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Unlocking Critical Thinking: The LCI Learning Model for Pre-Service Elementary School Teacher

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ABSTRACT

This study explores the effectiveness of the Learning Cycle-Inquiry (LCI) model in enhancing critical thinking skills among pre-service elementary school teachers in remote areas of Malang, Indonesia. The development of critical thinking skills is fundamental for educational success and effective problem-solving in real-world scenarios. Despite its recognized importance, the cultivation of these skills remains insufficiently addressed in Indonesia's educational practices, especially among pre-service teachers destined for elementary education in remote locales. To address this deficiency, a quasi-experimental research design was implemented, involving 82 pre-service teacher students distributed across four classes. These classes were systematically assigned to either the LCI model, the learning cycle, inquiry-based methods, or conventional teaching strategies. The effectiveness of these methods was measured using ANCOVA and LSD statistical analyses. The findings revealed that the LCI model significantly improved critical thinking skills ($p < 0.001$), outperforming other educational approaches, with a corrected mean value of 84.39. These results underscore the potential of the LCI model to substantially boost critical thinking capabilities and suggest its wider adoption could enhance educational outcomes in similar settings.

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1. INTRODUCTION

The challenge of the twenty-first century is the intensifying international competition between nations to solve ever-more-complex challenges in daily living (Scott, 2015). The main focus of each country is the fulfillment of superior human resources that can increase the country's competitiveness so that it does not lag behind other countries. In this regard, education in Indonesia must facilitate the development of various skills that support life in the 21st century (Ekici et al., 2019; Prasetyo et al., 2020). However, the learning patterns in most universities have not supported learning that empowers the development of 21st-century skills. Several studies' learning patterns in universities have not empowered 21st-century thinking skills, one of which is critical thinking skills.

Critical thinking is a process of thinking at a complex level using an analysis process and an evaluation process of the information obtained (Wilson, 2016; Muhlisin et al., 2016). The essential basic skill to adapt to the demands of 21st-century education. These skills are considered necessary in 21st-century learning because they are higher-order thinking skills that are useful for building knowledge (Kalelioğlu & Gülbahar, 2014). Critical thinking refers to the application of cognitive techniques or methods that raise the likelihood of a desired result. When the thinker uses skills that are deliberate and efficient for the specific context and type of thinking task, it is used to describe thinking that is purposeful, reasoned, and goal-directed. This type of thinking involves problem-solving, formulating inferences, calculating likelihoods, and making decisions.

Recent studies indicate a concerning trend in the development of critical thinking skills among students at various educational levels. For instance, Ramdiah and Corebima (2014) reported that several senior high schools in Banjarmasin have not conducted assessments of critical thinking skills. Additionally, educators in these schools predominantly focus on cognitive outcomes, relying heavily on traditional methods of lectures and discussions. Similarly, a study by Yanti et al. (2019) revealed that critical thinking skills among pre-service teacher students in the Malang district were alarmingly low, with only 38.7% demonstrating proficiency in this area.

Furthermore, Hasan et al. (2013) observed a lack of initiatives to foster higher-order thinking skills, including critical thinking, among teachers in the Ternate archipelago. This deficiency is manifested in students' inability to construct coherent arguments, provide rational assumptions, or accurately assess fact-based problems. The pervasive shortfall in critical thinking capabilities extends from elementary levels through to higher education, as highlighted in research by McVey (2012), Carlgren (2013), and Dewaelsche (2015). Given the global challenges that demand advanced cognitive skills, there is a pressing need to prioritize the development and empowerment of critical thinking within educational frameworks. This paper aims to explore effective strategies to cultivate these essential skills, ensuring that students are better prepared to navigate and address the complexities of the modern world.

8 Based on the description that has been explained, it is known that critical thinking skills are aspects that are still not maximally empowered in learning. These aspects have an essential role in student success. Critical thinking skills in solving problems can prepare students to live their careers and real-life(Ramdani & Badriah, 2018). According to Colley et al. (2012), critical thinking should focus on higher education to provide academic training for students. Students need to have skills that will facilitate success in life in the 21st century. Indonesian students' critical thinking abilities are still relatively low and have not been fully developed by classroom instruction. In order to assist students to become more logical thinkers and to increase reasoning, critical thinking skills are helpful in the classroom. They also inspire students to take action to solve, prevent, or overcome issues in the real world. As a result, critical thinking abilities must be taught in the classroom so that students are prepared to handle situations that are becoming more complicated on a global scale.

Critical thinking skills can be improved through specific learning models. Several research findings indicate that the application of specific learning models can improve critical thinking skills. Hidayah et al. (2019) show that the learning cycle model positively influences students' critical thinking. Empowerment of critical thinking skills in research conducted by Hidayah et al., (2019); Mustofa, (2018); Runisah et al. (2017) reported that the learning cycle model was able to train students' critical thinking skills. In addition to the learning cycle model, inquiry can also improve critical thinking skills. Pursitasari et al. (2020) reported that inquiry could improve students' thinking skills through active involvement in the learning process. The inquiry model can improve students' thinking skills by reflecting on their ideas to explain the studied phenomena (Prayogi et al., 2018).

To address the challenges identified in higher education, there is a need for a learning model that effectively enhances critical thinking skills. Among the models considered are the Learning Cycle (LC) and inquiry-based learning. Inquiry-based learning particularly supports the development of problem-solving and critical thinking by enabling students to pose questions, seek answers, and determine which questions are critical (Maxwell et al., 2015). This method not only boosts student engagement

and performance but also fosters personal growth across physical, emotional, spiritual, and intellectual domains through interactive and thoughtful activities (Kitot et al., 2010).

However, inquiry-based learning has limitations, such as not allowing students sufficient opportunity to elaborate on and evaluate their learning outcomes, potentially hindering their ability to deepen and assess their knowledge (Putra, 2013). Additionally, it may be less effective for students with lower academic abilities, who may lack the necessary experience and knowledge to fully engage with the process (Solihin, 2019). To overcome these challenges, it is suggested that inquiry learning be integrated with the learning cycle model to fill the gaps and provide a more robust educational experience.

The learning cycle model is a teaching model that can be useful for teachers in designing curriculum materials and learning strategies in science (Madu & Amaechi, 2012). Learning cycles can motivate students through several stages of learning, explore subjects, have definitions for learning experiences, get more detailed information about student learning and evaluate them. Learning using a learning cycle is an active cognitive process in which students experience various learning experiences that allow exploring knowledge into a skill. Students are also involved in mental activities indicated by the reorganization and rearrangement of learning materials (Jack, 2017). But the learning cycle also has shortcomings, including the lack of planned and organized class management because the activities carried out by students are less specific, and the learning activities are general. Learning cycle learning also requires the creativity and sincerity of lecturers in designing and implementing the learning process. According to Usmiatin (2014), cooperation between students in groups does not occur. Students with high initial knowledge tend to be indifferent to students with low initial knowledge. Active communication between students in groups does not occur because of learning alone, which occurs in LC 5E learning. It results in a gap in cognitive learning outcomes between students with low and high initial knowledge. A more structured inquiry learning model can complement weaknesses in the learning cycle model.

Based on the studies that have been presented on the two models, it is necessary to combine the two models, namely the Learning Cycle and Inquiry (LCI), so that it is hoped that the model will be more effective in improving critical thinking skills. This study aims to integrate the two learning cycles and inquiry learning models, which are expected to improve critical thinking skills of pre-service elementary school teacher students.

The LCI (Learning Cycle Inquiry) model is structured into eight distinct stages, designed to progressively enhance students' engagement and understanding. Initially, the orienting learning phase helps students connect past and present experiences, focusing their thoughts on achieving learning objectives. This is followed by the exploration stage, where students delve into phenomena, identify issues, and formulate relevant questions. Hypothesis formulation comes next, prompting students to use their observations and ideas to propose potential explanations. The explanation stage involves data collection and idea generation to address the identified problems through various investigative activities. Subsequently, in the analysis and interpretation stage, students evaluate the data to draw conclusions. This leads to the summarization of findings in the sixth stage. The seventh stage expands on these insights, applying them to broader contexts and enhancing their practical relevance. Finally, the evaluation stage allows students to reflect on their learning progress, assess their understanding, and receive feedback. Together, these stages form a comprehensive framework that not only fosters critical thinking but also prepares students to effectively tackle complex problems, setting a solid foundation for the discussions that follow in this paper.

2. METHODS

The research design used in this study is quasi-experimental because the treatment given to the independent variables is intended to determine their effect on the dependent variable. However, the influential external variables cannot be tightly controlled. The research design used is the Pretest-Post test Non equivalent Control Group. To further clarify, it is in the Table. 1.

Table 1. Research Design

Group	Pre-test	Treatment	Post-test
A	A_1	X_1	A_2
B	B_1	X_2	B_2
C	C_1	X_3	C_2
D	D_1	X_4	D_2

Description:

A = experiment group;
B = Control group positive (LC);
C = Control group positive (*Inquiry*);
D = Control Group;
A_1 = *pre-test* scores of experiment class;
A_2 =*post-test* scores of experiment class;
B_1 = *pre-test* scores of treatment class LC;
B_2 = *post-test* scores of treatment class LC;
C_1 = *pre-test* scores of treatment class *inquiry*;
C_2 = *post-test* scores of treatment class *inquiry*;
D_1 = *pre-test* scores of treatment class control;
D_2 = *post-test* scores of treatment class control.

The subjects related to this research are all students at Universitas in the Malang district. While the subjects used in this study were students of the elementary school teacher education study program, in this case, they were divided into four classes, each class numbering between 18-23 students. The total number of students was 82 students. Determination of the sample is done by random sampling technique, which is based on the average test scores, which are almost the same. The research instrument is used to measure the success of the learning carried out and the variables measured in a study. The variables measured in this study were critical thinking skills. The instruments used in this study included observation sheets and test questions.

The data obtained from the study results were tested first with prerequisite tests, namely normality and homogeneity. The normality test used the One-Sample Kolmogorov-Smirnov test. Homogeneity test using Levene's Test of Equality of Error Variances. The data was then tested by statistical inferential analysis of covariance (ANCOVA) at a significance level of 0.05%, with the pretest value as a covariate. If the results of ANCOVA are significant, then proceed with the BNT test.

A normality test is a preliminary test conducted to see if the data to be used comes from a normally distributed population. A population is said to be normally distributed if the significance value is > 0.05. The normality test used the One-Sample Kolmogorov-Smirnov test. The data normality test was carried out on both groups of dependent variable data, namely critical thinking skills, implemented using the LCI model. A summary of the results of the data normality test can be seen in Table 2.

Table 2. Summary of Data Normality Test Results

Dependent Variable		*Kolmogorov-Smirnov*		Score *Alpha*	Desc.
		Statistics	Sig.		
Critical Thinking Skills	Pre-test	0,087	0,188	0,05	Normal
	Post-test	0,062	0,200	0,05	Normal

Based on the test results, it is known that the tested samples are normally distributed. This can be seen from the analysis results, which show that the significant value of all dependent variables is greater than the alpha value used, which is 0.05, and then H0 is accepted. This means that there is no deviation from the data of each independent variable so that the dependent variable data is usually distributed.

The homogeneity test aims to see the sample data group comes from a population with the same variance. The homogeneity test was carried out on the corrected data, including the average critical thinking skills score. Homogeneity test using Levene's Test of Equality of Error Variances. The summary results of the homogeneity test can be seen in Table 3.

Table 3. Summary Results of the Homogeneity Test

Dependent Variable		*Levene Statistic*	df1	df2	Sig.	Description
Critical	Pre-test	0,753	3	78	0,524	Homogeneous
Thinking Skills	Post-test	1,798	3	78	0,154	Homogeneous

The criteria for testing the data homogeneity is that if the significance value is greater than the alpha value of 0.05, then H_0 is accepted. This means that there is no difference in variance between groups of dependent variable data so the variance is declared homogeneous. The results of all dependent variable data were declared homogeneous because they showed that the dependent variable data was more significant than the alpha value of 0.05.

The hypothesis test used to see the effect of the learning model on critical thinking skills was tested by the statistical inferential test of covariance analysis (ANCOVA). If the results of ANCOVA are significant, then proceed with the BNT test.

3. FINDINGS AND DISCUSSION

Based on the results of the ANCOVA calculations that have been carried out regarding the effect of the learning model on each critical thinking skill contained in Table 4, it shows that the F arithmetic model is 15.816 with a sig value of 0.000 so that H1 is accepted and H0 is rejected, it can be concluded that the application of the learning model used affects skills. Critical thinking of every student. The results of the analysis showed a significant effect, so it is necessary to carry out further tests (BNT/LSD) to find out which learning model is the most influential in improving each critical thinking skill. The results of the LSD test of the effect of the learning model on critical thinking skills can be seen in Table 5, which is available.

Table 4. Ancova Test Results from The Effect of Learning Models on Critical Thinking Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1836.556[a]	4	459.139	21.800	.000
Intercept	3405.320	1	3405.320	161.683	.000
Pretest-CT	44.513	1	44.513	2.113	.150
Class	999.350	3	333.117	15.816	.000
Error	1621.754	77	21.062		
Total	500258.100	82			
Corrected Total	3458.310	81			

a. R Squared = .531 (Adjusted R Squared = .507)

Table 5. LSD Test Results of Learning Models with Critical Thinking Skills

Learning Model	Pre-test	Post-test	Difference	Corrected	Notation
Conventional	30,3	74,4	44,2	75,858	a
Learning Cycle	31,2	75,9	44,9	76,774	a
Inquiry	32,0	80,5	46,9	80,922	b
Learning Cycle + Inquiry (LCI)	36,5	86,6	49,4	84,391	c

Based on the LSD test analysis results, it is explained that the four learning models affect students' critical thinking skills. The highest corrected mean value indicates this in the LCI learning model, which is 84.39. The average corrected for the inquiry learning model is 80.92, the average corrected for the learning cycle learning model is 76.77, and the lowest corrected for the conventional learning model is 75.86.

The observed differences in notation highlight that the conventional learning model does not exhibit a significant distinction from the LC (Learning Cycle) 5E model in terms of impacting students' critical thinking skills. Conversely, the LCI (Learning Cycle-Inquiry) and inquiry learning models demonstrate a marked difference. These models are represented in a separate notation that indicates a significantly greater enhancement of critical thinking skills compared to both the conventional and LC 5E models. This variance underscores the superior efficacy of the LCI and inquiry approaches in fostering analytical abilities among students, suggesting that these models engage and challenge students more effectively in developing critical thinking capabilities.

The results of the analysis that was carried out show that the LCI learning model has a very significant influence on the critical thinking ability of each student, with a sig value of 0.000. Based on the LSD/BNT test that has been done it shows that the LCI learning model is significantly different from the other three learning models. The LC and conventional learning models are not significantly different. The inquiry model significantly differs from the LC and conventional models and the LCI models. The LSD test shows that the conventional and LC learning models are significantly different from the other two learning models.

Conventional learning models are often less effective in fostering critical thinking skills because they typically do not facilitate the development of higher-order thinking. According to Khalid and Azeem (2012), these models fall short as they do not provide the real-life experiences that are integral to constructivism-based learning, which actively engages students in constructing their own understanding. Moreover, conventional methods often fail to encourage essential cognitive skills such as analysis, evaluation, argumentation, and self-regulation. In a typical classroom setting using this approach, student participation is uneven: while some may be actively involved during presentation discussions, many others remain disengaged from the activities. Consequently, students generally only grasp the material when required to present it, which limits their overall learning experience and development of deeper cognitive abilities.

The LC learning model is considered to improve each student's critical thinking skills than the conventional learning model, even though the two are not significantly different. The LC learning model consists of phases that allow students to act actively in LC learning, and students are challenged to solve problems related to concepts through group discussions. (Solihin, 2019). In contrast to conventional methods, learning using the LC 5E learning model will involve students actively in building concepts with the help of lecturers. The LC learning model developed based on Piaget's theory of development, such as assimilation, accommodation, and organization following the exploration, explanation, and expansion phases, provide opportunities for students to train their intelligence system so that they can improve their critical thinking skills (Budprom et al., 2010).

The inquiry learning model improves critical thinking skills better than the LC and conventional learning models. In the inquiry model, students actively participate in learning, can make connections between the evidence found and a concept, and can develop information through scientific activities(Ananda et al., 2021). The inquiry learning model positively contributes to improving critical thinking skills (Ramdani & Badriah, 2018). The finding in the application of the inquiry model is that students who are taught with the open inquiry learning model can determine problems, plan investigations, and make decisions based on the results of their investigations. The problem formulation stage in the open inquiry learning model provides opportunities for students to develop their scientific abilities in viewing a topic. This stage is the stage that most determine the success of the learning process using the open inquiry learning model (Solihin, 2019). Lecturers as facilitators have an essential role in this stage so that students can formulate problems based on the topics studied to achieve learning objectives.

Based on the findings, the LCI learning model is more effective in improving critical thinking skills than other learning models. This finding follows the findings of Sen & Oskay (2017), Yacob et al. (2020), Ong et al., (2020), and Ong et al. (2021) in terms of the effect of the LCI learning model even though the context, the variables measured and the students involved are different. The LCI learning model,

increasing students' critical thinking scores, is supported by the steps in the LCI learning model. In general, the steps of the LCI learning model that support the empowerment of critical thinking include formulating problems, analyzing, evaluating, submitting opinions, and reflecting. LCI learning can stimulate higher-order thinking through every stage carried out by students. The empowerment of critical thinking in each stage of the LCI model can be seen in Figure 1.

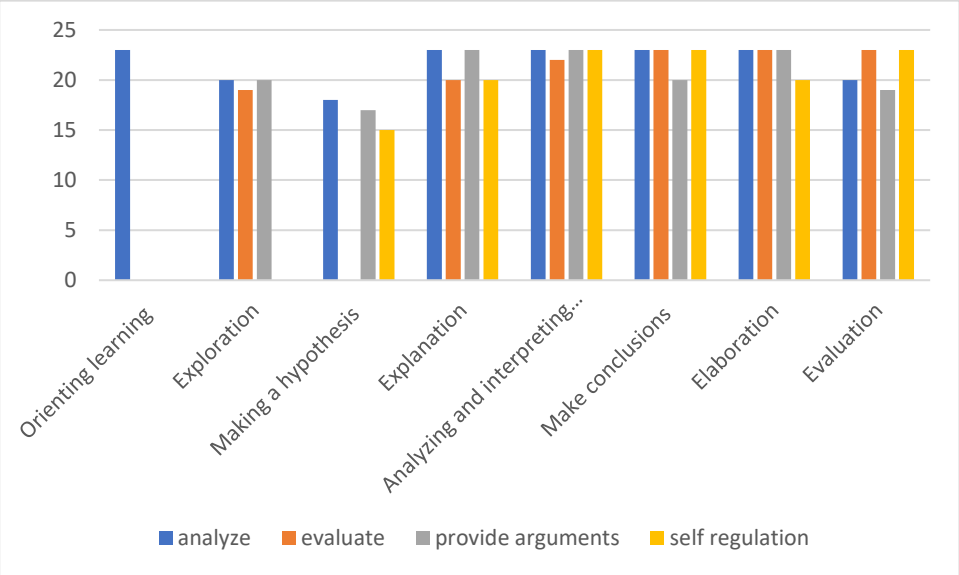

Figure 1. An illustration showing how students performed on critical thinking indicators at each level of the LCI model

At the exploration stage, students are asked to formulate problems and make hypotheses from the phenomena encountered. This activity tests students' abilities to analyze an event and predict the results obtained from their investigations. The exploration stage stimulates students' curiosity to try their ideas on a phenomenon. This follows the way a scientist explores new ideas or phenomena before conducting research (Yacob et al., 2020).

At the explanation stage, the activities carried out by students are conducting investigations or experiments, analyzing and interpreting data, and drawing conclusions. These activities can support students' critical thinking skills because students can design experiments according to their ideas, analyze and translate the results of their findings to find answers to the problems they encounter. Thus, students are actively involved in learning and can build their knowledge based on the investigations carried out. This stage also supports students' higher-order thinking skills because of a well-organized mental process. In the early stages of the LCI model, students are asked to identify unique phenomena and formulate problems encountered and conduct investigations. These stages reflect a person's critical thinking stages. Muhlisin et al. (2016) argue that if students who have critical thinking skills tend to be more sensitive to the problems around them, be able to access every problem around them and be able to identify the elements that cause these problems, make decisions, be able to find solutions to problems, and being able to communicate. The following stages can stimulate students to think critically: analyzing and interpreting the data that has been collected. This affects a person's ability to find solutions by analyzing and interpreting data in scientific inquiry activities (Lin, 2014).

Critical thinking is a process of thinking at a complex level using an analysis process and an evaluation process of the information obtained (Wilson, 2016; Muhlisin *et al.*, 2016). Critical thinking is also the ability to analyze existing facts, make ideas and defend those ideas, and then make comparisons (Howard *et al.*, 2014). Critical thinking skills are the essential basic skills to adapt to the demands of 21st-century education (Kalelioğlu & Gülbahar, 2014). Critical thinking skills are considered necessary in 21st-century learning because they are higher-order thinking skills that are useful for building knowledge (Kalelioğlu & Gülbahar, 2014). Critical thinking requires getting used to high-level abstract

thinking and logical thinking, which are characteristics of a person's intelligence in dealing with problems and identifying alternative solutions to solve problems (Mary & Nel, 2013).

5 Critical thinking skills increase students' awareness of learning, design their learning process well, have high curiosity, be responsible for decisions taken, find solutions to a problem, evaluate learning that has been done, and reflect on their strengths and weaknesses. This is in line with the research conducted by Muhlisin et al. (2016) that understanding ideas, analyzing, interpreting ideas, making conclusions, giving opinions, and self-regulation is activities that can facilitate students to develop critical thinking skills. Research conducted by Mustofa (2018) proves that critical thinking skills are essential for students because they train students to find answers to the problems they face by linking their knowledge with the knowledge they have just received to improve their learning outcomes. This is following the study results that students who are taught using the LCI learning model tend to be more independent in finding and able to build knowledge of a new phenomenon they encounter.

Schafersman (1991) argues that critical thinking must be empowered at every level of education. It is also stated that education as a facilitator can help students develop critical thinking skills through models, strategies, and learning methods oriented toward student learning activities. Referring to Facione's (2013) opinion, the critical thinking ability measured in this study is a mental process that includes analyzing, evaluating, arguing, and self-regulating. Thinking requires analytical and logical reasoning and demonstrates higher-order thinking skills.

4. CONCLUSION

6 The LCI (Learning Cycle-Inquiry) model has demonstrated significant effectiveness in enhancing students' critical thinking skills compared to the inquiry, LC (Learning Cycle), and conventional models. This effectiveness is largely due to the model's ability to help students transform abstract knowledge into tangible concepts, fostering a deeper understanding and sensitivity to their environment. Consequently, the LCI model holds substantial promise for adoption in 21st-century educational settings, where critical thinking is increasingly essential. However, this study is limited by its focus exclusively on different learning models without incorporating the aspects of online learning platforms. Given the growing prevalence of digital education, future research should explore the integration of the LCI model with various web-based applications. This would broaden the understanding of the model's effectiveness across different learning environments and enhance its applicability to a wider range of subjects and educational scenarios. Additionally, examining the model's impact in diverse courses and under different conditions can provide further insights into its versatility and potential modifications to optimize student engagement and learning outcomes.

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