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Effectiveness of Edugame Integration in Problem Based Learning: Impact Analysis on Students' Critical Thinking and Motivation

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Abstract

Several studies have shown that the low score of Indonesia's PISA in 2022 is due to weak 21st-century skills competencies, such as critical thinking skills. The implementation of learning models and media has not been able to facilitate students' critical thinking. Students only listen, read books, and do recall exercises. This study aims to provide alternative solutions for implementing a problem-based learning model assisted by edugames to improve critical thinking skills and learning motivation, using a quasi-experimental method with a Pretest and Posttest Control-Group. The study subjects involved 40 fifth-grade elementary school students, divided into a control class using problem-based learning without edugames and an experimental class using problembased learning assisted by edugames. Analysis of critical thinking skills using the N-Gain test showed that the control class obtained a score of 0.44 in the moderate category and the experimental class 0.71 in the high category. Student learning motivation was indicated by the questionnaire results, which were 93.4% in the very strong criteria. The t-test results illustrated a significant difference between the control and experimental classes. This study concluded that problem-based learning assisted by edugames is effective in improving students' critical thinking skills and learning motivation.

Keywords: *critical thinking; edugame; learning motivation; problem-based learning*

INTRODUCTION

Basic education plays a crucial role as the initial foundation for developing students' knowledge and skills. This foundation can be developed and developed through learning Natural and Social Sciences (IPAS). IPAS not only focuses on theoretical aspects, but also enhances critical thinking and process finding solutions to real problems (Mandjur, 2025). IPAS is aimed at creating a fun, active, analytical, and creative learning environment, enabling students to solve learning problems through critical thinking (Suryani et al., 2020).

Critical thinking is the process of maximizing the potential of students' minds in finding solutions to various real-world problems they face. Critical thinking also encourages students' self-reflection to become accustomed to higher-level thinking when facing life's challenges. Critical thinking is a fundamental component that must be developed in elementary schools, because it functions as the main key in helping students master 21st century competencies and handle problems effectively (Irwan et al., 2024). Critical thinking skills are students' skills in comparing several pieces of information to gain knowledge through examining phenomena that deviate from scientific truth (Pratama et al., 2024). When students engage in critical thinking, they are not only able to detect weaknesses their efforts to improve them directly activate and implement creativity, problem solving, and innovation in an

integrated manner (Patras et al., 2024). When students are able to think critically, they will become disciplined, independent, self-monitoring, and improve their thinking skills (Sholihah & Lastariwati, 2020). Students who master critical thinking skills are considered to have a significant competitive advantage because they can analyze and assess certain situations and are able to make appropriate and wise decisions (Xu et al., 2023).

The current reality, based on several studies, is that the factors contributing to Indonesia's low PISA scores are weak 21st-century skills competencies. Indonesian students have not been able to complete high-level questions that facilitate critical thinking (Eviota & Liangco, 2020). Limitations in critical thinking arise because there are few students who are accustomed to using high-level thinking skills, and teachers are not yet able to facilitate the learning process and high-level questions or HOTS (Cipta et al., 2023). Evidence from the PISA report and the 2022 Indonesian Education Quality Report (AKM) confirms the low critical thinking and reasoning skills of students in Indonesia (Prabawa et al., 2024). Sukowati & Harjono (2023) he stated that there are still many passive students who are not motivated to participate in learning because teachers use conventional learning, students are not used to assessing arguments. Students' critical thinking is hampered by the implementation of learning models and media that have not succeeded in encouraging active student participation (Suryani et al., 2020). The cause of low student thinking is that learning does not use innovative media and models, students only listen, read books and do practice questions (Devi et al., 2020). The lecture method is based on books, learning resources have not utilized real events experienced by students, so their thinking skills have not been trained and facilitated (Halimah et al., 2023).

Science learning only focuses on understanding the material concept theoretically and understanding the concept is still limited to memorization and has not stimulated students' critical thinking (Dewi et al., 2023). Low critical thinking skills are caused by the learning process not being student-centered, students only receive information without being actively involved such as answering questions or responding to events (Zulianti, 2024). Ardyanti & Rezania (2024), explain the cause of low critical thinking of students, namely learning tends to be boring, students only take notes, listen, and save. The results of pre-research conducted in five elementary schools in Cibitung District, Sukabumi Regency, revealed crucial issues related to student competency. Students' critical thinking skills were in the low category, with an average score of only 49.68 (far below the ideal limit of 70). Consistently, students' learning motivation was also relatively weak, with an average score of 40.3%. This issue was reinforced by findings from teacher interviews, which indicated that the use of innovative learning media was not optimal. In fact, many teachers were unfamiliar with various digital applications such as Quizziz, Wordwall, Kahoot, Scratch, Assembler Edu, and Augmented Reality, even though these media had the potential to develop 21st-century skills.

Based on the explanation, although the Industrial Revolution 4.0 is characterized by technological developments and massive availability of information, which should facilitate and encourage students' critical thinking skills, the reality shows that students' critical thinking skills are often not facilitated or even decline. This gap indicates a methodological gap in optimizing digital tools such as innovative learning media and models to effectively transfer critical thinking skills from the digital environment to real-world problem applications. This research can be a solution by cohesively integrating two elements that can facilitate students' critical thinking, namely integration (PBL and edugames) into one innovative model and media. Innovative learning models and media can facilitate students' critical thinking (Rahim et al., 2022). Innovative learning that can be implemented must be oriented towards real problems (Rukmi & Zulfiati, 2024). Innovative learning oriented towards real problems is learning whose implementation uses significant, relevant and contextual real-world issues

to hone, facilitate and train students' critical thinking, problem-solving and self-regulation skills (Cong & Ironsi, 2025). In addition, real problem-oriented learning is considered a superior learning model because it facilitates students to face real problems and phenomena (Suryaningtyas et al., 2020).

The urgency of this research is oriented towards real environmental problems in Sukabumi Regency which are relevant to the material of Science Chapter 8 Topic C on Environmental Problems in grade V of elementary school, so that the material is appropriately combined with a problem-based learning model assisted by edugame media which is very relevant to the current digital era with the aim that students are able to increase motivation, be critical of environmental problems, be facilitated to practice critical thinking, and be able to solve the problems they face.

METHOD

This study used a quasi-experimental method with a Pretest-Posttest Control Group Design. The study was conducted in the even semester of the 2024/2025 academic year at SD Negeri 2 Cibodas Sukabumi, with a total of 40 fifth-grade students taken using a saturated sampling technique (equally divided into control and experimental classes). Data analysis was carried out quantitatively using the N-Gain test and t-test to compare scores between groups, assisted by the IBM SPSS Statistics 25 program. The control class implemented the conventional Problem-Based Learning (PBL) model (without edugames), while the experimental class used PBL integrated with edugames on environmental problem material. The phases passed are student orientation to problems using videos of real environmental problems in Sukabumi Regency, organizing students to learn using *edugame wordwall* in group activities, guiding individual and group investigations using *edugame quizziz* so that group learning can activate all students, presenting his work through a presentation, then analyzing and evaluating the entire problem-solving process, last a posttest is carried out and filling out a learning motivation questionnaire in the experimental class. This research instrument used questions, a motivational questionnaire, and an observation sheet. The 15 multiple-choice test questions covered five indicators of critical thinking skills and were piloted to determine their validity and reliability. The pretest and posttest results provided information on improvements or changes before and after the treatment.

Table 1. Critical Thinking Skills Assessment

Aspect	Indicator	Sub Indicators
Identifying and formulating questions	Provide basic explanation	Focus on the question
Identifying and addressing irrelevance		Analyzing arguments
Consider the use of appropriate procedures	Building basic skills	Evaluating the credibility of information sources
Recording observation results		Considering the observation report
Interpreting questions	Conclude	Dedicate and consider the results
Put forward a hypothesis		Drawing general conclusions from specific data (induction), then assessing their validity or impact
Provide examples and non-examples	Provide further explanation	Identify terms and consider definitions
Decision-making	Implement strategies and tactics	Deciding on an Action

Descriptive statistics were specifically used to describe the average scores of the two variables studied.

Table 2. Critical Thinking Skills Assessment Criteria

Score	Category
90-100	Very High
80-89	High
70-79	Moderate
50-69	Bad
0-49	Very Bad

Inferential statistical analysis included normality and homogeneity tests (with P > 0.05 as the criterion for homogeneity). The N-Gain test was then used to measure the effectiveness of score improvement (pretest to posttest), followed by a t-test to test the hypothesis.

RESULTS AND DISCUSSION

Results

Improving Critical Thinking Skills

The study concluded that the problem-based learning model assisted by edugames was effective in improving critical thinking skills. The increase in mean scores from pretest to posttest was highly significant (Significance P = 0.000 < 0.05) in both groups. This finding confirms that the use of edugames in PBL has a substantially greater impact on students' ability to analyze and think critically about environmental issues.

Table 3. Description of Pretest Result Scores

Descriptive Statistics	Control Class	Experimental Class
Sample	20	20
Average	47.65	45.98
Median	47	40
Mode	47	33
Standard deviation	10.67	15.84

Pretest data (Table 3) showed that the initial critical thinking skills of both classes were relatively equivalent (control: mean 47.65; experimental: mean 45.98), although there were variations in the medians (47 vs. 40) and standard deviations. This balance in initial means validates the study, ensuring that the differences in posttest results were due to the treatment effect.

Table 4. Frequency Distribution and Percentage of Pretest Scores

Score Category	Control		Experiment	
	F	%	F	%
90-100 (Very High)				
80-89 (High)			1	5
70-79 (Moderate)			1	5
50-69 (Bad)	9	45	6	30
0-49 (Very Bad)	11	55	12	60
Amount	**20**	**100**	**20**	**100**

The pretest data (Table 4) showed that both classes were relatively balanced, with the majority of students (almost 100%) in the lowest critical thinking category. This low initial balance validates the research methodology, allowing the posttest results to be credibly attributed to the effects of the treatment (PBL-edugame intervention).

Table 5. Description of Posttest Result Scores

Descriptive Statistics	Control Class	Experimental Class
Sample	20	20
Average	71.4	83.95
Median	70	83.5
Mode	67	80
Standard deviation	10.23	10.01

The posttest results in Table 5 clearly show that the edugame-assisted Problem-Based Learning intervention is effective, as evidenced by the significantly higher average score for the experimental class (83.95) compared to the control class (71.4). However, the distribution of scores across both classes remains consistent (balanced standard deviations). Evidence that this model is superior is also reinforced by the experimental class's mode (80), which exceeds the control class's mode (67), indicating that this model is more successful in attracting interest and improving the performance of the majority of students in critical thinking.

Table 6. Frequency Distribution and Percentage of Posttest Scores

Score Category	Control		Experiment	
	F	%	F	%
90-100 (Very High)			6	30
80-89 (High)	7	35	10	50
70-79 (Moderate)	3	15	3	15
50-69 (Bad)	10	50	1	5
0-49 (Very Bad)				
Amount	**20**	**100**	**20**	**100**

Posttest results showed substantial improvement in the experimental class, with 80% of students achieving high or very high scores (consisting of 10 high and 6 very high students), and only 5% of students falling into the low category. In contrast, the control class was dominated by students in the low category (50%). This distribution comparison confirms that the edugame-assisted PBL model successfully elicited superior performance from most students, surpassing the control class, which tended to stagnate in the low category.

N-Gain Test

The N-Gain test is used to measure the extent to which students' scores improve between the pretest and posttest conditions. The N-Gain value indicates that students have a better ability to understand or master concepts after receiving appropriate instruction.

Table 7. Test Results N-Gain Critical Thinking

Class	Statistical Parameters	N	Scores Value		Std. Deviation	N-Gain	%	Category
			Pretest	Posttest				
Control	Average	20	47.65	71.4	0.20	0.4455	44.55	Moderate
Experiment	Average	20	45.95	83.95	0.16	0.7184	71.84	Tall

The data demonstrates the effectiveness of the PBL-edugame treatment in the experimental class, showing an increase in pretest scores (45.95) to posttest scores (83.95) with an average N-Gain of 0.71 (high category). In contrast, the control class, which started with a higher initial score (47.65) and ended at 71.4, only achieved an average N-Gain of 0.44 (medium category). The standard deviation data in the control class was 0.20 and the experimental class was 0.16. This treatment has produced more uniform or consistent results among students.

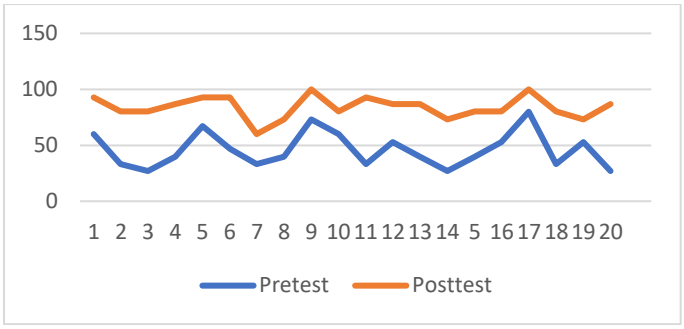

Figure 1. Improving Critical Thinking Skills in Experimental Class

The success of the edugame-assisted PBL model was confirmed by a very significant increase in the average critical thinking score in the experimental class, from 45.95 to 83.59.

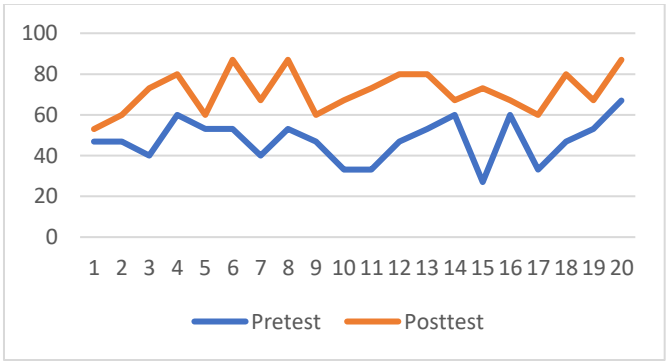

Figure 2. Improving Critical'Thinking Skills in;Control'Class

The control class's graph shows an increase from a pretest average of 47.65 to 71.4 on the posttest, even though they only used a problem-based learning model without any edugame intervention. The following are the analysis results for each critical thinking indicator:

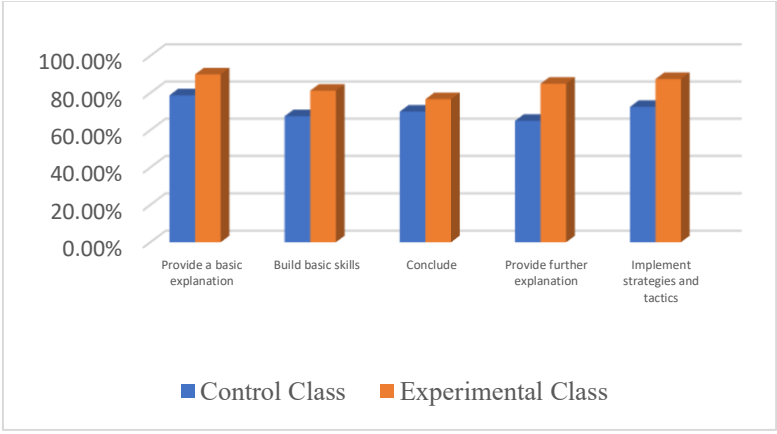

Figure 3. Percentage of learning outcomes for each critical thinking indicator

The N-Gain analysis per critical thinking skill indicator (environmental problem material) shows the dominance of the experimental class, which achieved a high category (N-Gain 0.71) on four indicators: basic explanation (0.80), basic skills (0.71), advanced explanation (0.76), and strategy/tactics (0.74). The control class only achieved a medium category on most indicators (0.59 to 0.36), even obtaining a low

category on Strategy/Tactics (0.08). On the Summarizing indicator, both groups were in the medium category.

Hypothesis Test Results

Before conducting an inferential test, a normality test was carried out to check the normal distribution of data, as well as a homogeneity test which aims to confirm that the level of diversity (variance) among the samples used is the same.

Table 8. Normality and Homogeneity Test

Class	N	Normality Test		Homogeneity Test	
		Sig.	Note	Sig.	Note
Control	20	0.166	Normal	0.751	Homogeneous
Experiment	20	0.288	Normal		

The statistical prerequisites have been met: the data of both classes are normally distributed (Significance of control 0.166, experiment 0.288 > 0.05), and the homogeneity of data variance is also confirmed (Significance 0.751 > 0.05). Hypothesis testing provides answers to research questions.

Table 9. T-test Results

Class	N	Hypothesis Testing	
		Sig. Value	Note
Control	20	0.000	Significant
Experiment	20		

The results of the t-test (paired samples test) showed a significant effect on students' critical thinking skills in both classes (control and experimental). A significance value of 0.000 (<0.05) clearly proves that there is a difference in the mean before and after the treatment.

Increasing Learning Motivation

One of the objectives of this study was to measure learning motivation. Researchers distributed a questionnaire (a total of 25 statements) after the learning process was completed in both classes. This questionnaire specifically aimed to determine students' responses to the problem-based learning model supported by edugames. The results were very positive, with student learning motivation analysis reaching 93.4%, indicating six indicators were in the Very Strong category.

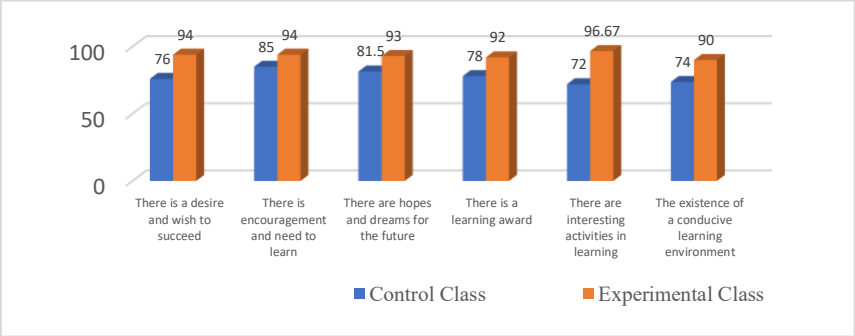

Figure 4. Increasing Learning Motivation According to Indicators

Hypothesis Test Results

The normality test ensures that the data is normally distributed, while the homogeneity test determines whether the variances of the compared data populations are the same.

Table 10. Normality and Homogeneity Test

Class	N	Normality Test		Homogeneity Test	
		Sig.	Note	Sig.	Note
Control	20	0.526	Normal	0.053	Homogeneous
Experiment	20	0.157	Normal		

The test results show that the data in both classes are normally distributed, because the significance values of the control class (0.526) and the experimental class (0.157) both exceed 0.05. In addition, the homogeneity test confirms that the data of both classes are homogeneous (the variances are equal) because the significance value obtained is 0.053 (> 0.05). Hypothesis testing aims to provide answers to research questions.

Table 11. T-test Results

Class	N	Hypothesis Testing	
		Sig. Value	Note
Control	20	0.000	Significant
Experiment	20		

The t-test results showed that the PBL model assisted by edugame significantly increased students' learning motivation (Significance 0.000 < 0.05). The average motivation of the experimental class (93.35) far exceeded the control class (77.90), proving the model's extraordinary effectiveness in increasing learning motivation.

DISCUSSION

The research results concluded that the problem-based learning model assisted by edugames is an innovation that has been proven to be effective. This study demonstrates how the integration of pedagogy and technology creates a contextual and engaging learning experience. This innovation is highly relevant because it focuses on developing students' critical thinking skills, an essential competency in modern 21st-century education.The needs analysis revealed that students' low critical thinking skills stem from teachers' limited use of textbook-based lectures in science teaching, and the lack of real-life learning resources, which has resulted in under-training and under-facilitation of students' critical thinking skills. This analysis provides a strong foundation for creating engaging and contextual learning that not only presents information but also facilitates students to think critically.

Learning involves students in observing and responding to images and videos about current environmental issues occurring in Sukabumi Regency. Teachers also use educational games/ *edugames. Wordwall* and *Quizz* make learning more engaging. In line with constructivism theory, teachers are required to be facilitators who present real environmental problems, so that students actively analyze and find solutions, building their own knowledge in depth (Saleem & Deeba, 2021). When students are guided through the *Wordwall game*, they become more confident and accustomed to asking questions to the teacher. Students not only receive material but also actively seek solutions and take responsibility for the learning process they experience. Grouping students heterogeneously encourages them to learn from each other and provide support through the interaction process, theoretically supported by Lev Vygotsky's social constructivism framework (Erbil, 2020)

Students are enthusiastic, active, and able to collaborate in groups when completing adventure missions in *Quizziz* . This stage focuses on developing students' ability to conclude. A conclusion is not just a summary, but is a final statement that is structured and logically justified which proves that the

critical thinking process has been completed (Yusuf et al., 2024). After students complete the assignment, they present it to develop detailed, logical, and comprehensive concluding skills. Through presentations and discussions, students learn to articulate their thoughts in depth. Presentation activities serve as formative evaluation instruments that facilitate students to integrate metacognition into critical reflection on their performance and strategies, thereby developing their critical thinking skills through the demonstrations they perform (Nobutoshi, 2023).

Improving critical thinking skills through problem-based learning assisted by edugames shows that there is alignment with research research by Yusup & Mastoah (2025), students tend to be more active in processing and remembering basic information when presented in an interesting and challenging format such as *edugames* because it affects engagement and performance, as well as understanding concepts by providing instant feedback, which allows students to immediately correct their understanding of basic explanations that are difficult to achieve in the traditional learning process. Edugames are an important learning resource because they provide an adaptive experience, with adjustable difficulty levels, edugames effectively facilitate students' learning progress, allowing them to develop skills gradually, from simple tasks to more complex challenges (Asyam et al., 2025). Well-designed *edugames can encourage students to think critically. Silberman et al.* (2021), explain the importance of understanding various systems interacting with each other, with *edugames* being able to effectively visualize and simulate these interacting systems, helping students see the bigger picture and provide more complete explanations.

An effective learning environment is a safe practice ground where difficulties are seen as opportunities for growth, not as obstacles, so that students become independent problem solvers (Jonassen, 2010). *Edugames* allow students to test hypotheses, learn from mistakes, and refine their strategies interactively in a dynamic learning environment. Overall, *edugames* are effective in problem-based learning because they provide an engaging, interactive learning environment and allow for rapid feedback. This encourages students to develop critical thinking indicators.

Rahmawati & Andaryani (2025), innovative learning media such as *edugames* are relevant for use in science learning because they are more practical, efficient and appropriate to student development. Packaging learning in a creative and innovative way, especially through the use of edugames, is very effective in increasing students' learning motivation (Eliyanti et al., 2024). Different findings from research by Khadijah et al. (2025), highlighting that problem-based learning does not work optimally if teachers are not skilled in facilitating, teachers who are still accustomed to dominating the class will make students passive, so that the essence of problem-based learning to encourage motivation, independence and collaboration is not achieved.

Research conducted by Senida et al. (2024), found that students who are accustomed to conventional learning tend to be passive and less courageous in asking questions or expressing opinions. This is a major obstacle for innovative learning because it is considered to require students to be active and independent in finding solutions. Other findings, while it is acknowledged that educational games like Quizziz can improve critical thinking skills, have also found significant risks to learning effectiveness (Nurfadila et al., 2024).

The applied model successfully addressed this weakness by integrating *edugames* as a supporting tool for problem-based learning, allowing students to remain focused on the subject matter while enjoying the game elements. Consequently, students' critical thinking skills improved across all indicators, surpassing those achieved by learning without *edugames* (the control group). Supported by

Saputri (2020), critical thinking skills experienced varying increases thanks to the edugame-assisted PBL model, with the percentage increase ranging from 0.61% to 18.15%.

Students' critical thinking skills in science can be effectively enhanced through real-world problem-oriented learning (Ariani, 2022). A crucial strategy for enhancing these skills is to combine problem-based learning (PBL) with innovative media. The PBL model has been consistently proven effective in improving students' critical thinking skills, as demonstrated by a research review from 2018 to 2022 (Anggraeni et al., 2023). This study shows stronger consistency in results compared to previous studies in terms of increasing learning motivation. PBL-based digital media effectively encourages students' critical thinking (Jihanifa, 2025). The success of the PBL model is not limited to one area; its impact on critical thinking skills is multidisciplinary, long-term, and applicable across a wide range of educational contexts (Hafizah et al., 2024).

Quantitative data shows strong empirical evidence that this model successfully increases student learning motivation. This research shares similarities with previous studies, namely the consensus that critical thinking skills and student learning motivation in Indonesia are still relatively low. The root cause is believed to be the same learning remains conventional and lacks support for innovative, technology-based/digital media. The differences are more specific in using *edugames* as a supporting medium for PBL. Detailed quantitative data and a focus on the local context (environmental issues in Sukabumi), more detailed indicators of critical thinking and learning motivation, providing strong empirical evidence compared to previous research that tended to be more descriptive or less specific in measurement. There was a significant impact on learning motivation by using *wordwall-based educational games* for fifth-grade students (Nisa & Susanto, 2022). A different finding, that *edugames* had no effect on fifth-grade students' learning motivation, proved that students had difficulty understanding the essence of the material being studied (Fakhrunnisaa & Mardiawati, 2024). PBL provides clear and meaningful learning objectives, making edugames merely a tool to achieve those objectives, not a source of distraction. Focusing on the local context of environmental issues also increases relevance, which becomes a stronger driver of intrinsic motivation. *Edugames* integrated into PBL provide elements of challenge, instant feedback, and *a sense of achievement* that stimulate students' intrinsic motivation.

The uniqueness of this research presents and combines problem-based learning and edugames on environmental issues relevant to the local context of Sukabumi Regency, which has been quantitatively tested. The contribution of this research is first as a learning innovation that provides a more holistic integrated model, combining real-world problem solving (PBL) with the appeal and motivation of digital media (Edugame), second it can increase student engagement because the material studied is close to students' daily lives which is a practical solution for curriculum contextualization in Indonesia, third it can complement previous literature by providing practical and detailed solutions for the curriculum in Indonesia, fourth it can expand the findings of previous research with more integrated, quantitative learning, relevant to the needs of 21st-century education, while opening opportunities for research on a wider scale with more specific media variations, fifth it offers practical and detailed solutions relevant to the needs of 21st-century education (focusing on critical thinking skills, digital literacy, and problem solving), sixth this research explicitly opens opportunities for research on a wider scale with more specific media variations (for example, different types of edugames or specific platforms).

The main similarity between this study and previous studies is the shared conclusion that the level of critical thinking skills and learning motivation of students in Indonesia is still in the low

category. The difference lies in a more specific and detailed approach. This study provides strong quantitative evidence, focuses on the local context of environmental problems in Sukabumi, and conducts more detailed measurements of the variables studied. In summary, the main contribution lies in providing strong, measurable, integrated empirical evidence relevant to 21st-century skills and opening opportunities for further research at a wider scale of educational levels or different media variations.

CONCLUSION

This study demonstrates that the implementation of the Problem-Based Learning (PBL) model, supported by edugames, achieved optimal success. This was evident in the 100% teacher and student engagement rate, as well as high praise from observers for the innovative learning implementation. The success of this implementation was directly correlated with the results, with students' critical thinking skills improving significantly, as evidenced by the high N-Gain test. The results of the motivation questionnaire reached a very strong category. These findings present an ideal pedagogical model, the integration of technology (*edugames*) effectively strengthens the advantages of pedagogical methods, resulting in not only high academic achievement (critical) but also high engagement and motivation to learn.

Due to its nature of offering contextual and interesting learning experiences, the problem-based learning model assisted by edugames can be used as a reference innovation in educational practice. This model successfully facilitates students to actively solve real-life issues, particularly environmental ones. This learning model has great potential for implementation in all subjects, with the key note being that it is adapted to the characteristics of the material being taught. This study has limitations, namely its focus on one level of education, namely elementary school, and only measuring the effects immediately after treatment (posttest). Overall, this research is highly relevant to the world of education because the results can provide alternative solutions for educators to foster learning motivation and improve 21st-century skills, especially students' critical thinking.

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