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The Influence of LCD Media through PjBL-STEM on Critical Thinking Skills

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Abstract

This study investigates the impact of LCD media integrated with Project-Based Learning STEM (PjBL-STEM) on enhancing elementary school science students' critical thinking skills. Despite employing a quantitative approach and true experimental design, further clarification on the practical implementation of PjBL-STEM and the role of LCD media in the learning process would be beneficial. PjBL-STEM engages students in hands-on science projects that promote problem-solving, which is typically essential in elementary-level science curricula. However, "LCD media" lacks specificity, raising questions about whether it encompasses slides, videos, or interactive digital content. Conducted at SDN Wonosalam in Demak Regency, the research targets Grade V students using a saturated sample technique. Pretests and posttests on animal life cycle content were analyzed using the t-test to evaluate the impact of LCD-enhanced PjBL-STEM on critical thinking. Results reveal a significant positive influence, with a 2-tailed significance score of 0.005 (<0.05). Critical thinking indicators reflected high percentages: clarification (83%), assessment (81%), inference (82%), and strategies (85%). Average scores improved from a pretest mean of 68.33 to a posttest mean of 82.67, signifying growth in 21st-century skills, particularly critical thinking. This suggests that LCD-supported PjBL-STEM enhances reasoning and fosters deeper scientific understanding among elementary students.

Keywords: Life Cycle Diology Media, PjBL -STEM, Critical Thinking Skills

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INTRODUCTION

Current knowledge of the 21st Century corresponds to the Industrial Revolution Era 4.0. However, according to current developments, a balance is needed between knowledge and skills as a basis for improving the quality of human resources. Competencies of 4C (collaboration, communication, critical thinking, and creativity) are needed in facing the 21st Century (Bedir, 2019; Yılmaz, 2021). One of the government's efforts to implement 21st-century skills is through improving the curriculum. Independent curriculum was conducted for the first time in driving schools, which, of course, is the flagship program of the Ministry of Education, Culture, Research, Technology and Higher Education (Sumarsih et al., 2022). This improvement effort can be observed through improving critical thinking skills and forming effective study habits. Critical thinking skills are related to cognitive activities where they think critically, analytically, and evaluatively in a systematic way to assess, solve a problem, make decisions, and demonstrate their

beliefs with evidence (Puspita et al., 2020; Puspita & Dewi, 2021). The benefits of critical thinking are very good for students because with critical thinking, students can capture information from the teacher easily, make students sensitive to problems, and have their own way of solving problems. Through practice and good learning, students become skilled at problem-solving so that they can make the right decisions, which in turn will make a positive contribution to their education. The driving schools for research activities are SDN Wonosalam, Wonosalam District, and Demak Regency.

It is hoped that the recommendations from the 2022 education report card at SDN Wonosalam can increase the dimension of critical reasoning in strengthening the profile of Pancasila students (Kemdikbud, 2022). Educators can apply learning with a focus on critical thinking skills through constructivist strategies that enhance students' critical thinking using project-based learning. Critical thinking helps students to increase curiosity and maturity (El-shaer & Gaber, 2014). It is proven that critical thinking skills can be improved through the application of STEAM-PjBL (Priantari et al., 2020). For this reason, this activity further encourages the application of models with the help of media, one of which is Life Cycle Diology (LCD) media through the PjBL-STEM model, which is an interactive educational application designed to help students learn the life cycle of living things, including humans, animals, and plants, with a project-based approach (PjBL) and STEM methods. This application presents learning content in the form of interactive modules, visual simulations, and quizzes designed to test student understanding through various interesting features such as visual illustrations, life cycle diagrams, and multimedia that support learning. In addition, this application is equipped with additional teaching materials for teachers so that learning can be done more interactively and in a fun way in the classroom.

The application of the PBL and PjBL models can actualize these two competencies (Afriana et al., 2016). PjBL (Project Based Learning) is a learning model, and STEM is a learning approach. The characteristics of PjBL and PjBL-STEM have similarities and differences in the design process. The design process is a systematic approach to developing solutions to problems with well-defined outcomes (Akgun, 2013)(Capraro et al., 2013). There are five steps in PjBL-STEM learning (Laboy-Rush, 2010) with specific process achievement steps (Laboy-Rush, 2011; Lestari & Rahmawati, 2020; Ng & Adnan, 2018; Sarwi et al., 2021) steps: 1) reflection, investigating to connect what is known and what is learned; 2) research, concretizing abstract understanding and focusing on relevant concepts based on the project; 3) discovery, carrying out a discovery process so that students can present solutions to various problems; 4) application, students learn a broader context by connecting between STEM disciplines; 5) communication, making products by communicating between friends and within the class.

The existence of learning media occupies an important position because it is used to interact in the teaching and learning process. It is hoped that the existence of learning media can help students obtain optimal results (Nurhayati, 2021). Therefore, Life Cycle Diology (LCD) media can be arranged via Smart Apps Creator (SAC). The application of this media cannot be made carelessly; it must be adjusted to the conditions and situation of the class to be effective. LCD with SAC has been proven through several studies to improve students' critical thinking skills.

With its interactive design, it facilitates students in understanding life cycle concepts in greater depth while stimulating analytical thinking and active engagement in the learning process. Of course, Life Cycle Diology (LCD) media with Smart Apps Creator (SAC) in several studies has been able to improve students' critical thinking skills (Hidayah et al., 2023; Widiyono et al., 2023). Apart from that, the results of studies related to PjBL-STEM revealed by (Quang et al., 2015) explained that the application of STEM-PjBL learning is beneficial because students are encouraged to find meaningful learning by finding and elaborating on the concept by doing activities so that students are actively involved in the process. Through PjBL-STEM, students can improve in creative aspects (Fitriyah & Ramadani, 2021; Zahara et al., 2020) (Kristiani et al., 2017), and students can develop increased critical thinking (Rahardhian, 2019; Ridlo, 2020). Through this study, researchers will focus on researching the influence of LCD media through PjBL-STEM on students' critical thinking skills in primary schools.

METHODS

The quantitative approach was used in this research through a true experimental design (one group pretest-posttest design). The research subject was class V, using a saturated sample technique and selecting all respondents to be the sample. The selection of this technique was based on criteria to measure students' critical thinking abilities in applying LCD media through PjBL-STEM. The data collection technique used in the research carried out was an essay test. The essay test is structured according to indicators of critical thinking skills with validity and reliability tests.

Table 1. Instrument and question grid

No.	Learning Objectives	Achievement Indicator	Category	Instrument
1	List the stages of metamorphosis	Students can explain the stages of perfect metamorphosis	C4	Explain in detail the stages of metamorphosis in butterflies and why it is called perfect metamorphosis.
2	Identifying types of metamorphosis	Students can distinguish perfect and imperfect metamorphosis	C4	Give an example of an animal undergoing incomplete metamorphosis and explain how it differs from complete metamorphosis.
3	Explain the function of each stage of metamorphosis	Students can explain the function of each stage in complete metamorphosis	C4	What is the main function of the pupa stage in the metamorphosis process in butterflies?
4	Relate metamorphosis	Students can explain the relationship	C4	Explain how the stages of metamorphosis help

No.	Learning Objectives	Achievement Indicator	Category	Instrument
	to the environment	between metamorphosis and adaptation to the environment.		butterflies adapt to their environment.
5	Summarize observation results	Students can conclude the process of metamorphosis from the observation results.	C5	Observe the changing stages in certain insects. What do you conclude about the benefits of metamorphosis for survival?
6	Analyze the effect of metamorphosis on ecosystems	Students can explain the role of metamorphosis in ecosystem balance	C6	How can metamorphosis in certain insects affect the surrounding ecosystem? Give an example.
7	List the physical changes in incomplete metamorphosis	Students can mention the physical changes in incomplete metamorphosis	C4	List and explain the changes that occur in grasshoppers in each stage of incomplete metamorphosis.
8	Link changes in animals to benefits for the species	Students can relate the changes in the stages of metamorphosis to the benefits for the species.	C6	Why do you think some animals undergo incomplete metamorphosis? Does this have a particular advantage for the species?

The number of questions presented is ten critical thinking questions. The data analysis technique uses prerequisite tests and hypothesis testing through the T-test. Rubric refers to (Facione 1994) about critical thinking skills.

Table 2. Categories of critical thinking skills

Interpretation	Categories
86<x≤ 100	Very high
79<x≤ 85	High
70<x≤ 78	Medium
63<x≤ 69	Low
50<x≤ 62	Very low

LCD media with Smart Apps Creator (SAC) can be accessed via the link https://bit.ly/3u5KyKr with the following display:

Figure 1. LCD Media- Smart Apps Creator (SAC)

RESULTS & DISCUSSION

Result

The data description carried out was to determine the influence of critical thinking skills on LCD media through PjBL-STEM with animal life cycle material. The data analyzed is in the form of an essay test. The description test is used to determine students' critical thinking skills.

Table 3. Validity test results

Question No	1	2	3	4	5	6	7	8	9	10
PC	.76 **	.53 *	62 *	77 **	69 **	53 *	54 *	83 **	72 **	53 *
2-tailed	,001	,048	017	001	006	048	045	000	003	048
N	14	14	14	14	14	14	14	14	14	14

Based on Table 3, it can be seen that for the validity test, the ten questions can be said to be valid because the significance value is less than 0.05.

Table 4. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,852	,856	10

Based on Table 4, it can be seen that for the reliability test, *Cronbach's alpha value* was 0.852, which is said to be reliable because the ten questions were above 0.6.

Table 5. Normality Test

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residuals
N		12
Normal Parameters [a, b]	Mean	.0000000
	Std. Deviation	1.61632195

a. Test distribution is Normal.

Based on the Kolmogorov-Smirnov test results presented in Table 5, it can be seen that the residual data used in this study has a normal distribution. In testing normality with Kolmogorov-Smirnov, it was found that the mean value of the residuals was not significantly different from the expected normal distribution, with a Mean of 0 and a Standard Deviation of 1.616. The significance of this test is less than 0.05, which indicates that the data does not show significant deviation from the normal distribution. These results support the normality assumption required in inferential statistical analysis, so the model used in the study can be considered valid for further testing.

Table 6. Hypothesis Testing

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.885a	784	,762	1,695

a. Predictors: (Constant), LCD

b. Dependent Variable: Critical_Thinking

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regress	104,179	1	104,179	62	,000b
	Residual	28,737	10	2,874		
	Total	132,917	11			

a. Dependent Variable: Critical_Thinking
b. Predictors: (Constant), LCD

Based on Table 6, the results of the hypothesis test can be said to be valid because the significance value is less than 0.05 through ***ANOVA*** [a]; hypothesis testing results show that the R Square value is 0.784. This value indicates that 78.4% of the variability in students' critical thinking skills can be explained by the predictor variable, i.e. the use of LCD media through PjBL-STEM (X1) on critical thinking skills (Y) makes a significant contribution to the improvement of students' critical thinking skills, where 78.4% of the change or variation in students' critical thinking scores can be explained by LCD media through this PjBL-STEM. The remaining 21.6% of the variability was influenced by other factors not included in this media, such as models, media, teaching methods, or learning environment factors. This high R Square value indicates that the use of LCD media through PjBL-STEM has a strong correlation to the improvement of students' critical thinking skills, making it an effective tool in supporting the development of student's critical thinking skills.

Table 7. Results of pretest and posttest scores

Respondent	*Critical thinking skills*												*Total Pretest Results*	*Total Post-Test Results*
	clarification			*assesment*			*inference*			*strategies*				
	Pretest	*Posttest*	*Difference*	*Pretest*	*Posttest*	*Difference*	*Pretest*	*Posttest*	*Difference*	*Pretest*	*Posttest*	*Difference*		
A1	*17*	*19*	*2*	*13*	*17*	*4*	*14*	*16*	*2*	*15*	*20*	*5*	*59*	*72*
A2	*15*	*19*	*4*	*16*	*20*	*4*	*16*	*20*	*4*	*16*	*21*	*5*	*63*	*80*
A3	*17*	*21*	*4*	*17*	*21*	*4*	*19*	*22*	*3*	*20*	*23*	*3*	*73*	*87*
A4	*15*	*20*	*5*	*17*	*20*	*3*	*16*	*21*	*5*	*17*	*22*	*5*	*65*	*83*
A5	*15*	*20*	*5*	*16*	*19*	*3*	*16*	*19*	*3*	*17*	*20*	*3*	*64*	*78*
A6	*19*	*22*	*3*	*18*	*22*	*4*	*19*	*22*	*3*	*20*	*22*	*2*	*76*	*88*
A7	*17*	*22*	*5*	*17*	*21*	*4*	*15*	*19*	*4*	*17*	*19*	*2*	*66*	*81*
A8	*19*	*22*	*3*	*19*	*21*	*2*	*18*	*22*	*4*	*19*	*23*	*4*	*75*	*88*
A9	*18*	*23*	*5*	*19*	*21*	*2*	*18*	*22*	*4*	*19*	*23*	*4*	*74*	*89*
A10	*18*	*22*	*4*	*18*	*20*	*2*	*18*	*22*	*4*	*18*	*20*	*2*	*72*	*84*
A11	*15*	*18*	*3*	*14*	*19*	*5*	*17*	*19*	*2*	*15*	*20*	*5*	*61*	*76*
A12	*18*	*22*	*4*	*18*	*21*	*3*	*18*	*21*	*3*	*18*	*22*	*4*	*72*	*86*
Average	*16,92*	*20,83*	***3,92***	*16,83*	*20,17*	***3,33***	*17,00*	*20,42*	***3,42***	*17,58*	*21,25*	***3,67***	*68,33*	*82,67*
Indikator Percentage	*68%*	***83%***	*16%*	*67%*	***81%***	*13%*	*68%*	***82%***	*14%*	*70%*	***85%***	*15%*		

Based on Table 7, it can be explained that the pretest and posttest scores for each indicator, such as clarification, experienced an increase in the overall student average of 3.92. The assessment indicator increased by 3.33, the inference indicator increased by 3.42, and the strategies indicator increased by 3.67. The average student's pretest results obtained a score of 68.33, while the posttest increased to 82.67. The results of applying LCD media through PjBL-STEM were able to provide an increase in value of 14.33. The distribution of student pretest and posttest score results can be seen in the following picture:

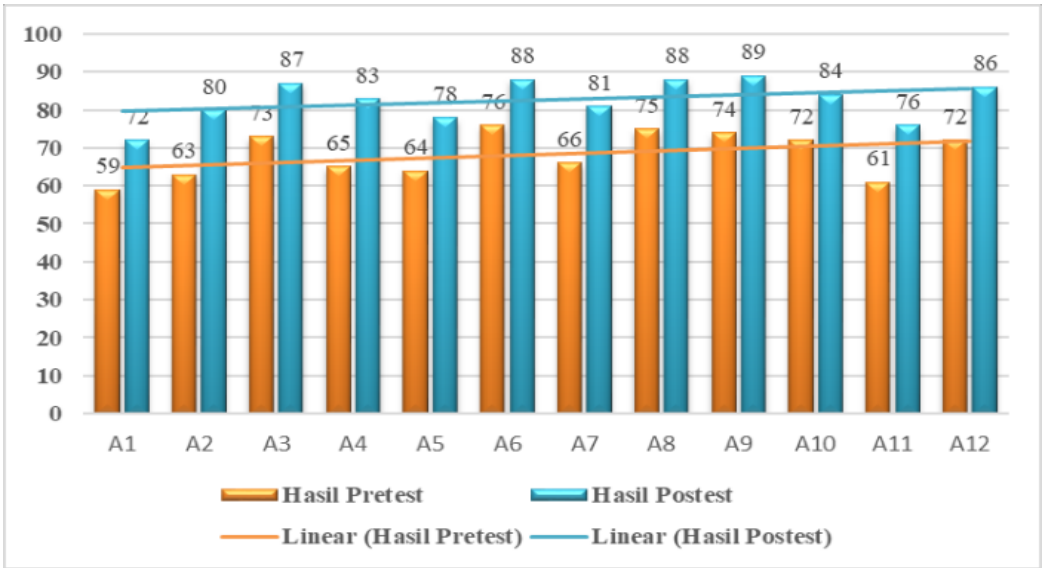

Figure 2. Diagram of increasing pretest and posttest results

Based on Figure 3, it can be seen that there is a significant increase in students' critical thinking skills after applying LCD media through the STEM-based Project-Based Learning (PjBL-STEM) learning model. In the pretest results, the lowest score was achieved by student A1 with a score of 59, while the highest score was achieved by student A6 with a score of 76. This indicates a variation in students' critical thinking skills prior to the intervention. After the implementation of PjBL-STEM, the posttest results showed an increase in critical thinking skills scores. The lowest score on the posttest was obtained by student A1 with a score of 72, which means an increase from the pretest results. The highest score on the posttest was achieved by student A9, with a score of 89, showing that the student experienced a significant increase in critical thinking skills. Analysis of the critical thinking skill items based on the posttest average showed that students achieved high scores in each aspect. The strategy aspect had the highest average, at 85%, followed by clarification at 83%, inference at 82%, and judgment at 81%. All aspects are in the high category according to a rubric that refers to the theory of critical thinking skills, which emphasizes the importance of analysis, evaluation, and decision-making skills in the critical thinking process.

The implementation of LCD media through PjBL-STEM had the highest impact on the strategy item, with an increase of 21.25%, while the assessment item had a lower increase of 20.17%. Overall, this data shows that the implementation of LCD media through PjBL-STEM is able to improve student's critical thinking skills in various aspects, with a significant average increase from the pretest to the posttest. These results indicate that the project-based learning approach supported by the use of LCD media is effective in encouraging students to think critically, understand information, analyze, and develop strategies in problem-solving ((Facione, 1994)

Discussion

The results of the critical thinking aspect of stage 1) clarification have the same characteristics, namely analyzing and discussing the scope of the problem, identifying the assumptions underlying the problem, and identifying the relationships between various problems. Through this indicator, students can write accurately and precisely the information they know and the questions they ask and are given a high category. This condition is by research which explains that students can explain accurately the information they know well (Chusni et al., 2020)(Handayani, 2015)2) Assessment, collecting and evaluating relevant information, providing reasons why the evidence presented is valid or relevant, and establishing value judgments regarding evaluation criteria.

The evaluation results are included in the medium category; students still have difficulty evaluating their learning activities according to the steps. Of course, these results require critical thinking to solve decision-making (Ananda & Salamah, 2021; Dywan & Airlanda, 2020)(Norrizqa, 2021)3) Inference, conclusions according to processed data, generalization according to relevance in determining results, and analysis of relationships regarding various problems. At the reasoning stage, students already have a high level of compliance with the stages of applying LCD media through the PjBL-STEM model in decision-making and have proven to be average in reaching correct conclusions. This condition is explained by research findings that the PjBL-STEM model can improve students' skills, especially critical thinking skills and self-efficacy (Nia et al.; Aan Widiyono, 2023).

This can be seen in student performance data, which increases in each indicator, even though the criteria categories remain the same (Allanta & Puspita, 2021; Kibtiyah, 2022). 4) Strategy, making decisions based on steps in finding solutions, discussing concrete steps in solving problems, and evaluating and estimating results based on steps in solving problems. At the stage of developing problem-solving strategies in implementing the PjBL-STEM model, students have reached a very high level so that the solutions developed in the discussion run smoothly. This activity is, of course, in line with research which shows that the PjBL-STEM model can increase concept mastery (medium) and improve critical thinking skills (high) (Dywan & Airlanda, 2020). These results certainly mean that every media requires integration in its learning implementation in order to improve the quality of learning (Sukmawati et al., 2023; Veri Kurtis & Dedy Irfan, 2024)

CONCLUSION

Based on the results of this study, the use of LCD media in the STEM-based Project-Based Learning (PjBL-STEM) learning model has a significant effect on students' critical thinking skills, with a hypothesis test significance value below 0.05. The increase was reflected in the posttest results, which showed the critical thinking skills indicators for clarification, judgment, inference, and strategy were in the high category. Quantitatively, the student's average score increased from 68.33 in the pretest to 82.67 in the posttest, which means there was an increase of

14.33 points. Referring to Facione's critical thinking framework, these results indicate that LCD media in PjBL-STEM not only stimulates critical thinking skills in general but also supports the development of deeper critical thinking skills in accordance with Facione's six cognitive elements, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation.

The application of PjBL-STEM through LCD media encourages students to understand and clarify information, conduct in-depth analysis, and make evaluations and inferences that underlie appropriate decision-making. The element of self-regulation, for example, is evident from students' increasing skills in assessing and controlling their thinking processes during learning. The implications of this study indicate that the use of LCD media through PjBL-STEM can be used as an effective tool by teachers or other researchers to develop students' critical thinking skills thoroughly.

This model is in line with the needs of the 21st Century, which requires students to master critical and scientific thinking skills comprehensively. The adoption of Facione's critical thinking framework can enrich the existing theoretical foundation and broaden the understanding of the influence of project-based learning strategies in improving students' critical thinking skills.

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