



The Impact of Digital News Media Integration within Problem-Based Learning on Students' Critical Thinking Skills and Learning Outcomes in Vocational Science Education

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Abstract: This study aims to investigate the impact of integrating digital news media as an authentic problem trigger within the Problem-Based Learning (PBL) model on students' critical thinking skills and cognitive learning outcomes in vocational science education (PIPAS). This research employed a quasi-experimental approach with a nonequivalent control group design at SMKN 1 Batam. Data were collected through pre-tests and post-tests structured to measure Robert H. Ennis' critical thinking indicators and cognitive achievements, which were then analyzed using descriptive statistics and independent sample t-tests. The descriptive analysis revealed that the experimental group achieved an average N-gain score of 0.32 in the moderate category for critical thinking skills, outperforming the control group which scored 0.10 in the low category. A similar trend occurred in cognitive learning outcomes, where the experimental group secured an N-gain score of 0.37 (moderate) compared to the control group's score of 0.15 (low). Furthermore, the independent sample t-test confirmed that this difference was statistically significant, yielding a t-value of 2.389 with a significance level of $p = 0.01$ ($p < 0.05$). The integration of dynamic, ill-structured problems from digital news portals successfully stimulated vocational students' analytical thinking, reflection, and problem-solving capacities. In conclusion, incorporating digital news media within the PBL framework is a highly effective instructional strategy to foster critical thinking and academic achievement in vocational science streams.

Keywords: Critical thinking skills; Digital news media; Learning outcomes; Problem-based learning; Vocational science education

Introduction

In the era of the fourth industrial revolution and rapid technological advancements, vocational high schools (SMK) are heavily challenged to equip students not only with technical expertise (*hard skills*) but also with essential cognitive competencies (*soft skills*), particularly critical thinking capacities. Critical thinking is an indispensable meta-cognitive skill that enables students to analyze, evaluate, and synthesize information logically to make informed decisions. In the context of vocational education in Indonesia, the Natural and Social Sciences Project (*Proyek Ilmu Pengetahuan Alam dan Sosial* or PIPAS) serves as a foundational

subject designed to foster scientifically literate graduates who can solve complex, real-world issues in their future workplaces. According to Kumala et al. (2022) and Golden (2023), critical thinking in science involves specific cognitive strands, such as elementary clarification, basic support, inference, advanced clarification, and strategies and tactics. Consequently, maximizing both critical thinking skills and cognitive learning outcomes within the PIPAS course is vital to ensuring that vocational students can adapt to dynamic occupational environments (Jaya et al., 2025; Raja et al., 2025).

However, the current reality of instructional practices in vocational schools frequently deviates from

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this ideal expectation. Preliminary observations and diagnostic assessments at SMKN 1 Batam reveal that students' critical thinking skills and science learning outcomes remain considerably low. This educational deficit is primarily driven by conventional, teacher-centered instructional methods that rely heavily on passive memorization and static textbook materials (Martin-Alguacil et al., 2024; Fitriani et al., 2021). Science concepts are often presented abstractly, disconnected from the practical and contemporary contexts relevant to vocational students. Furthermore, conventional learning models fail to provide students with ill-structured, real-world problems, leaving them ill-prepared to practice Ennis' critical thinking indicators (Yu & Zin, 2023; Loyens et al., 2023). As a result, students experience low engagement, which directly correlates with substandard cognitive achievements and an inability to bridge classroom theory with socioscientific realities (Basdogan et al., 2025; Wahyuningsih et al., 2026).

To overcome these instructional limitations, the implementation of Problem-Based Learning (PBL) has been widely advocated in science education literature. PBL is a student-centered instructional framework that utilizes authentic, unstructured problems as a trigger for student inquiry, collaboration, and higher-order thinking (Gusti Alfiyanti & Erita, 2023; Gusmawati et al., 2023). While the effectiveness of standard PBL is well-documented, its success heavily depends on the nature and quality of the problem presented to the students (Mutanga, 2024; Ssemugenyi, 2023). Traditional PBL scenarios often utilize hypothetical or outdated case studies that fail to capture student interest in the digital era (D'Elia et al., 2025; Hasni et al., 2016). Therefore, optimizing the problem-triggering phase in PBL is essential. One innovative approach is the integration of digital news media as a dynamic source of authentic problems (Smith et al., 2022; Lu et al., 2025). Digital news portals provide instantaneous, multifaceted, and socioscientific reports that mirror ongoing societal and industrial challenges, making them highly effective triggers for classroom investigations (Yee & Huey Shyh, 2024; Chueh & Kao, 2024).

Numerous studies have explored the application of PBL in science education, yet research focusing on the intersection of digital news media integration within the PBL model—specifically tailored for vocational science streams (PIPAS)—remains profoundly limited. Prior investigations have largely examined the use of digital media in general high schools, often neglecting the unique pedagogical needs of vocational students who require highly contextualized and practical problem-solving experiences. This research gap underscores the urgency of evaluating how dynamic information from digital news can transform standard PBL scenarios into

highly stimulating learning environments that specifically target Ennis' critical thinking strands and academic achievement in vocational contexts.

Hence, this study fills this empirical gap by integrating digital news media within the PBL model to foster vocational students' competencies. The primary objective of this study is to investigate the impact of digital news media integration within the Problem-Based Learning framework on students' critical thinking skills and cognitive learning outcomes in vocational science education at SMKN 1 Batam. By capturing real-time socioscientific issues, this integration is expected to offer a transformative educational strategy that elevates both analytical capabilities and academic achievements in vocational settings.

Method

This study employed a quantitative approach with a quasi-experimental method, specifically utilizing the nonequivalent control group design. This design was selected because the subjects could not be randomly assigned into new classes without disrupting the existing school schedule. The research was conducted at SMKN 1 Batam during the odd semester of the 2025/2026 academic year. The population encompassed all tenth-grade vocational students enrolled in the Natural and Social Sciences Project (Proyek Ilmu Pengetahuan Alam dan Sosial or PIPAS) course. Through a purposive sampling technique, two parallel classes with homogenous academic baselines were selected: class X Las 3 served as the experimental group ($n = 40$), while class X Las 4 served as the control group ($n = 40$).

The independent variable in this study was the instructional model, wherein the experimental group was exposed to Problem-Based Learning (PBL) integrated with digital news media, and the control group was taught using the conventional direct learning model. The dependent variables comprised students' critical thinking skills measured based on Robert H. Ennis' indicators and cognitive learning outcomes. The instructional treatment in the experimental class was systematically structured around five core phases of PBL adapted to incorporate digital news platforms: orienting students to the problem by presenting contemporary, ill-structured socioscientific issues from digital news portals (e.g., environmental pollution, industrial waste, energy crises); organizing students for study; guiding independent and group investigations to analyze the news context; developing and presenting artifacts; and analyzing and evaluating the problem-solving process. Meanwhile, the control class followed standard teacher-centered routines relying on static textbooks and structural worksheets.

Data collection instruments consisted of two primary assessment types administered as pre-tests and post-tests in both groups. First, a critical thinking skills test was developed in the form of structured essay prompts mapped explicitly to Ennis' five critical thinking strands: elementary clarification, basic support, inference, advanced clarification, and strategies and tactics. Second, a cognitive learning outcomes test consisting of multiple-choice items was utilized to measure students' academic achievement regarding PIPAS core competencies. Prior to deployment, all test items underwent rigorous construct validation by expert evaluators and empirical testing to ensure adequate reliability, item difficulty, and discrimination power.

To evaluate the impact of the intervention, the collected pre-test and post-test data were analyzed using descriptive and inferential statistics via SPSS software. Descriptive analysis calculated the mean, standard deviation, and Normalized Gain (N-gain) scores to

determine the magnitude of improvement in both variables. Prior to hypothesis testing, Anderson-Darling or Kolmogorov-Smirnov tests were executed to confirm data normality, alongside Levene's test to verify variance homogeneity. Hypotheses were then statistically tested using the Independent Sample T-test to evaluate post-test differences between the two groups.

Result and Discussion

The effects of integrating digital news media within the Problem-Based Learning (PBL) model were evaluated based on students' critical thinking skills and cognitive learning outcomes. The descriptive statistics summarizing the pre-test, post-test, and Normalized Gain (N-gain) scores for both the experimental and control groups are presented in Table 1.

Table 1. Descriptive Statistics of Critical Thinking Skills and Cognitive Learning Outcomes

Variable	Group	Pre-test (Mean)	Post-test (Mean)	Mean N-gain	Category
Critical Thinking	Experimental	52.00	67.25	0.32	Moderate
	Control	54.38	59.13	0.1	Low
Learning Outcomes	Experimental	53.83	71.00	0.37	Moderate
	Control	58.67	64.66	0.15	Low

As shown in Table 1, both groups experienced an increase in critical thinking skills and cognitive learning outcomes. However, the experimental group that received the digital news-integrated PBL intervention exhibited a more pronounced improvement. The average N-gain score for critical thinking in the experimental class was 0.32, which falls into the Moderate category, whereas the control class only achieved 0.10 in the Low category. A similar trend was observed in cognitive learning outcomes, where the experimental group outperformed the control group by scoring an N-gain of 0.37 (Moderate) compared to the control group's score of 0.15 (Low).

To verify whether these empirical differences were statistically significant, hypothesis testing was conducted using the Independent Sample T-test. Prerequisite testing confirmed that the data satisfied the assumptions of normality and homogeneity ($p > 0.05$). The statistical analysis comparing the post-test scores of critical thinking skills between the two classes yielded a t-value of 2.389 with a significance level of $p = 0.01$. Since the p-value is lower than the significance threshold ($\alpha = 0.05$), the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was accepted. This statistical outcome mathematically demonstrates that the implementation of Problem-Based Learning integrated with digital news media produces a significantly greater impact on vocational students'

competencies compared to conventional direct instructional practices.

The findings of this study demonstrate that the integration of digital news media as an authentic problem trigger within the PBL framework exerts a significant positive impact on vocational high school students' critical thinking skills and cognitive learning outcomes. This success is heavily attributed to the restructuring of the orientation phase in the PBL model (Fatimatu Zahro et al., 2025; Azizah et al., 2024). In the experimental class, students were not given abstract or hypothetical scenarios; instead, they were confronted with real-time, ill-structured problems sourced from digital news portals regarding actual socioscientific issues (Sarnoko et al., 2024; Hamid et al., 2025). This multi-modal stimulus successfully engaged the vocational students, who typically require highly contextualized prompts to connect scientific principles with real-world applications (Darling-Hammond et al., 2020; Trifonova et al., 2025).

The substantial increase in critical thinking skills is directly linked to the fulfillment of Robert H. Ennis' critical thinking indicators. During the first phase of PBL (orientation to the problem), analyzing digital articles required students to perform elementary clarification by identifying core problems, biases, and facts within the news reports (Boetje et al., 2024; Vieriu & Petrea, 2025). The subsequent group investigation phase forced

students to provide basic support and make logical inferences as they cross-referenced information from various digital media sources to formulate scientific solutions (Walter, 2024; Boulhrir et al., 2025). Finally, presenting their artifacts and evaluating their peer solutions stimulated advanced clarification and strategies and tactics (De Vries et al., 2024; Zamiri & Esmaeili, 2024). In contrast, the control group, which relied on conventional teacher-centered routines and static textbook materials, lacked the dynamic challenges necessary to practice these higher-order cognitive strands, resulting in lower critical thinking achievements (Mafarja et al., 2025; Udin et al., 2020).

Furthermore, the enhancement of cognitive learning outcomes in the experimental class indicates that fostering critical thinking simultaneously strengthens conceptual understanding (Rijal et al., 2018; Gomes & Barbosa, 2018). When vocational students are actively engaged in resolving authentic challenges presented by digital news such as industrial issues or energy transformations relevant to their environment they do not merely memorize formulas or definitions passively. Instead, they construct meaningful scientific knowledge through context-driven inquiries (Mhlanga, 2024; Zou et al., 2025). This deeply anchored cognitive processing leads to superior retention of PIPAS concepts and higher academic achievements in objective evaluations. This study aligns with cognitive constructivist theories and underscores that integrating dynamic digital media into problem-centered environments transforms science education from a rigid subject into a living, responsive discipline suitable for 21st-century vocational learners (Rahmawati et al., 2025; Vreuls et al., 2025).

Conclusion

This study concludes that the integration of digital news media as an authentic problem trigger within the PBL framework exerts a significant positive impact on students' critical thinking skills and cognitive learning outcomes in vocational science education (PIPAS) at SMKN 1 Batam. Statistical analyses confirmed that students exposed to the digital news-assisted PBL model achieved significantly higher post-test scores and demonstrated more substantial growth in both critical thinking components mapped across Robert H. Ennis' indicators and academic achievements compared to those taught via conventional instruction. The utilization of contemporary, ill-structured problems from digital news portals successfully transformed abstract science concepts into highly contextualized scenarios, thereby stimulating vocational students' engagement, independent inquiry, and analytical reasoning. Based on these findings, several

recommendations are proposed. First, science educators in vocational high schools are highly encouraged to adapt and utilize digital news platforms as active instructional triggers to foster 21st-century global competencies. Second, school administrators should support teachers by providing professional development workshops focusing on the design of digital media-integrated problem-centered curricula. Lastly, future researchers are suggested to extend this investigation by examining the long-term retention of students' cognitive achievements or by expanding the research scope across diverse vocational engineering specializations to further validate the cross-disciplinary efficacy of this learning model.

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Author Contributions

RC conceptualized the research framework, designed the quasi-experimental methodology, developed the instructional instruments and digital news media materials, conducted data collection at SMKN 1 Batam, performed the statistical data analyses, and drafted the initial manuscript. F. Y, D, and R provided comprehensive supervision throughout the study, reviewed and validated the research instruments, contributed to the intellectual interpretation of the results, and critically revised and approved the final version of the manuscript for publication.

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Conflicts of Interest

The authors declare that there are no conflicts of interest, whether financial, personal, or professional, regarding the conduct, analysis, or publication of this research. The study was executed with strict adherence to academic integrity, and all findings are reported objectively.

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