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Integrating Video Simulation into Hybrid Problem-Based Learning: A Strategy for Fostering Critical Thinking and Problem-Solving Abilities in Grade X Students Studying Basic Programming Algorithms

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ABSTRACT
Objective: This study aims to determine the effectiveness of video simulation on hybrid problem-based Learning (PBL) in improving grade X students' critical thinking and problem-solving skills using primary programming algorithm material. **Method:** The research method used is quantitative, with a quasi-experimental research type and pretest-posttest control group design. This study involved 30 students in the control and 30 in the experimental classes. The research sample was selected using a purposive sampling technique with the criteria of grade X students studying basic programming algorithms. Data collection techniques used questionnaires or questionnaires from 2 research instruments: critical thinking and problem-solving abilities. Data analysis in this study used normality tests and homogeneity tests. **Results:** This study showed a significant increase in grade X students' critical thinking and problem-solving abilities in studying basic programming algorithms after video simulation integration in HPBL intervention. **Novelty:** The integration of video simulation in HPBL provides a concrete visual representation that helps students understand abstract concepts and apply theory in real situations, enriching the learning process of basic programming algorithms. Future research is expected to explore other learning methods to improve the effectiveness of hybrid problem-based learning so that students have a learning style in learning basic programming algorithms.

INTRODUCTION

Critical thinking plays a crucial role in the academic development of high school students, particularly in subjects like Basic Programming Algorithms. By integrating critical thinking into the learning process, students can enhance their problem-solving abilities, make informed decisions, and evaluate information effectively (Matthee & Turpin, 2019). Critical thinking is not just about recognizing different ideas but also about researching and clarifying them to improve outcomes for everyone involved. (Yafie et al., 2020). It is a constructive and progressive mindset that can significantly impact teaching quality and students' learning experiences (Ronkainen et al., 2019). In addition to critical thinking, students also need problem-solving skills in this learning. It enables students to identify, analyze, and solve various problems that arise during the programming process. By honing their problem-solving skills, students can better understand and apply basic programming concepts and improve their ability to make the right decisions in complex situations. It also encourages students to innovate and look for alternative problem-solving approaches, which enhances their creativity and logical thinking skills.

However, students' critical thinking and problem-solving skills in learning Basic Programming Algorithms still need to be improved. Indonesian students' critical thinking skills are still low, with average scores below international standards. Factors that influence this low ability include teacher training in integrating critical thinking and problem-solving in learning, monotonous learning methods, and a lack of adequate learning resources. Critical thinking and problem-solving skills are among the top 10 most needed skills in the future. However, only 17.000% of the global workforce has these skills.

Meanwhile, the OECD study shows that the average score for students' critical thinking skills in OECD countries is still low. Indonesia is one of the countries with the lowest score. Therefore, students' critical thinking and problem-solving skills must be improved, especially in Basic Programming Algorithm learning. The impact that arises if these abilities are not discussed is that students will become individuals who depend on others to find solutions, lack confidence in facing challenges, and cannot compete in the world of work, which demands independence and critical thinking skills (Chew & Cerbin, 2021). This can also lead to stagnation in their personal and professional development and hinder the progress of society as a whole.

The Video Simulation in Hybrid Problem Based Learning (HPBL) learning approach in learning basic programming algorithms integrates video simulation with problem-based learning methods in a hybrid context. Video simulation is used to illustrate the concepts of basic programming algorithms visually and interactively, including demonstration of programming steps, code examples, and program execution results. (Chua & Islam, 2021). The HPBL method combines face-to-face and online learning, where students are presented with relevant problems and directed to seek solutions through collaboration and independent research. This approach enhances students' understanding of algorithmic concepts through interactive visualization, learning flexibility, and developing critical thinking and problem-solving skills (Hsu & Wang, 2018). Simulation videos increase student engagement with engaging visualizations, while PBL encourages collaboration and knowledge sharing among students. Video materials that can be accessed anytime provide opportunities for in-depth and personalized learning (Thamrin et al., 2022). Therefore, integrating video simulation in HPBL enriches the learning experience and encourages the development of students' critical, analytical, and collaborative skills.

Integrating video simulation into hybrid problem-based learning can be a powerful strategy to enhance critical thinking and problem-solving abilities in students studying basic programming algorithms. Research has shown that problem-based learning actively engages students in reflective cycles of learning domain-specific knowledge and encourages them to think independently, fostering critical thinking (Thorndahl & Stentoft, 2020). Additionally, studies have highlighted the positive impact of problem-based learning models on students' critical thinking skills, emphasizing the effectiveness of active learning in improving analysis, evaluation, and creation skills (Fadilla et al., 2021).

Research indicates that problem-based learning and problem-solving approaches can enhance students' critical thinking and problem-solving abilities in various subjects, including mathematics and programming. Studies have shown that problem-based learning can improve students' critical thinking skills, problem-solving abilities, and learning achievement in mathematics (Simanjuntak & Sudibjo, 2019). In programming education, multimedia learning tools using problem-posing models have been developed to support critical thinking in algorithm and programming courses (Riza et al., 2018). Problem-solving techniques have also been effective in developing students' analytical and critical thinking abilities (Ningrum, 2020). However, implementing problem-solving approaches may face challenges, such as thoroughly explaining problem planning, student motivation, and individual factors such as educational background (Kusniyah & Tjahja, 2020). These findings suggest that problem-based and problem-solving approaches can be valuable tools for fostering students' critical thinking and problem-solving skills.

Furthermore, incorporating activities such as laboratory work, inquiry-based instruction, and workshops can enhance student engagement and contribute to developing critical thinking abilities (Demaria et al., 2019). Developing critical thinking skills is crucial in education to improve learning outcomes and enhance students' performance and quality (Saepuloh et al., 2021). It has been observed that essential thinking abilities are refined through interactive activities and reflective practices, indicating the importance of creating a conducive learning environment to foster critical thinking (Alsaleh, 2020). In conclusion, by leveraging video simulation in hybrid problem-based learning, educators can create an environment that nurtures critical thinking and problem-solving skills in students studying basic programming algorithms, ultimately preparing them for the challenges of the 21st-century digital landscape.

Prior research has underscored the advantages of PBL in enhancing critical thinking abilities, as postulated by Thorndahl and Stentoft (2020). However, this research has not incorporated video simulation. Riza et al. (2018) and Ningrum, (2020) investigated multimedia learning tools and problem-solving techniques. However, they did not assess the impact of integrating video simulation within an HPBL framework. Moreover, Senyah's (2024) research demonstrated the efficacy of problem-solving approaches across various subjects. However, it did not specifically address the issue of programming education for grade X students. This research introduces a novel approach by integrating video simulation into an HPBL model for grade X students learning basic programming algorithms. By employing a quantitative correlational methodology, this research offers more precise and statistically robust measurements than qualitative or mixed approaches commonly used in past research. Furthermore, it provides new insights and empirical evidence supporting the effectiveness of this educational strategy.

The urgency of this research stems from the growing need to cultivate digital literacy and essential 21st-century skills, such as critical thinking and problem-solving, among students. Traditional teaching methods often fail to engage students effectively, particularly in complex subjects like programming. This study addresses this gap by integrating video simulation into an HPBL approach for Grade X students studying basic programming algorithms. The goal is to enhance educational outcomes, provide educators with innovative teaching strategies, and prepare students to meet the challenges of the modern workforce.

Based on this context, the research questions guiding this study are as follows: 1) How does video simulation integrate into hybrid problem-based learning affect students' critical thinking skills before and after the intervention? 2) How does video simulation integrated into hybrid problem-based learning impact students' problem-solving abilities before and after the intervention? 3) How effective is video simulation in enhancing critical thinking skills within a hybrid problem-based learning environment? and 4) How effective is video simulation in improving problem-solving abilities within a hybrid problem-based learning framework? Based on this background, this study aims to determine the effectiveness of video simulation on HPBL in improving grade X students' critical thinking and problem-solving skills in primary programming algorithm material.

RESEARCH METHOD

Research Design

The research method used is the quantitative method (Sugiyono, 2019). This method was chosen because the research objective was to measure the effectiveness of simulation video integration in hybrid problem-based learning on students' critical thinking and problem-solving skills. This research design used a quasi-experimental design with a pretest-posttest control group design. This design involved two groups of students: the experimental group, who received treatment in the form of integration of simulation videos in hybrid problem-based learning, and the control group, who received conventional learning.

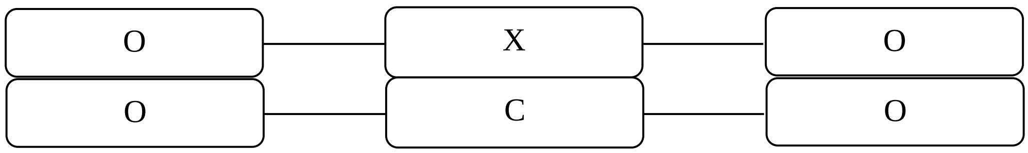

Figure 1. Research design.

Information:
O : Test of Critical Thinking and Problem-Solving Abilities
X : Conventional Learning
C : Video Simulation into Hybrid Problem-Based Learning

Population, Sample, and Sampling Technique

The population in this study were all class X students at 4rd Senior High School Sidoarjo. The sampling technique used was purposive sampling, so 60 students studying basic programming algorithms were obtained and consisted of two groups. The groups are the control group of 30 students and the experimental group of 30 students. The purposive sampling technique was chosen because not all X classes have the same schedule or need to learn basic programming algorithms. Therefore, the sample selection was carried out by considering classes that had a basic programming algorithm learning schedule at a time that corresponded to the research period.

Data Collection Technique

Data collection in this study used a questionnaire with two types of instruments: Critical Thinking, Which consists of 15 items divided into three dimensions, and Problem-Solving Abilities, Which consists of 20 items divided into five dimensions. Each item in both instruments is measured using a Likert scale with five answer options: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

Data Collection Procedure

The data collection involves several vital steps to ensure comprehensive and accurate results. Initially, the preparation phase focuses on preparing the questionnaire instrument and verifying its validity and reliability. A pre-test is administered to the experimental and control groups to establish baseline data before applying any treatment. The next step involves the implementation of treatment, in which the experimental group receives hybrid problem-based learning with integrated video simulation while the control group undergoes conventional learning methods. After the treatment, a post-test is administered to both groups to assess the effects of the respective learning approaches. Finally, data is collected through the questionnaires completed by the students, providing valuable insights into the study outcomes.

Data Analysis Technique

Descriptive analysis was used to describe the characteristics of the data in this study, followed by a normality test using the Kolmogorov-Smirnov Test to ensure normal data distribution. Furthermore, the variance homogeneity test was conducted using Levene's Test. Inferential analysis was conducted with an independent sample t-test to compare pre-test and post-test results within the same group. All analyses were conducted using statistical software such as SPSS to ensure accurate and valid results.

RESULTS AND DISCUSSION

Results

Descriptive Analysis

Normality test

The normality test aims to determine whether the distribution of the independent and dependent variables is normal or abnormal. The Kolmogorov-Smirnov test is used to check for normality. If the significance level is above 5.000% (or 0.050), the data is normally distributed. If the significance level is less than 5.000% (or 0.050), the data is considered not normally distributed.

Table 1. Result of critical thinking normality test.

Critical Thinking	Control			Experiment		
	Kolmogorov Smirnov	Asymp. Sig	Description	Kolmogorov Smirnov	Asymp. Sig	Description
Synthesizing	0.225	0.093	Normal	0.289	0.222	Normal
Articulation	0.346	0.079	Normal	0.325	0.166	Normal
Imagination	0.302	0.101	Normal	0.303	0.213	Normal

Based on the normality test results in Table 1, the normality test results for all dimensions of Critical Thinking obtained a significance value of > 0.050. This shows that all variables in Critical Thinking can be said to be normally distributed.

Table 2. Result of problem-solving abilities normality test.

Critical Thinking	Control			Experiment		
	Kolmogorov Smirnov	Asymp. Sig	Description	Kolmogorov Smirnov	Asymp. Sig	Description
Problem Identification	0.428	0.160	Normal	0.416	0.367	Normal
Achievement	0.466	0.146	Normal	0.452	0.297	Normal
Self-Confidence in Solving Problems	0.446	0.168	Normal	0.43	0.366	Normal

Critical Thinking	Control			Experiment		
	Kolmogorov Smirnov	Asymp. Sig	Description	Kolmogorov Smirnov	Asymp. Sig	Description
Putting Effort in Solving Problems	0.439	0.153	Normal	0.421	0.334	Normal
Procedure Followed to Solve Problems	0.432	0.158	Normal	0.428	0.334	Normal

Based on the normality test results in Table 2 above, the test results for all dimensions of Problem-Solving Abilities obtained a significance value of > 0.050. This shows that all variables in Problem-Solving Abilities are normally distributed.

Homogeneity test

A homogeneity test was conducted to ascertain whether the population variance fits the test criteria. If the p-value is more significant than 0.05, it can be concluded that the group's variance is constant (homogeneous). Levene's statistical test was applied to the Critical Thinking and Problem-Solving Abilities variables to determine their similarities.

Table 3. Result of critical thinking homogeneity test.

Critical Thinking	Levene Statistic	Asymp. Sig	Description
Synthesizing	0.432	0.726	Homogeneous
Articulation	0.525	0.63	Homogeneous
Imagination	0.496	0.534	Homogeneous

Based on the results of the statistical Levena test on the Critical Thinking variable in Table 3, the significance value is > 0.050, so there is no difference in variance between samples in the group. This shows that the sample variation in the group is the same (homogeneous).

Table 4. Result of problem-solving abilities homogeneity test.

Critical Thinking	Levene Statistic	Asymp. Sig	Description
Problem Identification	0.342	0.818	Homogeneous
Achievement	0.435	0.722	Homogeneous
Self-Confidence in Solving Problems	0.406	0.626	Homogeneous
Putting Effort in Solving Problems	0.409	0.630	Homogeneous
Procedure Followed to Solve Problems	0.473	0.674	Homogeneous

Based on the results of the statistical Levena test on the Problem-Solving Abilities variable in Table 4, the significance value is > 0.050, so there is no difference in variance between samples in the group. This shows that the sample variation in the group is the same (homogeneous).

Effect of Video Simulation into Hybrid Problem-Based Learning On Critical Thinking before and after intervention

The pre-test and post-test results were conducted after the research subjects were given an intervention in the form of video simulation into hybrid problem-based learning. The test results on critical thinking can be seen in Table 5.

Table 5. Result of critical thinking pre-test and post-test.

Class	Critical Thinking	n	Pre-test		Post-test		Gain
			Mean	Stdec	Mean	Stdev	
Control (PBL)	Synthesising	30	60.000	9.400	80.000	10.300	20.000
	Articulation		69.000	8.900	85.000	10.900	16.000
	Imagination		67.000	13.800	84.000	11.200	17.000
	Total		65.300	10.700	83.000	10.800	17.700
Experiment (PBL + Video Simulation)	Synthesizing	30	63.000	7.900	90.400	9.500	27.400
	Articulation		64.000	10.200	96.200	10.400	32.200
	Imagination		59.000	13.600	95.100	9.200	36.100
	Total		62.000	10.600	93.900	9.700	31.900

The results of data exposure in Table 5 show an increase in the value of the Critical Thinking variable. It can be seen from the control group that the average pre-test score of 65.300 increased to 83.000. Critical thinking increased by 17.700 points after students followed PBL. The average pre-test score of 62.000 in the experimental group rose to 93.900. Critical thinking increased by 31.900 points after students followed the PBL method and video simulation. These findings indicate a significant increase in Critical Thinking after students take part in learning the application of the PBL method, especially those equipped with simulation videos.

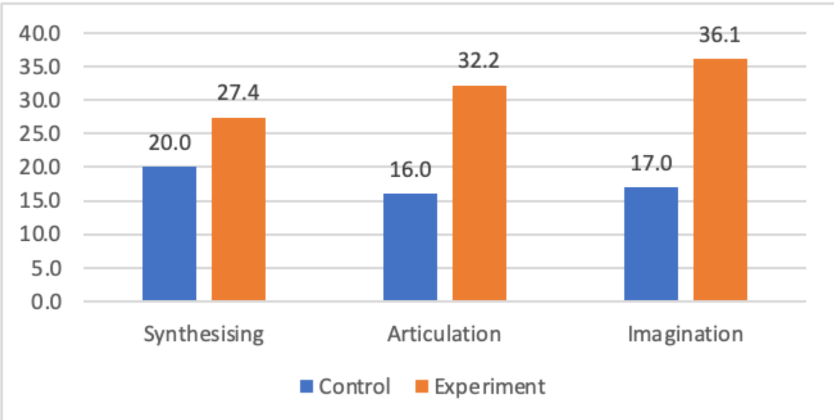

Figure 1. Comparative results of critical thinking improvement.

Figure 1 shows an increase in the Critical Thinking variable. This is because the experimental group was given a learning intervention using the PBL method and video simulation, so synthesizing, articulation, and imagination tend to increase significantly compared to the control group.

Effect of Video Simulation into Hybrid Problem-Based Learning On Problem-Solving Abilities Before And After Intervention

The pre-test and post-test results were conducted after the research subjects were given an intervention in the form of a video simulation to engage in hybrid problem-based learning. The test results on problem-solving abilities can be seen in Table 6.

Table 6. Result of problem-solving abilities pre-test and post-test.

Class	Problem-Solving Abilities	n	Pre-test		Post-test		Gain
			Mean	**Stdec**	**Mean**	**Stdev**	
Control (PBL)	Problem Identification	30	55.000	9.500	74.000	8.700	19.000
	Achievement		62.000	7.900	75.000	8.00	13.000
	Self-Confidence in Solving Problems		59.000	10.000	78.300	9.400	19.300
	Putting Effort in Solving Problems		52.000	8.400	70.200	6.700	18.200
	Procedure Followed to Solve Problems		51.000	7.600	72.100	8.000	21.100
	Total		55.800	8.700	73.900	8.200	18.100
Experiment (PBL + Video Simulation)	Problem Identification	30	47.000	8.000	89.300	9.500	42.300
	Achievement		55.000	7.600	88.800	9.600	33.800
	Self-Confidence in Solving Problems		49.000	7.400	91.200	8.600	42.200
	Putting Effort in Solving Problems		52.000	8.800	80.200	8.200	28.200
	Procedure Followed to Solve Problems		46.000	8.400	76.300	8.400	30.300
	Total		49.800	8.040	85.200	8.900	35.400

Based on the results of data exposure, Table 6 shows an increase in the value of the Problem-Solving Abilities variable. It can be seen from the control group that the average pre-test score of 55.800 increased to 73.900. Problem-solving abilities increased by 18.1 points after students followed PBL. In the experiment group, the average pre-test score of 49.800 rose to 85.200. Problem-solving abilities increased by 35.400 points after students followed the PBL method and video simulation. These findings indicate a significant increase in Problem-Solving Abilities after students take part in learning the application of PBL methods, especially those equipped with simulation videos.

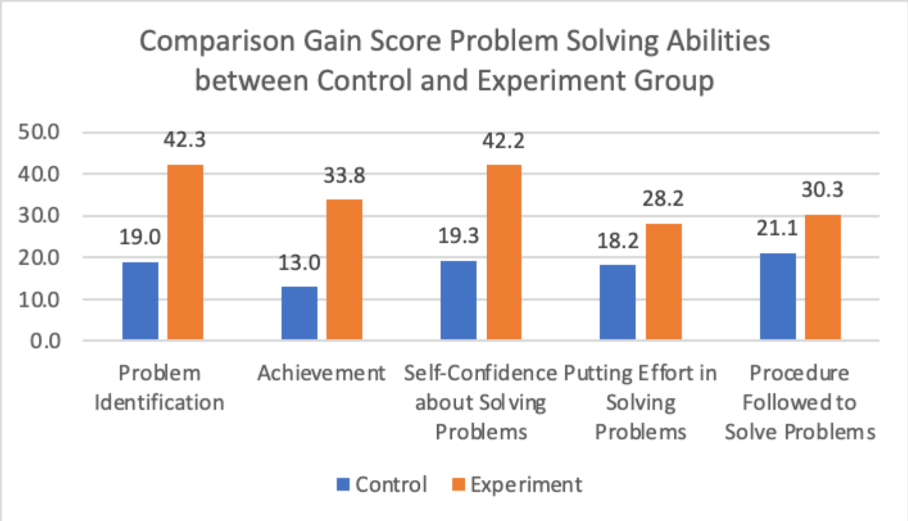

Figure 2. Comparative results of problem-solving abilities improvement.

Figure 2 shows an increase in the Problem-Solving Abilities variable. The experimental group was given a learning intervention using the PBL method and video simulation. Hence, the aspects of Problem Identification, Achievement, Self-Confidence about Solving Problems, Effort in Solving Problems, and Procedure Followed to Solve Problems tend to increase significantly compared to the control group.

The Effectiveness of Video Simulation in Hybrid Problem-Based Learning On Critical Thinking

This study examines the effectiveness of video simulation integration on HPBL in the control and experimental groups. This test is conducted to see if there is an influence on Critical Thinking when given intervention in the form of learning with PBL methods and simulation videos.

Table 7. Result of critical thinking hypothesis test.

Critical Thinking	t-statistic	t-table	Sig	Description
Synthesizing	3.183	2.000	0.000	Significant
Articulation	3.398	2.000	0.000	Significant
Imagination	3.399	2.000	0.000	Significant
Overall	3.219	2.000	0.000	Significant

Based on the results of data exposure in Table 7, the overall dimension of the Critical Thinking variable in the paired sample t-test shows a t-count value of 3.219 > 2.000 and a significance value of 0.000 < 0.050. This finding indicates a significant increase in Critical Thinking after students follow the learning with the PBL method and simulation video.

The Effectiveness Of Video Simulation Into Hybrid Problem-Based Learning On Poblem-Solving Abilities

This test is conducted to see if there is an influence on the Problem-solving Abilities when given intervention in the form of learning with PBL methods and simulation videos.

Table 8. Result of problem-solving abilities hypothesis test.

Problem-Solving Abilities	t-statistic	t-table	Sig	Description
Problem Identification	2.979	2.000	0.000	Significant
Achievement	3.186	2.000	0.000	Significant
Self-Confidence in Solving Problems	3.179	2.000	0.000	Significant
Putting Effort in Solving Problems	3.063	2.000	0.000	Significant
Procedure Followed to Solve Problems	3.240	2.000	0.000	Significant
Overall	3.608	2.000	0.000	Significant

Based on the results of data exposure in Table 8, the overall dimension of the Problem-Solving Abilities variable in the paired sample t-test shows a t-count value of 3.608 > 2.000 and a significance value of 0.000 < 0.050. This finding indicates a significant increase in problem-solving abilities after students follow the PBL method and learn video simulation.

Discussion

Effect of Video Simulation into Hybrid Problem-Based Learning On Critical Thinking Before And After Intervention

The intervention results using video simulation in hybrid problem-based learning on Cirital thinking of Grade X students demonstrate an increase in critical thinking in the experimental group of 31.900 points, compared to the control group, which showed a mere 17.700 points. This proves an undeniable increase in critical thinking in Grade X students studying basic programming algorithms using video simulation in hybrid problem-based learning.

PBL encourages students to engage with real-world problems, which requires them to analyze, evaluate, and synthesize information effectively. Research indicates that inquiry-based learning models, such as PBL, significantly contribute to developing critical thinking skills by aligning educational practices with the cognitive processes involved in critical thinking, such as analysis and evaluation of arguments (Zwiers & Crawford, 2023). This is particularly relevant in programming, where students must navigate complex problem-solving scenarios, enhancing their analytical skills. Moreover, integrating video simulation into the learning process is a powerful tool for enhancing critical thinking. Video simulations provide a dynamic and interactive learning environment that allows students to visualize abstract programming concepts and algorithms.

Additionally, the hybrid nature of the learning environment, which combines both online and face-to-face interactions, further supports the development of critical thinking skills. Hybrid learning environments facilitate collaborative learning experiences where students can discuss, share diverse perspectives, and collaboratively solve problems (Lhafra & Abdoun, 2023). This collaborative aspect is crucial, as it encourages students to articulate their thoughts and challenge each other's ideas, a fundamental critical thinking component (Boud & Bearman, 2024). Social interaction in such environments has been linked to improved critical thinking outcomes as students learn to navigate differing viewpoints and construct well-reasoned arguments (Pettersson, 2023). In conclusion, the increase in critical thinking among Grade X students studying basic programming algorithms through video simulation in an HPBL environment can be attributed to the synergistic effects of PBL methodologies, the interactive nature of video simulations, collaborative learning opportunities, and the development of metacognitive skills.

Effect of Video Simulation into Hybrid Problem-Based Learning On Problem-Solving Abilities Before And After Intervention

The study results show an increase in the value of the variable problem-solving abilities of students in the control class after being given intervention through PBL by 18.100 points. While in the experimental class, after being given intervention through learning intervention with the PBL method and video simulation by 35.400 points. This shows that video simulation in hybrid problem-based learning can improve problem-solving abilities in Grade X students studying basic programming algorithms. This improvement can be attributed to several key factors, including the interactive nature of video simulations, the collaborative environment fostered by hybrid PBL, and the experiential learning opportunities that arise from this educational approach.

The structured approach of hybrid PBL, combined with video simulations, promotes metacognitive skills. Metacognition involves self-regulation and reflection on one's thought processes, enabling students to assess their understanding and approach to problem-solving (Schunk & Zimmerman, 2023). Research has demonstrated that enhancing metacognitive skills correlates positively with improved problem-solving abilities, suggesting that combining PBL and video simulations effectively nurtures cognitive and metacognitive development (Chaiyasit et al., 2023). This is particularly relevant in programming, where students must navigate complex problem-solving scenarios, enhancing their analytical skills.

Furthermore, video simulations allow for repeated exposure to problem-solving scenarios, enabling students to practice and refine their skills in a safe environment. This iterative learning process is vital for mastering programming concepts, as it allows students to experiment with different approaches and learn from their mistakes without the pressure of real-world consequences (Boettcher et al., 2023). Such practice builds confidence and enhances students' ability to apply their knowledge in various contexts, further solidifying their problem-solving capabilities. In conclusion, integrating video simulation into hybrid problem-based learning significantly improves problem-solving abilities among students studying programming algorithms. The interactive nature of video simulations drives this enhancement, the collaborative learning environment fostered by hybrid PBL, and the development of metacognitive skills (Radovan & Radovan, 2024). As students engage with complex problems in a supportive and dynamic setting, they improve their problem-solving capabilities and prepare for future challenges in their academic and professional endeavors.

The Effectiveness of Video Simulation in Hybrid Problem-Based Learning On Critical Thinking

This is evidenced by the t-count value of 3.219 > 2.000 and a significance value of 0.000 < 0.050. This finding indicates a significant increase in Critical thinking after students take part in learning the application of the PBL method, especially those equipped with simulation videos. The findings of this study are supported by Ariyanti and Yusro (2023), who showed that using interactive videos in online learning can increase student engagement and understanding. Simulation videos also allow students to see the application of concepts in real situations, which improves critical thinking skills.

Integrating video simulations into an HPBL to teach basic programming algorithms significantly impacts students' critical thinking skills. Video simulations provide concrete and dynamic visual representations of abstract concepts, assisting students in better understanding and internalizing the material (Guo et al., 2020). In the context of PBL, where students are presented with real-world problems to solve, video simulations serve as a tool that allows students to explore and analyze situations more deeply, encouraging them to think critically in identifying, analyzing, and solving problems (Saunders et al., 2018). HPBL methods that combine face-to-face and online learning expand opportunities for students to collaborate and discuss, both in person and through digital platforms. These interactions enrich critical thinking as students can exchange ideas, present arguments, and test hypotheses using video simulations as concrete visual references (Fadilla et al., 2021). In addition, video simulations help students visualize the logical process of algorithms, which is often difficult to understand through text or verbal explanations alone.

Integrating video simulation in HPBL improves students' conceptual understanding of basic programming algorithms and sharpens their critical thinking skills. Students become more adept at analyzing and formulating solutions and making decisions based on the data and facts they obtain from these simulations (Falloon, 2019). This can equip students with valuable skills, both academically and in everyday life, as they learn to think critically in various scenarios. Educators can accommodate various learning styles by incorporating interactive and engaging materials and encouraging active student engagement.

Furthermore, the research emphasized the positive impact of using animated videos as teaching aids in improving students' mathematics learning outcomes (Kurniawati et al., 2023). This underscores the effectiveness of visual aids, such as animated videos, in facilitating understanding and retention of complex mathematical concepts. By utilizing multimedia resources such as animated videos, educators can create immersive learning experiences that resonate with students and improve their learning outcomes (Yafie et al., 2020). In conclusion, integrating video simulation in HPBL improves students' understanding of programming algorithms and fosters their critical thinking skills. This approach equips students with valuable and important skills not only in academic settings but also in the world of work, which emphasizes the importance of incorporating multimedia resources in modern educational practices.

The Effectiveness Of Video Simulation Into Hybrid Problem-Based Learning On Poblem-Solving Abilities

This is also evidenced by the t-count value of 3.608 > 2.000 and a significance value of 0.000 < 0.050. This finding shows a significant increase in problem-solving abilities after students take part in learning the application of the PBL method, especially those equipped with simulation videos. The findings of this study are supported by Lesmana (2024), who discusses how the PBL method helps students develop analytical and problem-solving skills through relevant case studies. Ruswan et al. (2024) also confirmed that using technology-based learning media in learning can increase students' motivation and engagement, improving their learning outcomes.

Integrating video simulation into HPBL significantly impacts students' problem-solving ability when learning basic programming algorithms. Students can understand algorithmic steps more concretely and intuitively by utilizing video simulations to provide dynamic visual representations of complex algorithmic concepts (Bordes et al., 2021). This approach allows students to explore different problem-solving approaches, test hypotheses, and understand the consequences of each step taken, leading to substantial improvements in their problem-solving skills. The integration of video simulation in PBL not only improves students' problem-solving ability but enhances their learning motivation by offering a more engaging and interactive learning experience (Huang et al., 2022). Incorporating video simulations in HPBL allows students to move beyond passive theoretical explanations and observe the practical application of theory in simulated real-world scenarios. This active engagement allows students to explore different problem-solving methods, analyze results, and understand the practical implications of students' decisions (Albay, 2019). Thus, students gain a more holistic and hands-on learning experience, which promotes the development of critical thinking and problem-solving skills.

The dynamic visualization of the video simulation and the effectiveness of PBL in promoting active and collaborative learning create a learning environment conducive to improving students' problem-solving skills (Astuti et al., 2022). Moreover, in mathematics education, integrating video-based learning with PBL has been recognized as a practical and suitable approach to enhance students' metacognitive skills. By combining the strengths of video simulation and PBL, educators can create engaging and interactive learning experiences that facilitate a more profound understanding and application of theoretical concepts in practical scenarios (Almulla, 2020). This integrated approach improves students' problem-solving skills and fosters critical thinking, collaboration, and motivation to learn (Khairani et al., 2020). Thus, integrating simulation videos in Hybrid Problem Based Learning positively develops students' problem-solving skills in learning basic programming algorithms. This approach combines the advantages of dynamic visualization of simulation videos with the effectiveness of the PBL method in encouraging active and collaborative learning, thus creating a learning environment conducive to developing critical thinking and problem-solving skills.

CONCLUSION

Fundamental Finding: The findings in this study showed an increase in critical thinking and problem-solving abilities of class X students studying basic programming algorithms after being given intervention in the form of video simulation integration in hybrid PBL. This finding is based on the high average post-test of students who use video simulation in HPBL on critical thinking. This is also supported by the significance of the overall variable, both critical thinking and problem-solving abilities. **Implication:** The integration of video simulation in HPBL provides concrete visual representations that help students understand abstract concepts and apply theory in real situations, enriching the learning process and student engagement. This approach deepens conceptual understanding and hones analytical, critical, and collaborative skills, creating an interactive and practical learning environment that equips students with valuable academic and daily life skills. **Limitation:** This study only involved grade X students at 4rd Senior High School Sidoarjo as the research population. The focus of this study was limited to basic programming algorithm material taught in grade X. Therefore, the results of this study may not apply to more complex programming material or different educational levels. Therefore, the results of this study may not apply to more complex programming materials or at different educational levels. **Future Research:** Future research is expected to explore other learning methods to increase the effectiveness of blended problem-based learning. This aims to ensure that students with various learning styles, especially in learning basic programming algorithms, can be maximally stimulated and foster their critical thinking and problem-solving skills.

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