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Analysis of Students' Critical Thinking Improvement in Teaching Inquiry with Cognitive Conflict Strategies

***Ni Nyoman Sri Putu Verawati, Hikmawati**
Physics Education Department, Universitas Mataram, Jl. Majapahit No.62, Mataram 83115, Indonesia

*Corresponding Author e-mail: veyra@unram.ac.id

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Abstract

This study aimed to analyze the improvement of students' critical thinking skills in teaching inquiry with cognitive conflict strategies. Quasi experiments were conducted in this study. The research sample was twenty students as physics teacher candidates at a private university in West Nusa Tenggara - Indonesia. The critical thinking skills test instrument in the form of essay questions is used to measure students' critical thinking skills. The analysis of increasing of critical thinking skills was analyzed descriptively with the n-gain equation, and the difference in critical thinking skills between the pretest and posttest using a pair t-test which was preceded by homogeneity and normality tests. The results of the n-gain analysis showed that the increase in students' critical thinking scores was in the moderate category. Qualitatively, the increase in scores from pretest to posttest in a row is from not critically to enough critically. The results of this study imply that inquiry teaching with cognitive conflict strategies has the potential to be implemented in classroom teaching for the purpose of improving students' critical thinking skills.

Keywords: critical thinking; inquiry; cognitive conflict

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INTRODUCTION

Today's essential skill that students need is critical thinking, and this is the direction of curriculum development found in several countries (Prayogi et al., 2017). Adoption into the learning curriculum was initially implemented in 1983 at the University of California where competence or learning outcomes lead to critical thinking (Ennis, 1991). In Indonesia, it was only in the 2013 Curriculum that included learning objectives, one of which was to direct students to think critically (Kemendikbud, 2013). Along with this, support comes from educators and policy makers that critical thinking should be the focus and foundation of learning achievement in Indonesia, because it is believed to be a capital for future learners to be creative, innovate, and solve problems (Prayogi et al., 2018).

To achieve goals in the context of students' critical thinking, an appropriate learning mode is needed which can provide opportunities for students to manipulate and develop their cognitive skills, in addition to their affective and psychomotor skills (Thompson, 2011). One of the recommended learning modes is inquiry. This is based on previous studies (eg Dewey in Roger et al., 2006) where learning modes that involve students in experimenting and exploring (this happens in inquiry teaching) can train students' critical thinking. Inquiry teaching also deserves to be implemented as a foundation in teaching to train critical thinking (Hamlin & Wisneski, 2012; Fine & Desmond, 2015).

Inquiry offers an activity that helps students construct their knowledge to achieve better learning outcomes (Samarapungavan et al., 2008). Arends (2012) termed inquiry as "inquiry-based lesson," the main phases, namely introduction, problem presentation,

formulating/building hypotheses, hypothesis testing (collecting data), compiling explanations and conclusions according to problems, and reflection. A study by Prayogi et al (2018) has developed an inquiry model that is attributable to critical processes, where cognitive conflict strategies are intervened in the introduction and problem presentation phases, which have been able to improve students' critical thinking. In this study we analyze the improvement of students' critical thinking skills in teaching inquiry with cognitive conflict strategies. The critical thinking indicators that assessed in this research consisted of six critical thinking skills indicators by Facione (1991) namely interpretation, analysis, evaluation, inference, explanation, and self-regulation that not assessed by previous research by Prayogi et al (2018).

METHOD

This study is a quasi-experimental with one group pretest-posttest design. The study used one sample group, namely as many as twenty prospective physics teacher students at Undikma Mataram who were given a critical thinking ability test as a pretest, then treatment (inquiry with cognitive conflict strategies) and a final test (posttest).

Group	Pretest	Treatment	Posttest
N	O	X	O

Measurement of critical thinking uses indicators of analysis, inference, evaluation, and decision making (Prayogi et al., 2018). The essay test instrument was used to measure critical thinking. Data analysis of students' critical thinking skills was analyzed based on the critical thinking rubric. The critical thinking rubric in the form of a multilevel scale, which is a statement followed by a scoring scale according to predetermined criteria. The score of critical thinking using a scale of five refers to the Ennis-Weir Critical Thinking Essay Test scoring technique where the highest score is plus three and the lowest is minus one. The number of critical thinking items is eight questions following the critical thinking indicator (one indicator consists of two questions), and then the max-score is plus twenty-four and the min-score is minus eight. Conversion of scores into five-scale qualitative data and categorized, this is adapted from Prayogi et al (2017, 2018) as presented in Table 1.

Table 1. Critical thinking category base on score

Range	Category
$X > 17,6$	Very critically (VC)
$11,2 < X \leq 17,6$	Critically (C)
$4,8 < X \leq 11,2$	Enough critically (EC)
$-1,6 < X \leq 4,8$	Less critically (LC)
$X \leq -1,6$	Not critically (NC)

Increased scores of students' critical thinking were analyzed using the N-Gain equation with three score criteria, namely high (n gain > 0.70), moderate (n gain with a range of 0.30 – 0.70), and low (n gain < 0.30) (Hake, 1999). Inferential statistical analysis was conducted to analyze the data. The test used, namely the pair t-test , and all of data analyzed statistically using the SPSS tool.

RESULTS AND DISCUSSION

The description of students' critical thinking ability test results is presented in Table 2. The measurement results show that the average score of critical thinking in the pretest is -2.2 with not critically criteria ($X \leq -1,6$), and posttest is 9.3 with enough critically criteria ($4,8 < X \leq 11,2$), with an n-gain of 0.43 with moderate criteria. The students' critical thinking ability was in the uncritical category in all aspects (indicators) during the pretest. The implementation of the inquiry model-based cognitive conflict strategy in the learning process

has an impact on increasing critical thinking skills in every aspect. The improvement of students' critical thinking skills as measured by n-gain shows the highest improvement in the indicators of making decisions followed by inference, evaluation and finally analysis.

Table 2. CT test result

Interval	Criteria	Pre test		Post test		N-gain	Criteria
		Freq.	Mean	Freq.	Mean		
X > 17,6	VC	0	-2,2	0	9,3	0,43	Moderate
11,2 < X ≤ 17,6	C	0	(NC)	2	(EC)		
4,8 < X ≤ 11,2	EC	0		16			
-1,6 < X ≤ 4,8	LC	7		2			
X ≤ -1,6	NC	13		0			
N		20		20			

The results of the homogeneity and normality tests are presented in Table 3, while the results of the t-test are presented in Table 4.

Table 3. The result of homogeneity test and normality test

Variant	N	Homogeneity		normality	
		Levene's test score	Sig.	Kolmogorov-Smirnov's test score	Sig.
Pretest-posttest	20	0,842	0,335	0,129	0,200

The results of the homogeneity and normality test shows that the data variance was homogeneous and normally distributed with a significance value of both greater than 0.05.

Table 4. The result of t-test

		Group	t-test for Equality of Means			
			t	df	Sig.	Mean diff.
Pretest-Postest	Equal var. assum.	Undikma.	-10,773	39	0,000	-11,227

The results of testing students' critical thinking skills using the t-test showed that the significance value of the test (0.000) was smaller than the alpha test (0.05), thus H0 was rejected and H1 was accepted, meaning that there was an increase in students' critical thinking skills between the initial scores with the final score after the implementation of the cognitive conflict strategy. The elaboration of the results of the study shows that the application of cognitive conflict strategies has an impact on increasing the critical thinking skills of prospective teacher students.

The results of the study that show the effect of teaching inquiry with cognitive conflict strategies on critical thinking are inseparable from the intervention of three learning phases, namely establising sets, presenting conflict by providing contradictory information related to daily life, and finally presenting an advance organizer. Student learning activities in this context, where students show attention to the establising set by the lecturer and the delivery of learning objectives, students then show attention and give responses related to the conflicts presented, and in the advance organizer process students show attention and responses.

Preparing students for learning is very important, this is in accordance with what Arends (2012) stated, where a good teacher begins his lesson by explaining the goal, establishing the learning set, and getting the attention of the learner. The positive impact on students is the growth of learning motivation and students' confidence in the material they will learn (Pintrich, 1999; Pintrich et al., 1993). On the one hand, when the teacher presents contradictory information related to everyday life, it can invite students' interest in learning (Ambrose & Lovett, 2014; Chinn & Malhotra, 2002; Chinn & Brewer, 1998). It also helps students reflect and express their ideas in learning (Limon & Carretero, 1997). This is a strong factor in supporting students' critical thinking (Prayogi et al., 2018).

After presenting contradictory information in the teaching of inquiry, then an advance organizer is carried out. This is a bridging between further learning and what has been done. In this context, the inquiry process starts based on the advance organizer. Theoretical studies stated that advance organizers are a way to stimulate students' cognitive thinking and found its benefits for meaningful learning (Dolezal et al., 2003), and support the acquisition of students' critical thinking (Kwaku et al., 2014; Prayogi et al., 2018).

CONCLUSION

The results showed that teaching inquiry with cognitive conflict strategies had an impact on increasing students' critical thinking. The results of the n-gain analysis showed that the increase in students' critical thinking scores was in the moderate category. Qualitatively, the increase in scores from pretest to posttest in a row is from not critically to enough critically.

RECOMMENDATION

The results of this study imply that inquiry teaching with cognitive conflict strategies has the potential to be implemented in classroom teaching for the purpose of improving students' critical thinking skills.

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