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Feedback received express appreciation for the scientific work in question and ask for some changes or additions as detailed below:

REFEREE A
• X ACCEPTED WITH THE INDICATED CHANGES MADE
The manuscript is interesting and deal with an important topic such as the critical thinking in preservice teachers.
I have some points that needs to be clarified:
- It is not very clear the meaning of the sentence at p. 3: "Learning that prepares the situation for learners to conduct their experiments is called Jean Piaget as inquiry learning". Please clarify the meaning.

- What do authors mean by "This study used weak experimental…" (p. 5)?

- Authors affirms that "They were given a test of critical thinking ability as the pretest before the treatment" (p.5). What kind of treatments was given?

- <u>A revision of the English is needed</u>

REFEREE B
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The paper addresses a relevant topic for the Journal, but major revisions are needed. The strength of the paper is that it covers an important and current topic that pertains the training for future teachers and that has several implication for the whole educational system.
Nevertheless, the paper needs major revisions for being accepted.
1. The Authors claim that the study is an experimental research, but according to Shadish, Cook, & Campbell (2002) the study has a quasi-experimental design. Please, modify and provide more information about the design of the research.
2. In the Introduction, it would be useful if the Authors can better explain the Critical-Inquiry-Based-Learning model that they propose.
3. In the Method section please provide more information about the treatment. In the paper there is no information about its duration, its objectives and the activities carry out. Moreover information about the participants is needed (age, sex, etc) and about the process of recruitment in the research.
4. In the Method section information about the test administration is needed. Furthermore, did the test have been administered in English? If no, plese provide information about the translation procedures and possible concerns about the translation process.

5. In the Method section the Authors refers to the Ennis-Weir Critical Thinking Essay Test saying that they use 5 scales. Please clarify. Do the Authors use the original version of the test? Have they used an adaptation? If it was the case, please justify and provide some references, also about the scoring attribution.

6. I don't see much sense in converting the score range into qualitative data. Why the Authors decided to do that?

7. The Ennis-Weir test deals with parking problems. Have the Authors taken into account this point in their analysis?

8. The statement "The results of this study were inseparable from cognitive conflict strategy interventions in 3 learning sequences, namely establishing sets and conveying learning objectives, presenting or demonstrating contradictory information (anomalous data) to generate motivation in learning, and finally present an advance organizer as a follow-up of the anomalous data presented" is unclear, can you please clarify? I think that this clarification could help the readers in the comprehension of the following part of the discussion.Thank you.

9. Several limitation are related to the use of a quasi-experimental design. It would be useful to add a Limitation section that clarifies, among other things, the disadvantages and concerns about its use.

10. It would be interesting for the readers that the section of the practical implication is more discussed. For example, what kind of practical actions can teachers do in classroom? How this kind of ability can be substained in both teachers and students over time?

11. Finally, a linguistic revision for fixing minor typos is needed.

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to allow the preparation of number 21 of the "Journal of Educational, Cultural and Psychological Studies" (Journal ECPS).
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Thanking you for your cooperation, best regards,

The ECPS Editorial Board

Rome, March 13rd, 2020.

CORRECTION

Draft	Correction
The Effect of Conflict Cognitive Strategy in Inquiry-based Learning on Preservice Teachers' Critical Thinking Ability Saiful Prayogi[1] - Ni Nyoman Sri Putu Verawati[2] [1] Universitas Pendidikan Mandalika (UNDIKMA) - Department of ....???........ (Indonesia) [2] Universitas Mataram (UNRAM) - Department of ....???...................................... (Indonesia)	[1]Universitas Pendidikan Mandalika (UNDIKMA) – Department of *Physics Education* (Indonesia) [2]Universitas Mataram (UNRAM) – Department of *Physics Education* (Indonesia)
plex in the 21st century. Critical thinking is one of the learners' essential skills in the 21st century learning that must be acquired (Verawati, Hikmawati, & Prayogi, 2019; Verawati *et al.*, 2019; Wahyudi *et al.*, 2019?). *inserire lettera (a, b, c?)* It has long been a trend and the main focus of learning and even the curriculum authorities in several developed countries putting critical thinking skills in their curriculum as learning goals (Wahyudi *et al.*, 2019?). For an instance, the University of California has declared «Executive Order 338», in which all students learn critical thinking according to the level of ECPS Journal – 21/2020 https://www.ledonline.it/ECPS-Journal/ 20	**(P. 20)** Critical thinking is one of the learners' essential skills in the 21st century learning that must be acquired (Verawati, Hikmawati & Prayogi, 2019; Verawati et al., 2019; Wahyudi *et al.*, 2019a). It has long been a trend and the main focus of learning and even the curriculum authorities in several developed countries putting critical thinking skills in their curriculum as learning goals (Wahyudi *et al.*, 2019b).
ers require a holistic approach and must involve a set of appropriate and goal-oriented learning that allows them to manipulate their cognitive skills (Thompson, 2011; Wahyudi *et al.*, 2018). Some previous studies recommended several models and approaches to learning that could develop students' critical thinking skills. Dewey (in Rodger *et al.*, 2006) implies a teaching approach emphasizing on experience requires reflective thinking to be able to develop learners' critical thinking ability. In contemporary terms, doing hands-on is not sufficient, Dewey assumes that minds-on experiences and activities are needed. Various instructional approaches *2019? a, b, c?* ECPS Journal – 21/2020 https://www.ledonline.it/ECPS-Journal/ 21 VISTO SI STAMPI PREVIO INSERIMENTO	**(P. 21)** require a holistic approach and must involve a set of appropriate and goal-oriented learning that allows them to manipulate their cognitive skills (Thompson, 2011; Wahyudi *et al.*, 2018).

Data analysis of preservice teachers' critical thinking ability was analyzed following critical thinking rubrics. The critical thinking rubric used in this study is in the form of a multilevel scale, which is a statement followed by a scale in line with predetermined criteria. The critical thinking ability score using 5 scale adapted from the Ennis-Weir Critical Thinking Essay Test scoring technique where the lowest score is -1 and the highest score is +3. Adaptation of this scoring technique was also carried out extensively by previous researcher (Wahyudi *et al.*, 2019?). The item test number of questions is 8 questions following the indicator of critical thinking (each indicator consists of 2 items) so that the maximum score is +24 and the minimum score is -8. The conversion of scores becomes qualitative data of 5 scale, it's provided in *Table 1*. The range of scores is converted into qualitative data (quantified) with the aim of categorizing preservice teachers into the categories of very critically, critically, quite critically, less critically, or not critically.	**(P. 24)** Adaptation of this scoring technique was also carried out extensively by previous researcher (Wahyudi *et al.*, 2019a).
Wahyudi, Verawati, N. N. S. P., Ayub, S., & Prayogi, S. (2019a). The effect of scientific creativity in inquiry learning to promote critical thinking ability of prospective teacher. *International Journal of Emerging Technologies in Learning, 14*(14), 122-131.	Wahyudi, Verawati, N. N. S. P., Ayub, S. & Prayogi, S. (2019a). The effect of scientific creativity in inquiry learning to promote critical thinking ability of prospective teacher. *International Journal of Emerging Technologies in Learning, 14*(14), 122-131.
Wahyudi, Verawati, N. N. S. P., Ayub, S., & Prayogi, S. (2019b). Development of inquiry creative process learning model to promote critical thinking ability of physics prospective teachers. *Journal of Physics: Conference Series, 1108,* 1-6. doi: 10.1088/1742-6596/1108/1/012005	Wahyudi, Verawati, N. N. S. P., Ayub, S. & Prayogi, S. (2018). Development of inquiry-creative-process learning model to promote critical thinking ability of physics prospective teachers. *Journal of Physics: Conference Series 1108,* 1-6. doi: 10.1088/1742-6596/1108/1/012005
Wahyudi, Verawati, N. N. S. P., Ayub, S., & Prayogi, S. (2019c). Effectiveness of inquiry creative process learning model to promote critical thinking ability of prospective physics teachers. *Journal of Physics: Conference Series, 1417,* 1-6.	Wahyudi, Verawati, N.N.S.P., Ayub, S. & Prayogi, S. (2019b). Effectiveness of Inquiry-Creative-Process Learning Model to Promote Critical Thinking Ability of Prospective Physics Teachers. *Journal of Physics: Conference Series 1417,* 1-6. doi: 10.1088/1742-6596/1417/1/012071

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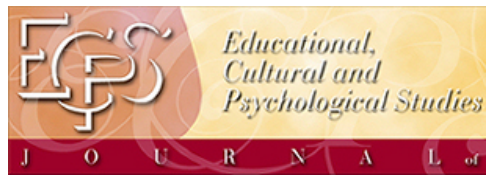To ensure the rapid release of the ECPS Journal by June 2020, a

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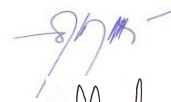
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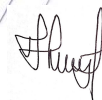 *Corresponding author*

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The Effect of Conflict Cognitive Strategy in Inquiry-based Learning on Preservice Teachers' Critical Thinking Ability

Saiful Prayogi [1] - Ni Nyoman Sri Putu Verawati [2]

[1] *Universitas Pendidikan Mandalika (UNDIKMA) - Department of ....???........ (Indonesia)*

[2] *Universitas Mataram (UNRAM) - Department of ....???.................................... (Indonesia)*

saifulprayogi@ikipmataram.ac.id
veyra@unram.ac.id

L'EFFETTO DELLA STRATEGIA COGNITIVA DEL CONFLITTO
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Abstract

The current trend of learning goals for universities that they are able to produce preservice teachers who think critically and the teaching process focusing on the empirical inquiry activities is recommended as a foundation for practicing critical thinking. Generating preservice teachers' prior knowledge in inquiry activities is needed using conflict cognitive strategies. Based on theoretical studies, the conflict cognitive strategy can treat learners to think critically. This study was aimed at describing the effects of the conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability. This study was quasi-experimental research with one group pretest-posttest design. The sample of this study consisted of 18 preservice teachers of the physics study program at State Islamic University of Mataram. The preservice-teachers' critical thinking ability were assessed using a critical thinking ability test instrument in the form of essay test. The data of critical thinking ability were analyzed descriptively and statistically, where homogeneity test, normality test, and t-test were applied. The results showed that

the conflict cognitive strategy in inquiry-based learning model had a significant effect on preservice teachers' critical thinking ability. The finding and discussion are further described in this article.

Keyword: Conflict cognitive strategy; Critical thinking ability; Inquiry-based learning model; Teacher preservice; Teaching based on empirical inquiry.

————

Introduction

Indonesia as a developing country until now still has problems in education. Indonesian students are generally still weak in the ability of critical thinking to solve the problems. Furthermore, they are also still difficult to think in processing information and only excel at questions or problems that have been encountered. Based on evaluated from the achievement of the Program for International Student Assessment (PISA) scores between the year of 2002-2015, Indonesian students PISA score is under 500 poin, and of the 69 countries that participated in PISA, Indonesia ranking is still around 63-64. Whereas, the Indonesian government through the Ministry of Education has established a K-13 (Curriculum-2013) program, one of the goals is to facilitated learners to think critically. The teachers as a determinant factor is often blamed by this situation because the teacher should be able to practice thinking skills for learners in school. Teacher training programs are encouraged to teach learners critical thinking, including the main focus of education in Indonesia is to train preservice teacher to be able to think critically. Future goals, when later they become a real teacher, they are able to train their learners to think critically. It is in line with Prayogi, Yuanita and Wasis (2017) who argue that critical thinking should properly be the focus of learning development in Indonesia, because it is believed that it has the potential to make learner possess life skills, creations, and innovations so as to solve various life problems which are increasingly complex in the 21st century. Critical thinking is one of the learners' essential skills in the 21st century learning that must be acquired (Verawati, Hikmawati, & Prayogi, 2019; Verawati *et al.*, 2019; Wahyudi *et al.*, 2019?). It has long been a trend and the main focus of learning and even the curriculum authorities in several developed countries putting critical thinking skills in their curriculum as learning goals (Wahyudi *et al.*, 2019?). For an instance, the University of California has declared «Executive Order 338», in which all students learn critical thinking according to the level of

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learning and become one of the basic competencies in learning. A list of the curriculum from curriculum-making authorities focusing on critical thinking skills in science learning in several countries includes Senior Biology Curriculum from Cape of Good Hope in South Africa, Queensland Board of Secondary School Studies in Australia, and the National Science Teachers Association in the United States (Bailin, 2002).

Learning is the process of forming and improving learners' ability to think. Experts have long explored the tendencies of individual thinking and related them to the learning outcomes obtained. Gallagher (1965) states students in solving problems in two ways of thinking, namely convergent and divergent. Convergent thinking refers to critical thinking patterns, while divergence is associated with creative thinking (Webb *et al.*, 2017). According to Facione (2011), critical thinking is a detailed description of some characteristics which include the process of interpretation, analysis, evaluation, inference, explanation, and self-regulation. One of the well-known contributors to the tradition of critical thinking is Robert Ennis. Ennis (1991) states that critical thinking as a reasonable and reflective thought that focuses on deciding what to believe or do. Lai (2011) has reviewed several works of literature and expert opinions towards critical thinking. In this rate, Lai concludes that critical thinking can be seen in three main approaches in its definition, namely philosophical approach, cognitive psychological approach, and educational approaches. Critical thinking in a philosophical approach places more emphasis on the quality and characteristics of a critical thinker. According to the cognitive psychology approach, critical thinking emphasizes real action and behavior that can be demonstrated by a critical thinker, so in its definition, there is a list of critical thinking skills (Lewis & Smith, 1993). Finally, as an educational approach, critical thinking is more emphasized as a higher-level thinking process or what is referred to as «higher-order thinking skills.»

Train critical thinking for preservice teachers are important, but until now ideas to practice it still need to be developed (Prayogi *et al.*, 2019). Learning and improving critical thinking ability for preservice teachers require a holistic approach and must involve a set of appropriate and goal-oriented learning that allows them to manipulate their cognitive skills (Thompson, 2011; Wahyudi *et al.*, 2018). Some previous studies recommended several models and approaches to learning that could develop students' critical thinking skills. Dewey (in Rodger *et al.*, 2006) implies a teaching approach emphasizing on experience requires reflective thinking to be able to develop learners' critical thinking ability. In contemporary terms, doing hands-on is not sufficient, Dewey assumes that minds-on experiences and activities are needed. Various instructional approaches

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such as problem-solving, exploration, inquiry, and asking for high-level questions can develop preservice teachers' critical thinking ability (Bower, 2006). Prayogi and Asyari (2013) previously conducted research and found that preservice teachers' critical thinking ability could be developed and improved through experimental activities in the laboratory to solve problems. Learning that conditions learners to explore through scientific experiment is called inquiry learning (Prayogi, Yuanita, & Wasis, 2018). The experts and developers of curriculum have agreed that the scientific inquiry process has several objectives. First, to help learners understand the basic aspects of scientific inquiry. The inquiry process in an experimental framework involves submitting hypotheses, gathering evidence, testing hypotheses, and concluding. Second, it gives learnerss the opportunity to practice and improve their critical thinking skills or abilities. These abilities are important, and cannot be separated from each other in a scientific inquiry process. Learners must be able to evaluate information from various sources and assess its usefulness and it is also applied in scientific inquiry activities.

In the context of learning, critical thinking cannot be separated from the process skills in inquiry activities. Cognitive processes in critical thinking such as «inference,» can be known from how a learner can identify and determine the elements needed to draw reasonable conclusions, formulate conjectures and hypotheses, consider relevant information and reap the consequences based on data, reports, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation (Facione, 1990). If the explanation is examined in the context of science process skills, it turns out «formulating conjectures and hypotheses» is also part of science process skills. This proves that critical thinking cannot be separated from science process skills in inquiry activities, meaning that critical thinking is built on the process that accumulates the process skills in it. Therefore, some previous researchers recommend inquiry activities as the foundation of teaching to promote the needs of the 21st century learning including critical thinking (Hamlin & Wisneski, 2012; Fine & Desmond, 2015). In inquiry activities, preservice teachers actively construct their knowledge so that the desired learning outcome can be achieved (Samarapungavan, Mantzicopoulos, & Patrick, 2008). Arends (2012) popularized inquiry teaching with the term «inquiry-based lesson» with six phases of teaching, namely; (a) prepare to learn and run the inquiry process, (b) present the problem situation, (c) encourage the learners to formulate the hypothesis, (d) collect data to test the hypothesis, (e) formulate explanations and/or conclusions, and (f) reflect the learning process. Prayogi *et al.* (2018) recently developed a learning model to train critical thinking, namely the critical inquiry-based learning model in

which inquiry is the basis of model development and one of the important attributions in its learning activities is the presentation of conflict cognitive strategies in the initial phase of learning. Conflict cognitive is a perceptual state in which preservice teachers see a difference between his cognitive structure and his environment (external information) or amongst different components (for example, conception, beliefs, substructure, etc.) of cognitive structures (Lee & Kwon, 2001).

Cognitive conflict occurs when learners' mental balance is interrupted by experiences that are not in line with their current understanding (Foster, 2011). According to Prayogi *et al.* (2018), conflicts that occur in the cognitive structure of students are the main part of inquiry learning. There is a fact that before the application of inquiry, the learners have a prior knowledge of the concept of the learning material being taught, so that generally in the learning process there will be conflicts between a prior knowledge and their inquiry process called conflict cognitive because of changes of conceptions (Limon, 2001). However, according to Piaget (in Lee *et al.*, 2003), the main concern when conflict cognitive strategies are conditioned in learning is the occurrence of unadapted responses in which participants are not aware of the existence of conflict so that it affects the desired learning outcomes. This is also a challenge when implementing the inquiry model. Therefore, it is necessary to do indeep explore to examine the effects of conflict cognitive strategies in scientific inquiry activities on improving preservice teachers' critical thinking ability. More specifically, the purpose of this study is to explore the effect of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability.

1. Method

This study is an quasi-experimental research with one group pretest-posttest design (Shadish, Cook, & Campbell, 2002).

Group	Pretest	Treatment	Posttest
N	*O*	*X*	*O*

This study used one sample group and 18 preservice teachers are involved at State Islamic University of Mataram. The sample was chosen purposively with the provisions of preservice teachers who take fundamental physics courses. The average sample was 19-20 years old consisting of 8 males and 9 females. The study was conducted during 7 meetings, where the first meeting for the pretest, the second meeting until the sixth meeting was the

learning process (treatment), and the last meeting was for the posttest. The intended treatment is learning by implementing conflict cognitive strategies in inquiry-based learning model. Critical thinking ability indicators in this study refer to the indicators used by Prayogi *et al.* (2018), namely analysis, inference, evaluation, and decisions making. The preservice teachers' critical thinking ability was measured using a critical thinking ability test instrument in the form of essay questions adjusted to indicators of critical thinking. Before being implemented, the test instrument was tested for validity by experts and its reliability was calculated. Sensitivity tests are conducted to determine whether the test items (questions) are able to measure the effects of learning that has been carried out. The sensitivity of the test item is expressed by the sensitivity index (S) referring to the Gronlund theory (Gronlund, 1982). Question items are stated to be sensitive if they are positive in the sensitivity index range from 0 to +1.

Data analysis of preservice teachers' critical thinking ability was analyzed following critical thinking rubrics. The critical thinking rubric used in this study is in the form of a multilevel scale, which is a statement followed by a scale in line with predetermined criteria. The critical thinking ability score using 5 scale adapted from the Ennis-Weir Critical Thinking Essay Test scoring technique where the lowest score is -1 and the highest score is +3. Adaptation of this scoring technique was also carried out extensively by previous researcher (Wahyudi *et al.*, 2019?). The item test number of questions is 8 questions following the indicator of critical thinking (each indicator consists of 2 items) so that the maximum score is +24 and the minimum score is -8. The conversion of scores becomes qualitative data of 5 scale, it's provided in *Table 1*. The range of scores is converted into qualitative data (quantified) with the aim of categorizing preservice teachers into the categories of very critically, critically, quite critically, less critically, or not critically.

Table 1. – Qualitative data conversion of scale 5 with 8 question items.

Score Interval	Range	Category
$X > X_i + 1.8\ Sbi$	$X > 17.6$	Very Critically (VC)
$X_i + 0.6\ Sbi < X \le X_i + 1.8\ Sbi$	$11.2 < X \le 17.6$	Critically (C)
$X_i - 0.6\ Sbi < X \le X_i + 0.6\ Sbi$	$4.8 < X \le 11.2$	Quite Critically (QC)
$X_i - 1.8\ Sbi < X \le X_i - 0.6\ Sbi$	$-1.6 < X \le 4.8$	Less Critically (LC)
$X \le X_i - 1.8\ Sbi$	$X \le -1.6$	Not Critically (NC)

Note: X = Scor empiris KBK; X_i = Mean ideal; *Sbi* = deviation ideal; Maximum score ideal = +24; Minimal score ideal = -8.

Increasing the score of critical thinking ability was analyzed using the N-gain equation according to Hake's theory (Hake, 1999) with the criteria as in *Table 2*.

Table 2. – Criteria of score change (N-gain).

Score Interval	Category
> 0,70	High
0,30 – 0,70	Moderate
< 0,30	Low

Statistical analysis (inferential statistics) was carried out to analyze the test data of preservice teachers' critical thinking ability. The test is the t-test which aims to examine the effects of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability, with the formulation of statistical hypotheses in the t-test, namely H_0: $\mu1 = \mu2$ (there is no improvement of preservice teachers'critical thinking ability between the pretest and posttest score after the treatment, and H_1: $\mu1 \neq \mu2$ (there is an improvement of preservice teachers' critical thinking ability between the pretest and posttest score after treatment). H_0 is rejected if the score of the t-test is less than α (0,05). H_1 is accepted if the score of t-test was higher than α (0,05). The acceptance of H_1 indicates that there is an effect of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability. Before conducting the t-test, the data are stated as a homogeneous and normally distribution. In this study, the homogeneity test uses Lavene's test, while the data normality test uses Kolmogorov-Smirnov's test. The data are analyzed using SPSS 23.0 statistical software tool.

2. Findings and discussion

The critical thinking ability test was given to preservice teachers as the pretest and posttest. Test was given to evaluate the improvement of preservice teachers' critical thinking ability after learning using conflict cognitive strategy based on the inquiry learning model. Test refers to four critical thinking indicators used in this study, namely analysis, inference, evaluation, and decision making, where each indicator consists of 2 items. The results of the validity and reliability test by experts show that the test instrument is qualitatively valid and reliable to be implemented. The results of sensitivity test of the test items are presented in *Table 3*, where all items of

the question are declared sensitive because they are positive with an average sensitivity score of 0.36 which indicates the test items (questions) are able to measure the effects of the learning that has been carried out.

Table 3. – Question item sensitivity.

KBK Indicators	$\overline{X}s$	Criteria
Analysis	0,32	Sensitive
Inference	0,45	Sensitive
Evaluation	0,25	Sensitive
Decision making	0,43	Sensitive
Mean	*0,36*	*Sensitive*

The description of the results of the preservice teachers' critical thinking ability test is presented in *Table 4*. The results of the measurement of preservice teachers' critical thinking ability indicate that the critical thinking average score in the pretest is -1 with criteria of «less critically» (less critically, if: -1,6 < X ≤ 4,8) and posttest was 9,89 with criteria of «quite critically» (quite critically, if: 4,8 < X ≤ 11,2), N-gain of 0,44 with «moderate» criteria. Preservice teachers' critical thinking ability are in the less critically category in all aspects (indicators) in the pretest. The implementation of conflict cognitive strategy in inquiry-based learning model has an effect to improve critical thinking ability in each aspect. Although the final results of preservice teachers' critical thinking ability in State Islamic University of Mataram are quite critically, but there is still an improvement of critical thinking ability in all aspects (indicators). Increasing preservice teachers' critical thinking ability at State Islamic University of Mataram measured by N-gain showed the highest increase in the inference indicator followed by indicators of evaluation, decision making, and analysis.

Table 4. – Preservice teachers' critical thinking ability.

Range	Category	Pretest		Post-test		N-gain	Category
		Freq.	Mean	Freq.	Mean		
X > 17.6	VC	0	-1	0	9.89	0.44	Moderate
11,2 < X ≤ 17.6	C	0	(LC)	6	(QC)		
4.8 < X ≤ 11.2	QC	0		12			
-1.6 < X ≤ 4.8	LC	9		0			
X ≤ -1.6	NC	9		0			
Num.		18		18			

Data of critical thinking ability were also statistically tested using the t-test (independent sample test), provided the data variants were homogeneous and normally distributed. The results of the homogeneity and normality test are provided in *Table 5*, while the results of the t-test are provided in *Table 6*.

Table 5. – The result of homogeneity and normality test.

Varian	N	HOMOGENEITY		NORMALITY	
		Levene's test score	*Sig.*	*Kolmogorov-Smirnov's test score*	*Sig.*
Pretest-posttest	18	0.716	0.403	0.096	0.200

The homogeneity and normality test of the data showed that the data variants are homogeneous and normally distributed with a significance value of 0,403 and 0,200, both of which are greater than alpha (α) testing (> 0,05).

Table 6. – The result of t-test.

	Group	T-TEST FOR EQUALITY OF MEANS			
		t	*df*	*Sig.*	*Mean diff.*
Pretest-Postest (Equal var. assumed)	SIU-Mtr.	-13.484	34	0.000	-11.277

The results of this study dealing with preservice teachers' critical thinking ability using the t-test show that the significance value of the test (0,000) is smaller than alpha testing (< 0,05). It means that H_0 is rejected and H_1 is accepted. It can be concluded that there is an increase of preservice teachers' critical thinking ability between pretest scores with the posttest score after the implementation of the conflict cognitive strategy. The elaboration of the results in this study presented that there is an effect of conflict cognitive strategy in inquiry-based learning towards preservice teachers' critical thinking ability. The results of this study were inseparable from conflict cognitive strategy interventions in inquiry-based learning. A form of conflict cognitive strategy intervention in inquiry learning, namely establishing sets and conveying learning objectives, presenting or demonstrating contradictory information (anomalous data) to generate motivation in learning, and present an advance organizer as a follow-up of the anomalous data presented. The preservice teachers' learning activities include they show attention to establishing sets conducted by lecturers as well as on delivering learning objectives, showing attention and giving responses related to contradictory information (anomalous data) presented by lecturers in learning, and showing attention to advance organizers that are explained by the lecturer as a follow-up of anomalous data.

Preparing preservice teachers to learn and deliver learning objectives at the beginning of classroom learning is increasingly important. According to Arends (2012), good teachers start their lessons by explaining goals, establishing learning sets, and getting learners attention. Teacher behavior at the beginning of learning affects the willingness, motivation, and formation of preservice teachers' beliefs about what they will learn (Pintrich, Marx, & Boyle, 1993; Pintrich, 1999). Besides, presenting contradictory information or anomalous data at the beginning of learning is often important to invite student interest and ensure that initial knowledge emerges (Chinn & Brewer, 1998; Chinn & Malhotra, 2002; Ambrose & Lovett, 2014). Presenting anomalous data helps preservice teachers reflect more on their ideas to provide an explanation of the phenomena being studied (Limon & Carretero, 1997). Providing explanations in accordance with ideas or phenomena being studied is one of the main factors that encourage and train learners to be able to think critically. It is in line with Prayogi *et al.* (2018) states it is important to start the learning process in scientific inquiry activities by presenting anomalous data because it can train to reason (critical thinking) and become the main instrument to motivate preservice teachers' in the learning process. Meanwhile, after presenting anomalous data, the learning process was followed up with an advanced organizer as a bridge to facilitate them with the initial action of learning with the inquiry process itself.

The peculiarity of the advance organizer lies in how contradictory information can be formulated into problems which later become the focus of the investigation activities. Theoretical studies showed that advance organizers are a form of cognitive thinking stimulation in learning that can encourage motivation and also the information conveyed at the beginning of learning is more meaningful (Dolezal *et al.*, 2003). Advance organizer in the form of presenting information that bridges new learning materials and related ideas that exist (Shah, 2004). Advance organizers can be used by preservice teachers to organize and interpret information that they can apply for further learning (Safdar *et al.*, 2014). In addition, advanced organizers encourage the use of critical thinking ability, such as both analyzing abstract concepts and deepening understanding and expanding the relationship amongst ideas.

3. Conclusion and implication

The results of this study showed that there is an effect of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability. Descriptively, preservice teachers' critical thinking ability

increased from less critically to quite critically after the implementation of cognitive conflict strategies. Statistically, testing hypotheses related to the focus of research showed that there was an improvement of preservice teachers' critical thinking ability between the pretest score and the posttes score after the implementation of cognitive conflict strategies.

Concerning to the practical implication, conflict cognitive strategies in inquiry learning are implemented to improve critical thinking skills as higher order thinking abilities. Lecturers can also employ this strategy for the purpose of improving cognitive learning outcomes in general. The use of this strategy is synonymous with efforts to arise student learning motivation in the learning process by presenting problems in a real-world context. Therefore, the lecturer's effort to demonstrate authentic phenomena is needed.

Acknowledgment

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Riassunto

L'attuale tendenza degli obiettivi di apprendimento per le università che sono in grado di formare insegnanti che pensano in modo critico e focalizzano il processo di insegnamento sulle attività di indagine empirica è raccomandato come base per la pratica del pensiero critico. È necessario promuovere le conoscenze degli insegnanti in formazione riguardo alle attività di indagine che utilizzando strategie cognitive di conflitto. Sulla base di studi teorici, la strategia cognitiva del conflitto può portare gli studenti a pensare in modo critico. Questo studio ha avuto lo scopo di descrivere gli effetti della strategia cognitiva del conflitto nell'ambito del modello di apprendimento basato sull'abilità di pensiero critico degli insegnanti. Si è trattato di una ricerca quasi sperimentale con disegno pretest / post-test. Il campione di questo studio ha compresp in 18 insegnanti in formazione del corso di studi di fisica dell'Università statale islamica di Mataram. Le capacità di pensiero critico di questi insegnanti sono state valutate usando uno strumento sulla capacità di pensiero critico sottoforma di saggio. I dati della capacità di pensiero critico sono stati analizzati in modo descrittivo e statistico, sono stati applicati test statistici di omogeneità, di normalità e test t. I risultati hanno mostrato che la strategia cognitiva del conflitto nell'ambito del modello di apprendimento proposto ha avuto un positivo effetto significativo sulla capacità di pensiero critico degli insegnanti. I risultati vengono discussi in questo articolo.

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E CONTRIBUTI DI RICERCA

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STUDIES
AND RESEARCH CONTRIBUTIONS

The Effect of Conflict Cognitive Strategy in Inquiry-based Learning on Preservice Teachers' Critical Thinking Ability

Saiful Prayogi [1] - Ni Nyoman Sri Putu Verawati [2]

[1] *Universitas Pendidikan Mandalika (UNDIKMA) - Department of ....???........ (Indonesia)*

[2] *Universitas Mataram (UNRAM) - Department of ....???.................................... (Indonesia)*

saifulprayogi@ikipmataram.ac.id
veyra@unram.ac.id

L'EFFETTO DELLA STRATEGIA COGNITIVA DEL CONFLITTO SULL'APPRENDIMENTO CENTRATO SULL'ABILITÀ DI PENSIERO CRITICO DEGLI INSEGNANTI IN FORMAZIONE

Abstract

The current trend of learning goals for universities that they are able to produce preservice teachers who think critically and the teaching process focusing on the empirical inquiry activities is recommended as a foundation for practicing critical thinking. Generating preservice teachers' prior knowledge in inquiry activities is needed using conflict cognitive strategies. Based on theoretical studies, the conflict cognitive strategy can treat learners to think critically. This study was aimed at describing the effects of the conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability. This study was quasi-experimental research with one group pretest-posttest design. The sample of this study consisted of 18 preservice teachers of the physics study program at State Islamic University of Mataram. The preservice-teachers' critical thinking ability were assessed using a critical thinking ability test instrument in the form of essay test. The data of critical thinking ability were analyzed descriptively and statistically, where homogeneity test, normality test, and t-test were applied. The results showed that

the conflict cognitive strategy in inquiry-based learning model had a significant effect on preservice teachers' critical thinking ability. The finding and discussion are further described in this article.

Keyword: Conflict cognitive strategy; Critical thinking ability; Inquiry-based learning model; Teacher preservice; Teaching based on empirical inquiry.

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Introduction

Indonesia as a developing country until now still has problems in education. Indonesian students are generally still weak in the ability of critical thinking to solve the problems. Furthermore, they are also still difficult to think in processing information and only excel at questions or problems that have been encountered. Based on evaluated from the achievement of the Program for International Student Assessment (PISA) scores between the year of 2002-2015, Indonesian students PISA score is under 500 poin, and of the 69 countries that participated in PISA, Indonesia ranking is still around 63-64. Whereas, the Indonesian government through the Ministry of Education has established a K-13 (Curriculum-2013) program, one of the goals is to facilitated learners to think critically. The teachers as a determinant factor is often blamed by this situation because the teacher should be able to practice thinking skills for learners in school. Teacher training programs are encouraged to teach learners critical thinking, including the main focus of education in Indonesia is to train preservice teacher to be able to think critically. Future goals, when later they become a real teacher, they are able to train their learners to think critically. It is in line with Prayogi, Yuanita and Wasis (2017) who argue that critical thinking should properly be the focus of learning development in Indonesia, because it is believed that it has the potential to make learner possess life skills, creations, and innovations so as to solve various life problems which are increasingly complex in the 21st century. Critical thinking is one of the learners' essential skills in the 21st century learning that must be acquired (Verawati, Hikmawati, & Prayogi, 2019; Verawati *et al.*, 2019; Wahyudi *et al.*, 2019?). It has long been a trend and the main focus of learning and even the curriculum authorities in several developed countries putting critical thinking skills in their curriculum as learning goals (Wahyudi *et al.*, 2019?). For an instance, the University of California has declared «Executive Order 338», in which all students learn critical thinking according to the level of

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learning and become one of the basic competencies in learning. A list of the curriculum from curriculum-making authorities focusing on critical thinking skills in science learning in several countries includes Senior Biology Curriculum from Cape of Good Hope in South Africa, Queensland Board of Secondary School Studies in Australia, and the National Science Teachers Association in the United States (Bailin, 2002).

Learning is the process of forming and improving learners' ability to think. Experts have long explored the tendencies of individual thinking and related them to the learning outcomes obtained. Gallagher (1965) states students in solving problems in two ways of thinking, namely convergent and divergent. Convergent thinking refers to critical thinking patterns, while divergence is associated with creative thinking (Webb *et al.*, 2017). According to Facione (2011), critical thinking is a detailed description of some characteristics which include the process of interpretation, analysis, evaluation, inference, explanation, and self-regulation. One of the well-known contributors to the tradition of critical thinking is Robert Ennis. Ennis (1991) states that critical thinking as a reasonable and reflective thought that focuses on deciding what to believe or do. Lai (2011) has reviewed several works of literature and expert opinions towards critical thinking. In this rate, Lai concludes that critical thinking can be seen in three main approaches in its definition, namely philosophical approach, cognitive psychological approach, and educational approaches. Critical thinking in a philosophical approach places more emphasis on the quality and characteristics of a critical thinker. According to the cognitive psychology approach, critical thinking emphasizes real action and behavior that can be demonstrated by a critical thinker, so in its definition, there is a list of critical thinking skills (Lewis & Smith, 1993). Finally, as an educational approach, critical thinking is more emphasized as a higher-level thinking process or what is referred to as «higher-order thinking skills.»

Train critical thinking for preservice teachers are important, but until now ideas to practice it still need to be developed (Prayogi *et al.*, 2019). Learning and improving critical thinking ability for preservice teachers require a holistic approach and must involve a set of appropriate and goal-oriented learning that allows them to manipulate their cognitive skills (Thompson, 2011; Wahyudi *et al.*, 2018). Some previous studies recommended several models and approaches to learning that could develop students' critical thinking skills. Dewey (in Rodger *et al.*, 2006) implies a teaching approach emphasizing on experience requires reflective thinking to be able to develop learners' critical thinking ability. In contemporary terms, doing hands-on is not sufficient, Dewey assumes that minds-on experiences and activities are needed. Various instructional approaches

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such as problem-solving, exploration, inquiry, and asking for high-level questions can develop preservice teachers' critical thinking ability (Bower, 2006). Prayogi and Asyari (2013) previously conducted research and found that preservice teachers' critical thinking ability could be developed and improved through experimental activities in the laboratory to solve problems. Learning that conditions learners to explore through scientific experiment is called inquiry learning (Prayogi, Yuanita, & Wasis, 2018). The experts and developers of curriculum have agreed that the scientific inquiry process has several objectives. First, to help learners understand the basic aspects of scientific inquiry. The inquiry process in an experimental framework involves submitting hypotheses, gathering evidence, testing hypotheses, and concluding. Second, it gives learnerss the opportunity to practice and improve their critical thinking skills or abilities. These abilities are important, and cannot be separated from each other in a scientific inquiry process. Learners must be able to evaluate information from various sources and assess its usefulness and it is also applied in scientific inquiry activities.

In the context of learning, critical thinking cannot be separated from the process skills in inquiry activities. Cognitive processes in critical thinking such as «inference,» can be known from how a learner can identify and determine the elements needed to draw reasonable conclusions, formulate conjectures and hypotheses, consider relevant information and reap the consequences based on data, reports, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation (Facione, 1990). If the explanation is examined in the context of science process skills, it turns out «formulating conjectures and hypotheses» is also part of science process skills. This proves that critical thinking cannot be separated from science process skills in inquiry activities, meaning that critical thinking is built on the process that accumulates the process skills in it. Therefore, some previous researchers recommend inquiry activities as the foundation of teaching to promote the needs of the 21st century learning including critical thinking (Hamlin & Wisneski, 2012; Fine & Desmond, 2015). In inquiry activities, preservice teachers actively construct their knowledge so that the desired learning outcome can be achieved (Samarapungavan, Mantzicopoulos, & Patrick, 2008). Arends (2012) popularized inquiry teaching with the term «inquiry-based lesson» with six phases of teaching, namely; (a) prepare to learn and run the inquiry process, (b) present the problem situation, (c) encourage the learners to formulate the hypothesis, (d) collect data to test the hypothesis, (e) formulate explanations and/or conclusions, and (f) reflect the learning process. Prayogi *et al.* (2018) recently developed a learning model to train critical thinking, namely the critical inquiry-based learning model in

which inquiry is the basis of model development and one of the important attributions in its learning activities is the presentation of conflict cognitive strategies in the initial phase of learning. Conflict cognitive is a perceptual state in which preservice teachers see a difference between his cognitive structure and his environment (external information) or amongst different components (for example, conception, beliefs, substructure, etc.) of cognitive structures (Lee & Kwon, 2001).

Cognitive conflict occurs when learners' mental balance is interrupted by experiences that are not in line with their current understanding (Foster, 2011). According to Prayogi *et al.* (2018), conflicts that occur in the cognitive structure of students are the main part of inquiry learning. There is a fact that before the application of inquiry, the learners have a prior knowledge of the concept of the learning material being taught, so that generally in the learning process there will be conflicts between a prior knowledge and their inquiry process called conflict cognitive because of changes of conceptions (Limon, 2001). However, according to Piaget (in Lee *et al.*, 2003), the main concern when conflict cognitive strategies are conditioned in learning is the occurrence of unadapted responses in which participants are not aware of the existence of conflict so that it affects the desired learning outcomes. This is also a challenge when implementing the inquiry model. Therefore, it is necessary to do indeep explore to examine the effects of conflict cognitive strategies in scientific inquiry activities on improving preservice teachers' critical thinking ability. More specifically, the purpose of this study is to explore the effect of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability.

1. Method

This study is an quasi-experimental research with one group pretest-posttest design (Shadish, Cook, & Campbell, 2002).

Group	Pretest	Treatment	Posttest
N	O	X	O

This study used one sample group and 18 preservice teachers are involved at State Islamic University of Mataram. The sample was chosen purposively with the provisions of preservice teachers who take fundamental physics courses. The average sample was 19-20 years old consisting of 8 males and 9 females. The study was conducted during 7 meetings, where the first meeting for the pretest, the second meeting until the sixth meeting was the

learning process (treatment), and the last meeting was for the posttest. The intended treatment is learning by implementing conflict cognitive strategies in inquiry-based learning model. Critical thinking ability indicators in this study refer to the indicators used by Prayogi *et al.* (2018), namely analysis, inference, evaluation, and decisions making. The preservice teachers' critical thinking ability was measured using a critical thinking ability test instrument in the form of essay questions adjusted to indicators of critical thinking. Before being implemented, the test instrument was tested for validity by experts and its reliability was calculated. Sensitivity tests are conducted to determine whether the test items (questions) are able to measure the effects of learning that has been carried out. The sensitivity of the test item is expressed by the sensitivity index (S) referring to the Gronlund theory (Gronlund, 1982). Question items are stated to be sensitive if they are positive in the sensitivity index range from 0 to +1.

Data analysis of preservice teachers' critical thinking ability was analyzed following critical thinking rubrics. The critical thinking rubric used in this study is in the form of a multilevel scale, which is a statement followed by a scale in line with predetermined criteria. The critical thinking ability score using 5 scale adapted from the Ennis-Weir Critical Thinking Essay Test scoring technique where the lowest score is -1 and the highest score is +3. Adaptation of this scoring technique was also carried out extensively by previous researcher (Wahyudi *et al.*, 2019?). The item test number of questions is 8 questions following the indicator of critical thinking (each indicator consists of 2 items) so that the maximum score is +24 and the minimum score is -8. The conversion of scores becomes qualitative data of 5 scale, it's provided in *Table 1*. The range of scores is converted into qualitative data (quantified) with the aim of categorizing preservice teachers into the categories of very critically, critically, quite critically, less critically, or not critically.

Table 1. – *Qualitative data conversion of scale 5 with 8 question items.*

Score Interval	Range	Category
X > X$_i$ + 1.8 *Sbi*	X > 17.6	Very Critically (VC)
X$_i$ + 0.6 *Sbi* < X ≤ X$_i$ + 1.8 *Sbi*	11.2 < X ≤ 17.6	Critically (C)
X$_i$ – 0.6 *Sbi* < X ≤ X$_i$ + 0.6 *Sbi*	4.8 < X ≤ 11.2	Quite Critically (QC)
X$_i$ – 1.8 *Sbi* < X ≤ X$_i$ – 0.6 *Sbi*	-1.6 < X ≤ 4.8	Less Critically (LC)
X ≤ X$_i$ – 1.8 *Sbi*	X ≤ -1.6	Not Critically (NC)

Note: X = Scor empiris KBK; X$_i$ = Mean ideal; *Sbi* = deviation ideal; Maximum score ideal = +24; Minimal score ideal = -8.

Increasing the score of critical thinking ability was analyzed using the N-gain equation according to Hake's theory (Hake, 1999) with the criteria as in *Table 2*.

Table 2. – Criteria of score change (N-gain).

Score Interval	Category
> 0,70	High
0,30 – 0,70	Moderate
< 0,30	Low

Statistical analysis (inferential statistics) was carried out to analyze the test data of preservice teachers' critical thinking ability. The test is the t-test which aims to examine the effects of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability, with the formulation of statistical hypotheses in the t-test, namely H_0: μ1 = μ2 (there is no improvement of preservice teachers' critical thinking ability between the pretest and posttest score after the treatment, and H_1: μ1 ≠ μ2 (there is an improvement of preservice teachers' critical thinking ability between the pretest and posttest score after treatment). H_0 is rejected if the score of the t-test is less than α (0,05). H_1 is accepted if the score of t-test was higher than α (0,05). The acceptance of H_1 indicates that there is an effect of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability. Before conducting the t-test, the data are stated as a homogeneous and normally distribution. In this study, the homogeneity test uses Lavene's test, while the data normality test uses Kolmogorov-Smirnov's test. The data are analyzed using SPSS 23.0 statistical software tool.

2. Findings and discussion

The critical thinking ability test was given to preservice teachers as the pretest and posttest. Test was given to evaluate the improvement of preservice teachers' critical thinking ability after learning using conflict cognitive strategy based on the inquiry learning model. Test refers to four critical thinking indicators used in this study, namely analysis, inference, evaluation, and decision making, where each indicator consists of 2 items. The results of the validity and reliability test by experts show that the test instrument is qualitatively valid and reliable to be implemented. The results of sensitivity test of the test items are presented in *Table 3*, where all items of

the question are declared sensitive because they are positive with an average sensitivity score of 0.36 which indicates the test items (questions) are able to measure the effects of the learning that has been carried out.

Table 3. – Question item sensitivity.

KBK Indicators	$\overline{X}s$	Criteria
Analysis	0,32	Sensitive
Inference	0,45	Sensitive
Evaluation	0,25	Sensitive
Decision making	0,43	Sensitive
Mean	*0,36*	*Sensitive*

The description of the results of the preservice teachers' critical thinking ability test is presented in *Table 4*. The results of the measurement of preservice teachers' critical thinking ability indicate that the critical thinking average score in the pretest is -1 with criteria of «less critically» (less critically, if: -1,6 < X ≤ 4,8) and posttest was 9,89 with criteria of «quite critically» (quite critically, if: 4,8 < X ≤ 11,2), N-gain of 0,44 with «moderate» criteria. Preservice teachers' critical thinking ability are in the less critically category in all aspects (indicators) in the pretest. The implementation of conflict cognitive strategy in inquiry-based learning model has an effect to improve critical thinking ability in each aspect. Although the final results of preservice teachers' critical thinking ability in State Islamic University of Mataram are quite critically, but there is still an improvement of critical thinking ability in all aspects (indicators). Increasing preservice teachers' critical thinking ability at State Islamic University of Mataram measured by N-gain showed the highest increase in the inference indicator followed by indicators of evaluation, decision making, and analysis.

Table 4. – Preservice teachers' critical thinking ability.

Range	Category	Pretest		Post-test		N-gain	Category
		Freq.	Mean	Freq.	Mean		
X > 17.6	VC	0	-1	0	9.89	0.44	Moderate
11,2 < X ≤ 17.6	C	0	(LC)	6	(QC)		
4.8 < X ≤ 11.2	QC	0		12			
-1.6 < X ≤ 4.8	LC	9		0			
X ≤ -1.6	NC	9		0			
Num.		18		18			

Data of critical thinking ability were also statistically tested using the t-test (independent sample test), provided the data variants were homogeneous and normally distributed. The results of the homogeneity and normality test are provided in *Table 5*, while the results of the t-test are provided in *Table 6*.

Table 5. – The result of homogeneity and normality test.

Varian	N	HOMOGENEITY		NORMALITY	
		Levene's test score	*Sig.*	*Kolmogorov-Smirnov's test score*	*Sig.*
Pretest-posttest	18	0.716	0.403	0.096	0.200

The homogeneity and normality test of the data showed that the data variants are homogeneous and normally distributed with a significance value of 0,403 and 0,200, both of which are greater than alpha (α) testing (> 0,05).

Table 6. – The result of t-test.

	Group	T-TEST FOR EQUALITY OF MEANS			
		t	*df*	*Sig.*	*Mean diff.*
Pretest-Postest (Equal var. assumed)	SIU-Mtr.	-13.484	34	0.000	-11.277

The results of this study dealing with preservice teachers' critical thinking ability using the t-test show that the significance value of the test (0,000) is smaller than alpha testing (< 0,05). It means that H_0 is rejected and H_1 is accepted. It can be concluded that there is an increase of preservice teachers' critical thinking ability between pretest scores with the post-test score after the implementation of the conflict cognitive strategy. The elaboration of the results in this study presented that there is an effect of conflict cognitive strategy in inquiry-based learning towards preservice teachers' critical thinking ability. The results of this study were inseparable from conflict cognitive strategy interventions in inquiry-based learning. A form of conflict cognitive strategy intervention in inquiry learning, namely establishing sets and conveying learning objectives, presenting or demonstrating contradictory information (anomalous data) to generate motivation in learning, and present an advance organizer as a follow-up of the anomalous data presented. The preservice teachers' learning activities include they show attention to establishing sets conducted by lecturers as well as on delivering learning objectives, showing attention and giving responses related to contradictory information (anomalous data) presented by lecturers in learning, and showing attention to advance organizers that are explained by the lecturer as a follow-up of anomalous data.

Preparing preservice teachers to learn and deliver learning objectives at the beginning of classroom learning is increasingly important. According to Arends (2012), good teachers start their lessons by explaining goals, establishing learning sets, and getting learners attention. Teacher behavior at the beginning of learning affects the willingness, motivation, and formation of preservice teachers' beliefs about what they will learn (Pintrich, Marx, & Boyle, 1993; Pintrich, 1999). Besides, presenting contradictory information or anomalous data at the beginning of learning is often important to invite student interest and ensure that initial knowledge emerges (Chinn & Brewer, 1998; Chinn & Malhotra, 2002; Ambrose & Lovett, 2014). Presenting anomalous data helps preservice teachers reflect more on their ideas to provide an explanation of the phenomena being studied (Limon & Carretero, 1997). Providing explanations in accordance with ideas or phenomena being studied is one of the main factors that encourage and train learners to be able to think critically. It is in line with Prayogi *et al.* (2018) states it is important to start the learning process in scientific inquiry activities by presenting anomalous data because it can train to reason (critical thinking) and become the main instrument to motivate preservice teachers' in the learning process. Meanwhile, after presenting anomalous data, the learning process was followed up with an advanced organizer as a bridge to facilitate them with the initial action of learning with the inquiry process itself.

The peculiarity of the advance organizer lies in how contradictory information can be formulated into problems which later become the focus of the investigation activities. Theoretical studies showed that advance organizers are a form of cognitive thinking stimulation in learning that can encourage motivation and also the information conveyed at the beginning of learning is more meaningful (Dolezal *et al.*, 2003). Advance organizer in the form of presenting information that bridges new learning materials and related ideas that exist (Shah, 2004). Advance organizers can be used by preservice teachers to organize and interpret information that they can apply for further learning (Safdar *et al.*, 2014). In addition, advanced organizers encourage the use of critical thinking ability, such as both analyzing abstract concepts and deepening understanding and expanding the relationship amongst ideas.

3. Conclusion and implication

The results of this study showed that there is an effect of conflict cognitive strategy in inquiry-based learning model on preservice teachers' critical thinking ability. Descriptively, preservice teachers' critical thinking ability

increased from less critically to quite critically after the implementation of cognitive conflict strategies. Statistically, testing hypotheses related to the focus of research showed that there was an improvement of preservice teachers' critical thinking ability between the pretest score and the posttes score after the implementation of cognitive conflict strategies.

Concerning to the practical implication, conflict cognitive strategies in inquiry learning are implemented to improve critical thinking skills as higher order thinking abilities. Lecturers can also employ this strategy for the purpose of improving cognitive learning outcomes in general. The use of this strategy is synonymous with efforts to arise student learning motivation in the learning process by presenting problems in a real-world context. Therefore, the lecturer's effort to demonstrate authentic phenomena is needed.

Acknowledgment

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Riassunto

L'attuale tendenza degli obiettivi di apprendimento per le università che sono in grado di formare insegnanti che pensano in modo critico e focalizzano il processo di insegnamento sulle attività di indagine empirica è raccomandato come base per la pratica del pensiero critico. È necessario promuovere le conoscenze degli insegnanti in formazione riguardo alle attività di indagine che utilizzando strategie cognitive di conflitto. Sulla base di studi teorici, la strategia cognitiva del conflitto può portare gli studenti a pensare in modo critico. Questo studio ha avuto lo scopo di descrivere gli effetti della strategia cognitiva del conflitto nell'ambito del modello di apprendimento basato sull'abilità di pensiero critico degli insegnanti. Si è trattato di una ricerca quasi sperimentale con disegno pretest / post-test. Il campione di questo studio ha compresp in 18 insegnanti in formazione del corso di studi di fisica dell'Università statale islamica di Mataram. Le capacità di pensiero critico di questi insegnanti sono state valutate usando uno strumento sulla capacità di pensiero critico sottoforma di saggio. I dati della capacità di pensiero critico sono stati analizzati in modo descrittivo e statistico, sono stati applicati test statistici di omogeneità, di normalità e test t. I risultati hanno mostrato che la strategia cognitiva del conflitto nell'ambito del modello di apprendimento proposto ha avuto un positivo effetto significativo sulla capacità di pensiero critico degli insegnanti. I risultati vengono discussi in questo articolo.

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