayaan, the PBL syntax consists of five main stages: orienting students to the problem, organising students to learn, guiding individual and group investigations, developing and presenting work, and analysing and evaluating the problem-solving process. This approach emphasises collaboration among students, interdisciplinary connections, and independent research that encourages students to produce products or works as a form of problem-solving. The advantages of PBL include creating a pleasant learning atmosphere, developing real-world knowledge, boosting self-confidence, and fostering collaborative attitudes in teamwork, as explained in the book entitled "PBL di Masa Pandemi" by Mahendradhani. However, PBL also has drawbacks, such as requiring relatively more time and not always covering all the basic information from the subject matter. Despite this, PBL remains an effective learning model for optimising students' thinking skills through a systematic and collaborative process.

Prezi Interactive Learning Media

Learning media is a communication tool used by teachers to convey messages, information, and lesson material to students more clearly and interestingly. The use of appropriate media can stimulate the mind, attract interest, and increase student motivation to learn. One of the increasingly popular interactive media in the field of education is Prezi. Unlike conventional presentations, such as Microsoft PowerPoint, Prezi utilizes a Zooming User Interface (ZUI) that enables users to dynamically zoom in and out of the presentation, making the delivery of content feel more dynamic and engaging (Nasution & Siregar, 2019).

Prezi can be used to create both linear and non-linear presentations, and it can even function as a mind map to help students visually understand the relationships between concepts. A variety of attractive template designs that suit user needs, easy-to-create animations, and flexible navigation make Prezi an effective choice for supporting active learning (Nurlaela et al., 2024). The process of using it is relatively simple, starting with creating an account, selecting a template, filling in the content with text, images, and videos, and inserting shapes and changing the background as needed. However, Prezi has some limitations, such as a dependence on an internet connection, difficulty inserting mathematical symbols, and the requirement for a personal account.

Nevertheless, with its advantages, Prezi can overcome limitations of the senses, space, and time, and help align students' perceptions of the material being presented, making it highly potential as a support tool for learning models that require active student involvement, such as PBL. The general functions of educational media include facilitating communication between teachers and students, making abstract material more concrete by providing context, and addressing diverse learning needs. Thus, integrating Prezi into learning not only enhances the quality of material delivery but also encourages students to be more active in the learning process, potentially improving engagement and learning outcomes (Aulia et al., 2024).

Critical Thinking Skills

Critical thinking skills are an important aspect of the learning process that involves intellectual activities such as analysing, synthesising, evaluating, and making decisions based on information obtained from observation, experience, reflection, and communication. Critical thinking is an intellectual process that involves the creation, application, synthesis, and evaluation of information as a basis for belief and action. This is explained in the book entitled "*Berpikir Kritis and PBL (Problem-Based Learning)*" by Lismaya. The leading indicators of critical thinking skills include analysing, synthesising, identifying and solving problems, drawing conclusions, and evaluating and assessing (Angelo, 1995).

Analysing requires students to break down a problem into smaller parts so that the structure and relationships between components can be understood. Synthesising requires the ability to connect various pieces of information to create new ideas or solutions. Problem recognition and solving emphasise the application of relevant concepts to address real-world problems. Conclusion involves inductive or deductive reasoning to draw conclusions based on available data, while evaluation requires students to assess an argument or decision based on specific criteria. These skills are crucial in biology learning, particularly in the context of environmental change and conservation, which requires students to understand the impact of human activities and natural phenomena on ecosystems and to provide scientifically based solutions.

Several previous studies have proven the effectiveness of combining PBL and interactive media in improving critical thinking skills (Gifari & Robandi, 2024). The PBL model, when combined with Prezi media, can improve higher-order thinking skills (HOTS) (Arviani et al., 2023). These research findings provide strong evidence that integrating PBL with Prezi media can create a more active, contextual, and meaningful learning environment, thereby optimally developing students' critical thinking skills. Thus, the combination of a problem-solving-focused learning model and visually appealing media holds great potential for application in high school biology education.

METHODS

The type of research used was quasi-experimental research. The research was conducted in class X of SMAN 4 Pekanbaru from April to June 2023, in the even semester of the 2022/2023 academic year. The researcher employed a pre-test-post-test control group design. The research design is presented in **Table 1**.

Table 1. Pre-test-Post-test Control Group Design

KE	O1	X1	Q1
KK	O2	X2	Q2

Source: Pre-test-Post-test Control Group Design by Sugiyono in the book entitled "Metode Penelitian Kombinasi (Mixed Methods)"

Explanation:

EC : Experimental Class

CC : Control Class

O1 : Pre-test of Critical Thinking Skills in the Experimental Class

- O2 : Pre-test of Critical Thinking Skills in the Control Class
- X1 : Problem-Based Learning (PBL) assisted by Prezi Interactive Media
- X2 : Discovery Learning assisted by PowerPoint
- Q1 : Post-test of Critical Thinking Skills in the Experimental Class
- Q2 : Post-test of Critical Thinking Skills in the Control Class

The population in this study consisted of all 12 classes of 10th-grade students at SMAN 4 Pekanbaru. Sampling was conducted using random sampling techniques without regard to existing strata. A homogeneity test was conducted on the population of 12 classes based on daily test scores, and a significance value of $0.540 > 0.05$ was obtained, indicating that the data were homogeneous. Class X.4 served as the control class, utilizing the Discovery Learning model supported by PowerPoint. In contrast, Class X.1 served as the experimental class, utilizing the PBL model assisted by interactive media, specifically Prezi.

The parameters in this study were critical thinking skills, which included five indicators: analysing, synthesising, identifying and solving problems, concluding, and evaluating and assessing. Data collection techniques included pre-test and post-test critical thinking questions. The questions used for the pre-test and post-test were identical to ensure no differences in knowledge and understanding occurred. The difference in pre-test and post-test scores before and after the treatment was used to determine the difference in critical thinking ability of students who received the treatment.

To provide a clearer context for the analysis, **Table 2** outlines the specific sub-indicators used to measure each critical thinking skill.

Table 2. Critical Thinking Indicators

No	Critical Thinking Indicators	Critical Thinking Sub-Indicators
1	Analysing	Finding similarities and differences Finding the structure of a statement Identifying and grouping Identifying information from images, charts, graphs, diagrams, and maps
2	Synthesising	Finding and connecting information to develop new ideas Organising relevant facts, concepts, and theories Developing plans or steps by finding connections between specific units
3	Recognising and Solving Problems	Identifying the elements of a problem Applying concepts to solve problems Being able to provide responses or solutions based on relevant facts and theories
4	Concluding	Striving to understand Inductive or deductive reasoning Providing varied ideas and options
5	Evaluating and Assessing	Expressing and defending opinions Assessing using specific criteria Being able to complete evaluation questions

Source: Research 2025

The research results were analysed by calculating the percentage of each indicator measured using Microsoft Excel.

Data Analysis Techniques

The research results were analyzed by calculating the percentage of critical thinking for each aspect measured using Microsoft Office Excel. To analyze the percentage increase per critical thinking indicator, data obtained from the critical thinking ability test results were analyzed using the following formula:

$$\text{Critical Thinking} = \frac{\text{Number of Correct Answers}}{\text{Number of students}} \times 100$$

The criteria for critical thinking are presented in **Table 3**.

Table 3. Critical Thinking Criteria

No	Competency Mastery Level	Criteria
1	90 - 100	Very Critical
2	80 - 89	Critical
3	65 - 79	Fairly Critical
4	55 - 64	Less Critical
5	<55	Very Uncritical

Source: *Wulandari et al. (2020)*

RESULTS AND DISCUSSION

Pre-tests and post-tests were given to 70 students who were sampled, with 35 students from class X.4 as the control class and 35 students from class X.1 as the experimental class. Data were obtained through test scores using multiple-choice questions that measured students' critical thinking skills. The pre-test-post-test results for the control class and experimental class are presented in **Table 4**.

Table 4. Critical Thinking Skills Based on Pre-test-Post-test

Critical Thinking Indicators	Control Class Score		Experimental Class	
	Pre-test	Post-test	Pre-test	Post-test
Analysing	41,67 (VU)	66,67 (FC)	43,75 (VU)	82,64 (C)
Synthesising	33,33 (VU)	70,14 (FC)	30,56 (VU)	81,25 (C)
Recognising and Solving Problems	33,33 (VU)	65,28 (FC)	38,89 (VU)	80,56 (C)
Concluding	36,81 (VU)	65,28 (FC)	36,81 (VU)	80,56 (C)
Evaluating and Assessing	22,22 (VU)	61,81 (LC)	42,36 (VU)	77,08 (FC)
Average	33,47 (VU)	65,84 (FC)	38,47 (VU)	80,42 (C)

Description: C (Critical); FC (Fairly Critical); LC (Less Critical); VU (Very Uncritical)

Source: *Research 2025*

The average pre-test results for critical thinking skills among students in the control class were 33.47, categorised as very uncritical. In contrast, the average post-test results in the control class were 65.84, categorised as fairly critical. The average pre-test score for critical thinking skills of students in the experimental class was 38.47, categorised as very uncritical, and the average post-test score in the experimental class was 80.42, categorised as critical.

Normality Test

The normality test in this study used the Shapiro-Wilk test in SPSS version 21. The normality test results for the pre-test of critical thinking skills in the control class and the experimental class obtained values of 0.077 and 0.077. The normality test results for the post-test of critical thinking skills in the control class and the experimental class obtained values of 0.067 and 0.052. This indicates that the significance value is > 0.05 , so the data is normally distributed.

Homogeneity Test

The homogeneity test was conducted using SPSS version 21 with the One-Way ANOVA test. The results of the homogeneity test for the pre-test of critical thinking ability in the control class and the experimental class yielded a value of 1.000. The results of the homogeneity test for the post-test of critical thinking ability in the control class and the experimental class yielded a value of 0.365. This indicates that the significance level is > 0.05 , so the data is homogeneously distributed.

Hypothesis Test

Based on the hypothesis test using the Independent Samples T-Test with SPSS version 21, the sig. (2-tailed) value was $0.00 < 0.05$ and the calculated t-value was greater than the table t-value, i.e., $6.743 > 1.994$. This indicates that H_0 is rejected and H_1 is accepted.

Analysing

The analysis indicator was implemented during the problem orientation phase, where students were stimulated with real-life environmental cases delivered through interactive Prezi media. The structured presentation of Prezi—featuring motivation, learning objectives, and multimedia content on environmental change, pollution, and waste—enabled students to observe and interpret phenomena visually and contextually. As shown in **Figure 1**, students actively engaged in asking questions and identifying key elements from videos and images, thereby developing their analytical skills.



Figure 1. Analysing Cases by Asking Questions
Source: Author's documentation 2023

The post-test results indicated that the experimental class outperformed the control class in the analysis indicator, with the highest scores achieved in the polar bear case question. Students in the experimental class successfully linked visual cues (e.g., melting ice caps) to underlying causes of climate change, demonstrating strong analytical reasoning. This outcome aligns with findings indicating that PBL combined with digital media enhances students' ability to break down complex problems and extract relevant information (Erayani & Jampel, 2022). Furthermore, the use of Prezi provided a dynamic platform for visual analysis, supporting the argument that interactive media improves students' engagement and comprehension during problem-solving tasks (Rosyiddin et al., 2023; Septarini & Kholiq, 2021).

Synthesising

The synthesising indicator was embedded in the syntax of organising student learning, where students completed the Student Assignment Sheet (LTPD) to develop solutions to the presented problems, as illustrated in **Figure 2**.



Figure 2. Developing Plans for Problem Solving
Source: Author's documentation 2023

Post-test scores for synthesis were higher in the experimental class, especially in questions related to water pollution. Students demonstrated the ability to connect observed pollution scenarios with practical mitigation strategies, indicating effective integration of knowledge. The highest performance occurred in the third session, under learning objective 10.5.6, which focused on waste classification and the organisation of relevant facts. This improvement can be attributed to the active involvement encouraged by the PBL model, as collaborative inquiry fosters deeper conceptual understanding and synthesis of information (Pasaribu et al., 2020). Moreover, the integration of Prezi enabled students to access layered information efficiently, thereby reinforcing their ability to combine ideas into coherent solutions.

Recognising and Solving Problems

This indicator was addressed during the individual and group investigation stage, where students were guided to identify problems and formulate responses using the LTPD. To support exploration, the researcher shared an interactive Prezi link, enabling students to review images, videos, and textual explanations, as shown in **Figure 3**.

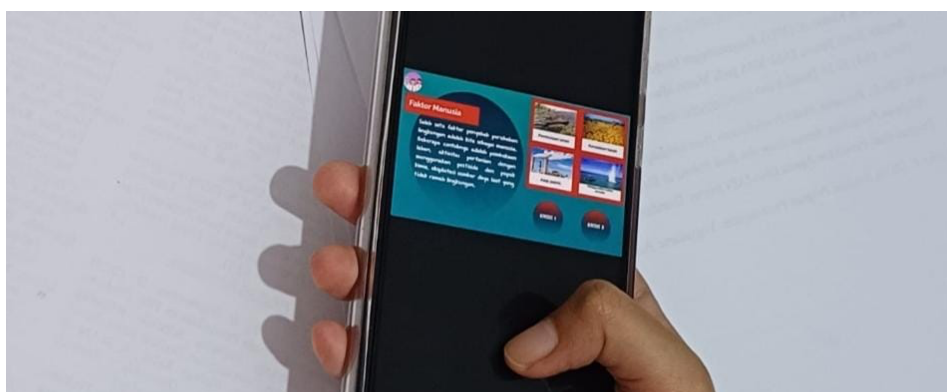


Figure 3. Exploring Information through Prezi Interactive Media
Source: Author's documentation 2023

The experimental class again outperformed the control class in this indicator, particularly in questions involving hazardous waste classification and its environmental impacts. Students could interpret data, select appropriate categories, and propose logical solutions. This result reflects the effectiveness of the PBL model in promoting problem-oriented learning, consistent with findings that such models enhance students' ability to solve authentic problems (Erayani & Jampel, 2022). Additionally, PBL can lead to significant improvements in critical thinking and problem-solving abilities, which are key cognitive skills developed through such approaches (Tursynkulova, 2023).

Concluding

The concluding indicator was implemented during the development and presentation of work results, where students formulated conclusions based on their discussions and created posters addressing global warming and environmental conservation. The researcher

displayed example posters via Prezi, serving as a reference to prevent misconceptions and guide accurate reasoning, as seen in **Figure 4**.

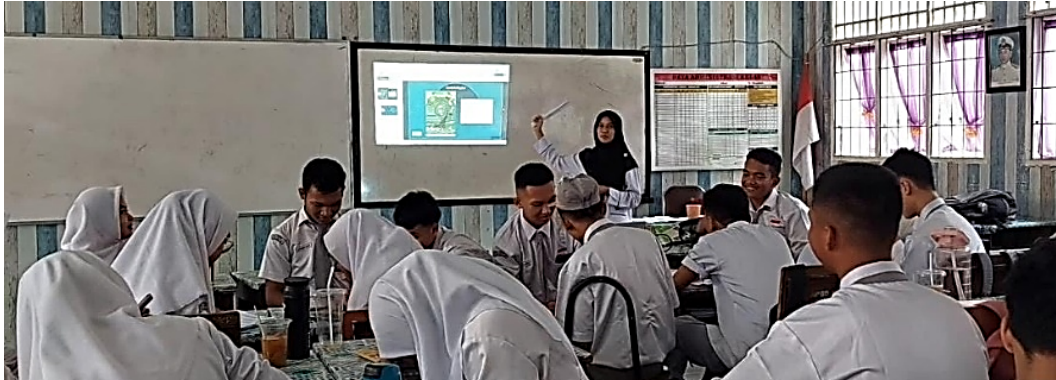


Figure 4. Displaying Works on Prezi Interactive Media
Source: Author's documentation 2023

Post-test results showed higher scores in the experimental class, particularly in questions involving environmental damage and data interpretation from graphs. The highest achievement was recorded in the second session for learning objective 10.5.5, where students applied inductive or deductive reasoning to propose solutions for pollution. This success is directly linked to the PBL model's emphasis on reasoning and reflection (Erayani & Jampel, 2022). Furthermore, Prezi's non-linear structure allows students to navigate concepts flexibly, enhancing their ability to draw logical conclusions (Jamil, 2023). Active participation in learning activities, particularly through PBL supported by interactive media such as Prezi, significantly strengthens students' confidence in expressing and justifying their conclusions (Aisyah & Wulandari, 2024).

Evaluating and Assessing

This indicator was implemented during the evaluation of problem-solving processes, where students assessed the accuracy and feasibility of proposed solutions. The researcher used Prezi to present detailed explanations of LTPD answers, incorporating text, images, and videos to clarify concepts, as shown in **Figure 5**.

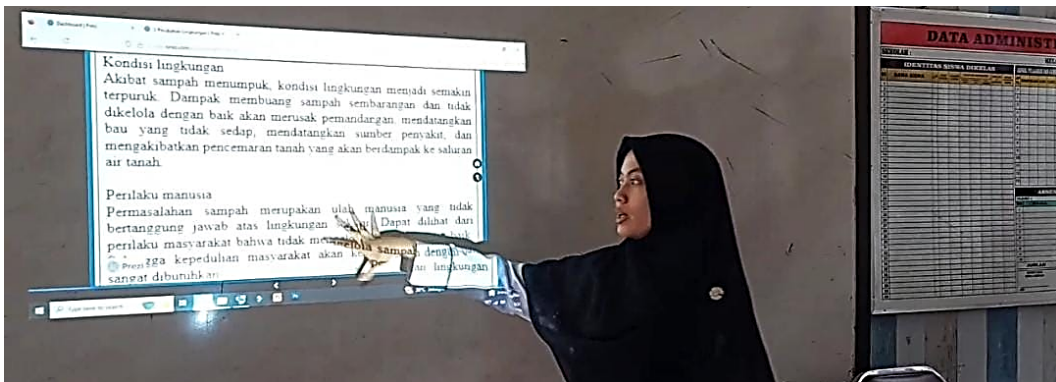


Figure 5. Evaluating Material through Prezi Interactive Media
Source: Author's documentation 2023

The experimental class achieved higher post-test scores in evaluation, particularly in the forest logging case, where students connected reforestation efforts with ecological impacts and expressed informed opinions. The highest performance was observed in the first session for learning objective 10.5.2, focusing on assessment based on specific criteria. While the experimental class reached the "fairly critical" level, students still struggled to provide reflective critiques, often affirming rather than challenging conclusions—a limitation indicating that evaluation skills require targeted scaffolding within PBL environments (Bilqiis et al., 2023).

Despite this, the overall improvement in the experimental class underscores the potential of PBL supported by interactive media to foster evaluative thinking. PBL promotes higher-order thinking, including evaluation, by encouraging students to justify decisions and reflect on outcomes (Kusumawati & Adawiyah, 2019). However, the current study reveals that even with strong engagement, explicit instruction in metacognitive evaluation is necessary to deepen critical judgment.

Overall Interpretation

The implementation of the PBL model assisted by interactive Prezi media led to a statistically significant improvement in students' critical thinking skills compared to the conventional learning approach used in the control class. This finding is consistent with prior research demonstrating that PBL provides opportunities for students to develop higher-order thinking skills (Kusumawati & Adawiyah, 2019). However, the current study shows an even greater enhancement across all indicators, likely due to the synergistic effect of integrating Prezi's multimedia capabilities into the PBL framework.

Prezi's engaging design enhances memory retention and conceptual understanding, which facilitates deeper cognitive processing (Sani et al., 2023). In contrast to other digital tools, this study highlights Prezi's unique advantage in presenting complex, interconnected environmental topics in a non-linear yet coherent manner, which is ideal for exploring cause-and-effect relationships in environmental change (Erayani & Jampel, 2022). Moreover, while PBL has been found to improve evaluation skills, this study identifies a gap in students' ability to offer constructive critique, suggesting that future interventions should include dedicated training in reflective assessment (Bilqiis et al., 2023). Thus, the combination of PBL and Prezi proves effective not only in improving critical thinking but also in revealing contextual nuances that inform pedagogical refinement—particularly in secondary science education in Indonesia.

In summary, the integration of the PBL model with interactive Prezi media at SMAN 4 Pekanbaru demonstrates significant potential for enhancing students' critical thinking skills, especially in biology topics closely tied to real-world environmental challenges. The findings contribute to the growing body of evidence supporting innovative, technology-enhanced instructional approaches in the era of Kurikulum Merdeka.

CONCLUSION

The implementation of the Problem-Based Learning (PBL) model assisted by interactive Prezi media has a significant positive effect on the critical thinking skills of 10th-grade students at SMAN 4 Pekanbaru. The post-test results demonstrated a notably higher average score in the experimental class (80.42) compared to the control class (65.84), with a significance value (2-tailed) of 0.00, which is well below the alpha level of 0.05. This suggests that the PBL model, supported by interactive Prezi media, is more effective in enhancing students' critical thinking abilities than conventional teaching methods. Furthermore, the model proves effective in developing all critical thinking indicators, particularly in the domains of analysis, synthesis, and problem-solving, enabling students to understand complex concepts better and apply their knowledge in meaningful contexts.

Based on these findings, it is recommended that educators and school stakeholders consider integrating technology-enhanced PBL models into their instructional strategies to foster deeper student engagement and higher-order thinking skills. For future research, it is recommended that the study's scope be expanded by involving multiple schools and different subject areas to assess the generalizability of the findings. Additionally, longitudinal studies could be conducted to evaluate the long-term impact of this learning model on students' academic performance and the development of their critical thinking. Exploring the integration of other interactive digital tools alongside PBL may also provide further insights into optimizing student-centered learning environments.

AUTHOR'S NOTE

The authors declare that there are no conflicts of interest related to the publication of this article. The authors affirm that the content of this article is free from plagiarism and is an original work. The researchers would also like to thank the principal, biology teachers, and students of class X SMAN 4 Pekanbaru for their support in carrying out this research.

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