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Effectiveness of a case-based learning model using a digital pop-up book on students' critical thinking skills

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Abstract. The purpose of this study is to determine the effectiveness of the case-based learning model using digital pop-up books in enhancing students' critical thinking skills. This innovative approach aims to enhance critical thinking skills through interactive media that meet the demands of the 21st century, as outlined in the Merdeka Curriculum, which underscores the urgency of this research. The population of this study involved two classes, X6 and X8, at SMAN 1 Polanharjo, with class X6 designated as the experimental group and class X8 as the control group. The sampling technique used by the researcher was non-probability sampling of the purposive type. Critical thinking skills were measured through pretest and post-test assessments conducted before and after the learning process. The independent t-test analysis resulted in a significance value of 0.017 < 0.05, indicating a statistically significant difference. The independent samples t-test showed a meaningful difference in the average post-test scores between the experimental and control groups, leading to the rejection of Ho and acceptance of Ha. These findings emphasize that integrating digital pop-up books into case-based learning enhances critical thinking skills in real-world contexts. Therefore, the case-based learning model using digital pop-up books has proven effective in improving the critical thinking abilities of students in class X at SMAN 1 Polanharjo, offering an alternative for practical learning in an active digital era centered on students.

Introduction

Education is a fundamental pillar in shaping a competent, innovative generation of successors for the nation, capable of facing global challenges. In the era of Industry 4.0 and Society 5.0, digital transformation has brought significant changes in how individuals, especially the youth, acquire and process information. Generation Z (Gen Z), born into a technology-saturated environment, tends to obtain information instantly via the internet and prioritizes speed in information retrieval over deep conceptual understanding (Szymkowiak et al., 2021). Therefore, the education sector is required to adjust its teaching approaches to meet the needs and characteristics of this generation.

Technological advancements demand not only intellectual competence from learners but also encourage higher-order thinking skills, such as critical thinking, creativity, and contextual problem-solving abilities (Fogarassy & Finger, 2020; Kusumantoro et al., 2023; Barbera & Garcia, 2024). Critical thinking skills are crucial in helping students filter information, make rational decisions,

and solve problems independently. This makes the development of critical thinking skills a primary focus in 21st-century educational policies and curriculum (Evi Yupani & Widana, 2023).

However, in reality, students' literacy and science skills in Indonesia are still relatively low. The results of PISA 2022 show that Indonesian students' reading scores only reached 359, far below the OECD average, ranking 70th out of 81 countries. This weak reading ability poses a barrier to the development of students' critical thinking skills (Gadot & Tsybulsky, 2025). The curriculum should provide space for students to develop their critical thinking abilities through learning activities that demand active participation and idea exploration (Rossouw & Steenkamp, 2025). In practice, the application of critical thinking skills in the independent curriculum is still not optimal. Many teachers struggle to design lessons that encourage in-depth analysis and evaluation (Dwiputra et al., 2023). Compounded by disparities in access to educational resources and a lack of professional training for teachers (Wijayanti et al., 2024).

On March 1, 2025, the researcher conducted observations of the learning process in Class X at SMAN 1 Polanharjo, located on Jl. Karanglo, Polanharjo, Karanglo, Klaten Regency, Central Java. The implementation of learning activities was suboptimal due to an unengaging learning process. Students were only asked to listen, take notes, analyze, reason, and conclude. As a result, students exhibited low critical thinking skills, particularly in economics, with scores below 75. The mid-semester test scores of students in economics are presented in Table 1 below.

Table 1. Mid-Semester Test Assessment of Class X Students in Economics

No.	class	Number of students	KKM	Completeed	Persentase	Not Completed	Persentase
1	X1	35	75	14	40%	21	60%
2	X2	35	75	18	51.43%	17	49%
3	X3	35	75	19	54.29%	16	46%
4	X4	35	75	17	48.57%	18	51%
5	X5	36	75	12	33.33%	24	67%
6	X6	35	75	8	22.86%	27	77%
7	X7	36	75	10	27.78%	26	72%
8	X8	35	75	6	17.14%	29	83%
9	X9	35	75	15	42.86%	20	57%
10	X10	35	75	13	37.14%	22	63%

Source: Processed Data, 2025

Table 1. The Mid-Semester Test results also indicate that the majority of students have not achieved the Minimum Passing Grade (MPG) of 75, particularly in classes X6 and X8, which have passing rates of only 22.86% and 17.14%, respectively. Based on interviews with the economics teacher, the learning process is still limited to lectures and sharing e-books via WhatsApp. The lack of direct explanations and individual assignments has led to low understanding and critical thinking skills among students. According to an interview with the economics teacher, Ms. Auliya Tyas Ismiyatri, S.Pd, on March 3, 2025, it was revealed that economics instruction at the school still relies on conventional methods such as lecturing and note-taking. The teacher also only shares e-books through the WhatsApp group, but this approach is deemed insufficient to help students understand the material. Additionally, students have difficulty following lessons taught in this conventional manner. They lack knowledge and critical thinking skills. Interviews with students from classes X6 and X8 also revealed that the learning process is not explained directly, as the teacher often misses class due to other commitments at school. Consequently, the teacher only assigns tasks through WhatsApp, which consist of note-taking and summarizing the shared material. With this learning

process, students face numerous challenges in understanding and solving problems. One of the obstacles faced by students is the reinforcement of knowledge that should enable them to achieve a broader understanding; however, they are only given tasks to complete independently. This results in students being less optimal in relying on their critical thinking abilities.

The proposed solution to address these issues is the implementation of the Case-Based Learning (CBL) model, which has been shown to enhance active learning and critical thinking through discussions based on real cases. Bruen et al. (2025) demonstrate that Case-Based Learning can facilitate active learning by engaging students actively with the support of facilitators during the learning process. This aligns with the research by Zhao et al. (2020); Purnadewi & Widana (2023), which indicates that case-based learning is a teaching model that supports and enhances a person's skills. Supported by Obidovna (2024). CBL is a learning model that bridges theory and practice in the real world through discussions and arguments between teachers and students, which can strengthen both theory and practical application (Sriwati, 2021; Sumandya et al., 2023). As knowledge continues to evolve, CBL has been applied across various other disciplines, including the use of educational media.

This model will be supported by digital pop-up book media, which has been proven to make the learning process more engaging and easier to understand. Dai et al. (2024) state that technological media, such as digital pop-up books in education, are significant as they create visually appealing designs in three dimensions. According to Rahmayanti and Setiawan (2023), digital pop-up books not only provide attractive visuals but also help students understand the material through illustrations, animations, and interactive elements that can be accessed directly. This media also assists teachers in delivering content uniquely and creatively, making learning more interesting.

Critical thinking skills are one of the essential competencies in 21st-century education that students need to navigate the dynamics of modern life. Critical thinking involves four important indicators: interpretation, analysis, evaluation, and inference (Jamil & Chohan, 2025). The more actively students engage in the learning process, the greater their understanding (Noris et al., 2024). Piaget's constructivist theory posits that intellectual processes develop through active interaction between students and their environment (Yildiz, 2025). Critical thinking skills are vital because they enable students to make informed choices, sift through information, and face challenges in the era of globalization with greater confidence. Therefore, there is a need for more engaging teaching models and interactive learning media to make students more active, creative, and better at understanding the material.

Several studies have examined the effectiveness of the CBL model on critical thinking skills. Alfiandra et al. (2022) found that critical thinking improved through case-based learning, as indicated by a pretest score of 60.4 and a post-test score of 91.2. Xiang et al. (2025) reported that CBL can enhance students' critical thinking abilities in the classroom; however, this is highly dependent on the research design, learning materials, and educational context. Their results showed a significant overall effect ($z = 6.74$, $p < 0.01$), confirming the efficacy of CBL in enhancing critical thinking disposition. Additionally, efforts to improve the effectiveness of the case-based learning model involve using engagingly designed learning media to boost critical thinking skills.

Based on these findings, this study is intriguing as it investigates Class X students at SMAN 1 Polanharjo using the Case-Based Learning paradigm with digital pop-up books to develop their critical thinking skills. This topic is rarely researched in economics subjects. This study explores the implementation of digital pop-up books in the classroom, an area that has not been extensively studied at SMAN 1 Polanharjo using a quasi-experimental design. The aim is to assess students' abilities in addressing real-life problems through the Case-Based Learning model, aided by digital

pop-up books, which involves students interactively, creatively, and actively, while presenting engaging content based on real-life issues. Another unique aspect of the digital pop-up book media is its attractive, interactive, and creative design. By understanding how effectively this Based Learning paradigm enhances critical thinking skills, it is hoped that this research will provide new perspectives for students on creating creative, efficient, and cooperative digital learning resources. As a guide for developing teaching models across various educational levels, the results of this study can also assist SMAN 1 Polanharjo and other researchers in building a digital-based economics learning methodology.

Based on the issues outlined, the research question is whether there is a difference in the critical thinking skills of students who participate in the Case-Based Learning model using digital pop-up books compared to those who follow the conventional teaching model. The research hypotheses are: (H0) there is no difference in critical thinking skills between students using the digital pop-up book-assisted Case Based Learning model and those using the conventional teaching model, and (H1) there is a difference in critical thinking skills between students who follow the CBL model with digital pop-up books and those who follow the conventional teaching model. Thus, the purpose of this study is to determine the effectiveness of the digital pop-up book-assisted Case-Based Learning model on students' critical thinking skills in economics at SMAN 1 Polanharjo.

Method

This quantitative research employs a non-equivalent control group design and a quasi-experimental methodology. The non-equivalent control group design is a type of quasi-experimental design where the experimental and control classes are not selected randomly (Syahrizal & Jailani, 2023). This design is utilized because it addresses the challenges associated with determining experimental and control classes. Below is a table explaining the quasi-experimental design used in this study.

Table 2. Nonequivalent Control Group Design

Group	pretest	Treatment	Postest
E	O1	X1	O2
K	O3	X2	O4

The research in Table 2 defines the experimental class as the class that receives treatment in the form of a model and media that enables students to actively engage in discussions through the application of the Case-Based Learning model assisted by digital pop-up books. Meanwhile, the control class is given treatment in the form of a conventional model with lectures. The subjects of this research are Class X students from SMA Negeri 1 Polanharjo in Klaten City during the second semester of the 2024/2025 academic year, totaling 346 students.

The researcher selected the population of Class X students at SMA Negeri 1 Polanharjo because they have implemented the Merdeka curriculum phase E, which focuses on understanding and solving real-life problems. After selecting the population, samples were taken for the study, specifically Classes X6 and X8, based on interviews conducted with Ms. Auliya Tyas Ismiyatri, S.Pd. Class X6, consisting of 35 students, was chosen as the experimental class and received treatment in the form of the Case-Based Learning model assisted by digital pop-up books. Meanwhile, Class X8, also with 35 students, served as the control class and was given treatment using a conventional model in the form of lectures. The sampling technique used in this study was non-probability sampling, specifically purposive sampling, with Classes X6 and X8 selected as samples due to initial conditions indicated by students' performance on the PSTS, which had not yet met the average score. The research outlines the process to be undertaken using the CBL model assisted by digital pop-up books. This technique must be supported by data validity techniques,

utilizing a validity test with previously validated HOTS questions, which were then trialed at SMA Negeri 1 Jogonalan. If the instrument is valid, it will have high validity; if the instrument is less valid, its validity will be low. The validity test in this study used IBM SPSS Version 26. Subsequently, reliability was tested using IBM SPSS Version 26 by examining the Cronbach's alpha column.

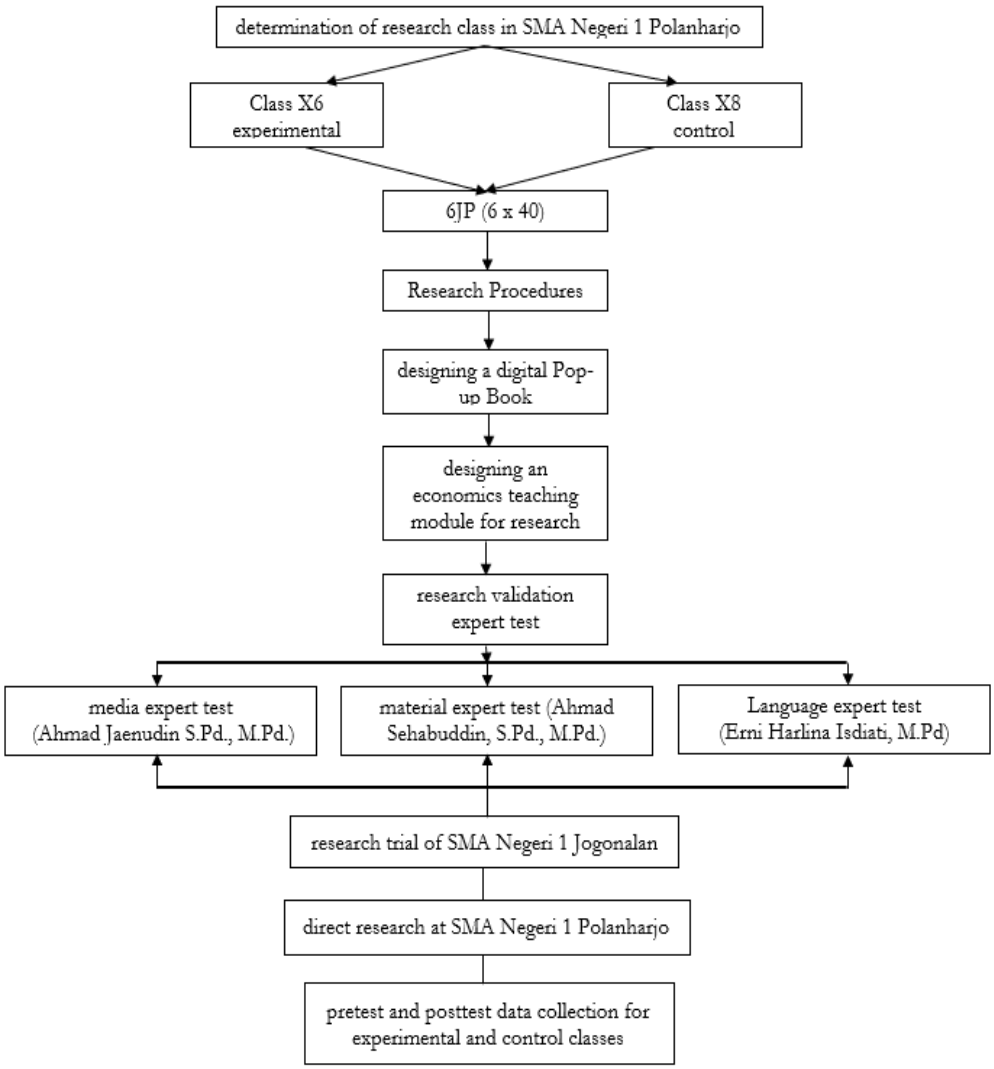

Image 1. Stages of the Research Flow for the Case-Based Learning Model Assisted by Digital Pop-Up Books

Image 1 provides a detailed scheme for conducting the research. After conducting the research and collecting data, the next step is to perform data analysis using IBM SPSS Version 26, which includes: 1) validity testing; if the calculated r > table r, it is deemed valid, whereas if the calculated r < table r, it is deemed invalid; 2) descriptive statistics, which present the research findings based on the data obtained to assess the feasibility of the pretest and post-test; 3) prerequisite tests; a) normality test to determine whether the data is normally distributed, with a significance value criterion > 0.05, b) homogeneity test to ensure the equality of variances, with a significance value criterion > 0.05; 4) difference tests; a) paired sample test to identify significant differences with a criterion of < 0.05, b) independent sample test to assess significant differences between the experimental and control classes, with a significance criterion of < 0.05; 5) N-gain test to evaluate whether this study demonstrates the effectiveness of the Case Based Learning model assisted by

digital pop-up books in enhancing students' critical thinking skills. The N-gain score categories are presented in Table 3.

Table 3. Category N-gain

N-gain score	Category N-gain Score
0,00 < GT < 0,30	Low
0,30 < GT < 0,70	Moderate
0,70 < GT < 1,00	High

Source from (Azizah & Paksi, 2024)

Results and Discussion

Based on the research conducted at SMA Negeri 1 Polanharjo during the 2024/2025 academic year, the researcher identified several key findings: 1) classes primarily utilized lectures, discussions, and blackboards for instruction; 2) teachers focused more on explaining the material, while students mostly took notes and listened; 3) students were seldom given opportunities to analyze cases or discuss topics in depth; and 4) the teaching media used in the classroom remained unchanged. Therefore, it is necessary to conduct research testing with experiments in both the experimental and control classes. The experimental class will be tested using Case-Based Learning assisted by digital pop-up books to enhance critical thinking skills. In contrast, the control class will only use the conventional lecture method. At SMA Negeri 1 Polanharjo, economics teachers still rely on the lecture method because they believe it allows them to convey lessons more quickly and manage time according to curriculum targets. Consequently, not all material covered through lectures is effective, especially since the subject of this research is payment systems and payment tools, which are addressed through the conventional teaching model in the control class.

The implementation of the CBL model integrated with digital pop-up books shows quite promising results, with Class X6 designated as the experimental group and Class X8 as the control group. The intervention in Class X6 was conducted over two sessions, each lasting three class hours. Similarly, the control class underwent two sessions with the same duration. Both groups were given pretests and posttests consisting of 15 questions: 10 multiple-choice questions and five essay questions designed to assess higher-order thinking skills (HOTS) at an equivalent level. The learning activities in both classes serve as the basis for evaluating the impact of the CBL model on students' critical thinking abilities. Furthermore, the learning products developed for this research have undergone validation and reliability testing by experts in content, language, and learning media. The results of the validation process are summarized in Table 4 below.

Table 4. Validation by specialists in language, media, and materials

No.	Assessment Indicators	Criteria
1	Feasibility of materials, media, and language style in terms of material content and media	Very good
2	Feasibility of materials, media, and languages used to understand students	Vergy good

Based on Table 3, it is evident that the validators' assessments of the teaching module, language, and teaching media are excellent. Therefore, the validation results are suitable for use in data collection.

Data collection was conducted from May 2, 2024, to May 16, 2025, in Class X at SMA Negeri 1 Polanharjo. This study consisted of two sessions for the experimental class and two sessions for the control class, with activities beginning with 1) a pretest, 2) the experimental class receiving

treatment through CBL assisted by digital pop-up books, while the control class engaged in discussions and lectures using a whiteboard on the topics of payment systems and payment tools, and 3) a posttest. Before conducting data collection, a pilot study was carried out at SMA Negeri 1 Jogonalan to determine the r count. If the r count is > 0.05, it is considered valid, and direct research testing will be conducted; if < 0.05, it is considered invalid, and the data from the pretest and posttest will need to be revised. The results of the pilot study are presented to assess whether the data is reliable, as shown in Table 5.

Table 5. Results of the SMAN 1 Jogonalan trial of the experimental class and control class pretest

No	R count pretest	Sig	Information
1.	0.349	0.00	Valid
2.	0.357	0.00	Valid
3.	0.375	0.00	Valid
4.	0.385	0.00	Valid
5.	0.373	0.00	Valid
6.	0.385	0.00	Valid
7.	0.352	0.00	Valid
8.	0.357	0.00	Valid
9.	0.352	0.01	Valid
10.	0.349	0.01	Valid
11.	0.457	0.00	Valid
12.	0.547	0.00	Valid
13.	0.452	0.01	Valid
14.	0.448	0.00	Valid
15.	0.484	0.00	Valid

The table presented above details the outcomes of the pretest instrument validity assessment conducted with IBM SPSS Version 26, demonstrating that every item is deemed valid. The R-count values for the pretest range from 0.349 to 0.547, with significance levels (sig) of 0.00 or 0.01, indicating that the significance levels fall below the threshold of 0.05. The test items serve as a means to assess the targeted abilities in the pretest. Table 6 displays the findings of the post-test.

Table 6. Results of the SMAN 1 Jogonalan Posttest Validation Test post-test questions for the experimental class and control class

No	R count Postest	Sig	Information
1	0.350	0.00	Valid
2	0.963	0.00	Valid
3	0.505	0.01	Valid
4	0.624	0.00	Valid
5	0.429	0.00	Valid
6	0.456	0.00	Valid
7	0.425	0.00	Valid
8	0.502	0.01	Valid
9	0.089	0.01	Valid
10	0.061	0.01	Valid
11	0.724	0.00	Valid
12	0.619	0.01	Valid
13	0.725	0.00	Valid
14	0.691	0.00	Valid
15	0.748	0.00	Valid

The validity test results indicate that all items are valid, with R count post-test values ranging from 0.061 to 0.963 and significance values of 0.00 or 0.01, all of which are less than 0.05. Consequently, the instrument employed has a substantial correlation with the overall score. Consequently, the pretest and post-test can be administered directly in the study.

Table 7. Analysis of descriptive statistics

	N	Range	Min	Max	Mean
Pretest_experimen	35	20	50	70	62.03
Post-test_experimen	35	30	70	100	88.00
Pretest_control	35	33	30	63	48.94
Post-test_control	35	48	50	98	72.80

The results from IBM SPSS Version 26 indicate that the average scores of the pretest and post-test for both the experimental and control classes show a significant difference, with higher scores in the experimental class. The average pretest score in the experimental class was 62.03, which increased to 88.00 in the post-test, while the control class had an average pretest score of 48.94, which only increased to 72.80 in the post-test. This demonstrates an improvement in critical thinking skills in both classes. However, the increase in the experimental class, which used case-based learning assisted by digital pop-up books, was higher compared to the control class that only used the lecture method. These results reaffirm that students can be encouraged to engage more actively, thoughtfully, and analytically with their knowledge of the learning material when case-based learning is combined with interactive technology.

The prerequisite data analysis consists of normality and homogeneity tests. The normality test is conducted to determine whether the pretest and post-test results meet the assumptions, using the Kolmogorov-Smirnov test as the method for assessing data normality. A Kolmogorov-Smirnov significance value greater than 0.05 indicates that the data is normally distributed; however, if the value is less than 0.05, the data must be transformed or adjusted. The homogeneity test, on the other hand, is used to ensure that the variances of the pretest and post-test data between the experimental and control classes are equal or homogeneous. The homogeneity and normality tests are performed using Levene's test, as it is crucial to determine whether the data meet the requirements for parametric t-tests. This ensures that the differences between the pretest and post-test results can be accurately assessed. The results of the normality test are presented in Table 8.

Table 8. The pre-test's Normality test

Classes	Kolmogorov-Smirnova		
	Statistic	Degree of freedom	Sig.
Experiment	.123	35	.198
Control	.125	35	.185

The results of the normality test using IBM SPSS Version 26, as shown in Table 8, indicate that the significance (p-value) for the experimental class is 0.198, and for the control class, it is 0.185. Both values are greater than 0.05, which means that the data from both groups are normally distributed. Therefore, the normality assumption is met, and further statistical analysis can employ a parametric testing approach since the data do not deviate from a normal distribution.

Table 9. Normailty test for the post-test

Classes	Kolmogorov-Smirnova		
	Statistic	Degree of freedom	Sig.
Experiment	0.106	35	0.200

Control	0.124	35		0.200

Table 9 shows that the significance value of the Kolmogorov-Smirnov test for both the experimental and control classes is 0.200, which exceeds the significance threshold of 0.05. This result reinforces the finding that the post-test data are also normally distributed, thus meeting the criteria for proceeding with parametric analysis. The results of the homogeneity test for the pretest can be found in Table 10.

Table 10. Test of homogeneity for the pre-tests

LS	Df 1	Df 2	Sig.
3.548	1	68	.064

Levene's test for homogeneity of variances between the experimental and control classes showed a significance value of 0.064, which is greater than 0.05. This indicates that the variances between the two groups at the pre-test stage are homogeneous; in other words, both groups have similar initial diversity in their abilities before the treatment was given. This homogeneity is important as a prerequisite for proceeding to the difference test (t-test). Therefore, the results of this homogeneity test support the validity of the data analysis in the next stage, as shown in Table 11.

Table 11. Homogeneity test for the posttest

LS	Df 1	Df 2	Sig.
2.975	1	68	.089

Similarly, the results of the homogeneity test for the post-test data (Table 11) show a significance value of 0.089 > 0.05, which indicates that the variances of the two groups after the treatment are still considered homogeneous. This means that the parametric independent sample t-test can be used to test the hypothesis regarding differences in learning outcomes between the groups. The purpose of this test is to determine whether the pretest and post-test results of each group differ significantly. The testing is conducted at a significance level of 0.05. If the significance value (p) < 0.05, it can be concluded that there is a significant difference before and after the treatment was given. The results of the hypothesis test are presented in the following Table 12.

Table 12. Sample t-test for the control class

	Mean	95% Confidence Interval of the Difference		t	df	Sig.(2 tailed)
		Lower	Upper			
Pair 1 Pretest post-test	23.857	28.624	19.091	10.172	4	.000

The results from IBM SPSS Version 26 for the control class also indicate an improvement in critical thinking scores, with a mean difference of 23.857 and a significance value of 0.000 < 0.05. This means that although the lecture method can still enhance students' critical thinking abilities, the improvement tends to be lower compared to the CBL model.

Table 13. T-test sample for the experimental group

	Mean	95% Confidence Interval of the Difference		t	df	Sig.(2 tailed)
		Lower	Upper			
Pair 1 Pretest post-test	25.971	22.004	22.939	17.47	34	.000

Table 13 shows that the mean difference between the pretest and post-test in the experimental class is 25.971, with a significance value of 0.000 < 0.05, indicating that there is a statistically significant difference between the pretest and post-test scores after the treatment was administered. This indicates that the Case-Based Learning model assisted by digital pop-up books is effective in significantly enhancing critical thinking abilities in the experimental class. To assess the effectiveness of the case-based learning model assisted by digital pop-up books, an independent test is needed to compare the post-test results as follows.

Table 14. Independent Sample Size for Pretest and Posttest

Levene's Fourier Transform Test for Variance Equality			Test for Ratio of Sets (Post-test and Pre-test Values for Control and Experimental Levels)				
	F	Sig.	T	F	Sig (2tailed)	95% Confidence Interval of the Mean	
						Under	Top
Skor. The same assumption applies.	2.160	0.884	2.437	68	.017	0.751	7.535
Similar Variants of Assumptions			2.437	67.972	.017	0.751	7.535
Skor. The same assumption applies	3.194	0.078	6.675	68	0.00	7.231	13.398
Similar Variants of Assumptions			6.676	67.972	0.00	7.228	13.400

The results of the independent sample t-test in Table 14 show that the significance value (2-tailed) = 0.000 < 0.05, indicating a significant difference between the post-test results of the experimental class and the control class. With a higher mean score in the experimental class, it can be concluded that CBL assisted by digital pop-up book media is more effective in enhancing students' critical thinking abilities compared to conventional methods. The effectiveness is further assessed as shown in Table 15.

Table 15. Results of the N-Gain test

Descriptive	
Class	Mean
N-Gain score experimental class	0.5651
N-Gain score control class	0.2809

Table 15 shows the results of the N-Gain score calculations, which are used to measure the effectiveness of the improvement in students' critical thinking abilities. The experimental class achieved an average score of 0.5651, which falls into the moderate to high category, while the control class only reached 0.2809, placing it in the low to moderate category (Azizah & Paksi, 2024). This difference confirms that the implementation of the CBL model assisted by digital pop-up book media is significantly more effective in enhancing critical thinking skills compared to conventional learning.

The research findings indicate that there is a significant difference in the critical thinking abilities of students in class X6, which uses the case-based learning model with digital pop-up books, compared to class X8, which employs conventional learning methods. Based on the N-gain test results, the average improvement in critical thinking skills in the experimental class is higher than that in the control class. This is evidenced by the average post-test score of 88.00 in the experimental class and 72.80 in the control class. The results obtained in the study show that the t-

test hypothesis (sig) is 0.000 < 0.05, meaning that Ho is rejected and Ha is accepted. These findings suggest that the implementation of case-based learning encourages students to analyze, evaluate, and solve real problems that they study. This aligns with Lestari and Sari (2021), who state that interactive visual media can enhance student abilities, such as motivation and critical thinking. This is supported by Rahmayanti and Setiawan (2023), who state that pop-up book learning media can help improve students' critical thinking skills. Therefore, the case-based learning model using digital pop-up books is effective in enhancing students' critical thinking abilities.

The case-based learning model using digital pop-up books provides novelty and uniqueness for researchers, as it is rarely implemented together in the learning process at SMAN 1 Polanharjo. This approach makes students more interested in what they are learning. One effect is that students become more active in the learning process independently and no longer rely entirely on the teacher. This contrasts with previous research by Rihadatul and Nani (2022), which indicated that a lack of supervision from teachers, low student participation, and the brief application of the learning model did not significantly impact the improvement of students' critical thinking skills in Case-Based Learning (CBL). Thus, the results of this study can serve as a reference for teachers in innovative learning that optimally combines problem-based approaches with interactive media.

Previous research by Ma and Zhou (2022) demonstrated that the case-based learning model assisted by virtual reality media effectively enhances the critical thinking skills of nursing students. The use of digital pop-up book media helps teachers to engage students more enthusiastically in learning and allows them to see real-life images to solve problems. Supported by Nawawi et al. (2024), the implementation of case-based learning improves critical thinking skills at the educational level and provides solutions to student problems through discussion and case studies. Therefore, this research offers novelty and reinforces important findings in the case-based learning model using digital pop-up books to enhance critical thinking skills.

Based on the overall results, this research has important implications both theoretically and practically. Theoretically, this study reinforces the constructivist framework that emphasizes the importance of active student engagement in building knowledge through social interaction and meaningful learning experiences, as explained in Piaget's theory and problem-based learning. The Case-Based Learning model integrated with digital pop-up book media expands the constructivist approach by providing interactive visual tools that encourage students to explore, analyze, and solve contextual problems, thereby deepening their critical thinking skills. Practically, these findings contribute significantly to teachers, schools, and education policymakers in designing learning that is not only informative but also transformative. The use of digital media, such as pop-up books, can serve as an innovative solution to address the passive learning that is still prevalent in classrooms. Furthermore, these results provide evidence that the Merdeka Curriculum can be effectively implemented through creative and technology-based learning strategies, thereby promoting improvements in the quality of education that are more relevant. This method offers a project-based learning experience focused on problem-solving, where students are required to think critically when facing challenges. Collaborative critical thinking skills, through analysis and discussion of data, allow students to build knowledge using modern methods (Wardani & Fiorintina, 2023).

Conclusion

Based on the research results and discussion, the CBL approach using digital pop-up books successfully enhanced students' critical thinking skills. The average scores in the experimental class differed significantly from those in the control class. The experimental class utilized the CBL learning model, while the control class employed conventional methods. This improvement

demonstrates how case-based learning and interactive media can stimulate students' thinking. The constructivist approach states that students actively create contextual experiences and interactions, which is further supported by these findings. The CBL paradigm using digital pop-up books can enhance critical thinking skills. Based on these findings, it is recommended that teachers implement the CBL learning model using digital pop-up books as interactive media to encourage more active student participation in learning. Additionally, researchers are encouraged to develop similar learning media but with different interactive contexts and materials for various educational levels to test effectiveness.

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