

Enhancing Pre-Service Biology Teachers Critical Thinking Through Critical Analysis-Intervened Lesson Study

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This research aims at recognizing student enhancement of critical thinking ability based critical analysis-intervened lesson study. Classroom action research is based on the lesson study method. The subject involves 28 students in semester three taking a biological instructional technology course in the Biological Education Department, the Faculty of Teacher Training and Education at Universitas Muhammadiyah, Bengkulu, Indonesia. This research applies four stages of cycle: planning, acting, observing, and reflecting. The research instruments include a critical thinking observation sheet and critical thinking test. The data analysis uses descriptive analysis. The result of this research found that there was an enhancement of the students' critical thinking ability based critical analysis-intervened lesson study in the Biological instructional technology course. The critical analysis-intervened lesson study is a good instructional strategy to develop students' critical thinking and literacy during the instructional process.

Keywords: *Critical Thinking, Critical Analysis-Intervened Lesson Study.*

Introduction

The quality of education in Indonesia is low, indicated by its peoples' level of critical thinking. A survey by The World Bank found that Indonesia had the worst education system from six countries surveyed (Subadi, Priyono, Dahroni, & Musyiyam, 2015). The students' abilities in thinking are in the low level cognitive range – including remembering, understanding, and implementing – while their higher thinking skills, such as analyzing, evaluating and creating, are also low (Dirjen Pembelajaran dan Kemahasiswaan, 2012).

The low quality of education in Indonesia is indicated by the complexity of the test given. Questions framed in the low, medium and high level of complexity reached 75%, 40% and 3%, respectively (Irwandi, Wulandari, & Topano, 2018). Higher Education, therefore, has not effectively established the students' critical thinking ability. This is because of the lesser effort on the part of the lecturer's instructional technique, which does not compel the students to do the higher complexity test (Heft & Scharff, 2017). In addition, inappropriate learning materials complicate the students' capacity to do the higher complexity test.

The problem of students' ability in critical thinking is not restricted to Indonesia. Biology teachers in Niger lack a sufficient awareness of Biology as a field of study. This leads to misunderstanding in the teaching of Biology (Catherine & Bello, 2017), while in Turkey, there is an inadequate emphasis on critical reading and writing for primary school through to higher education (Polat, 2015). This severely impacts on the student's critical thinking, because students are not accustomed to learning science, and analyzing a higher level of questions. They only possess ability in lower thinking skills which affects their critical thinking ability (Saroni & Hasan, 2018). Tasci stated that in this level of knowledge (C1), students do not deeply understand the concept (Taşçı, 2015). Therefore, we need high levels of questions (Suwono, Pratiwi, Susanto, & Susilo, 2017). The questionnaire results showed that the students' understanding of critical thinking was only 2% for those who had good prior knowledge, while 64% were neutral, with 23% good and 11% very low (Allison & Pan, 2011).

Critical thinking ability can be enhanced by using a lesson study. The first stage of lesson study is planning – that is, developing lesson plan (Nuha, Waluya, & Junaedi, 2018). A good level of planning will lead students to develop their critical thinking ability (Mutakinati, Anwari, & Kumano, 2018). However, there are many lecturers who are not skilled in designing good lesson plans. The evidence shows that good lesson plans will produce a good quality learning process (Sudirman, 2017).

The concept of the lesson study is a strategy to enhance learning quality as well as to build up a teacher's awareness related to teaching and learning (Adams, 2013; Elliott, 2012). It does not aim at building a perfect instruction, but it intends to improve the students' understanding of how the learning is conducted (Bozkurt & Yetkin-Özdemir, 2018; Ylonen & Norwich, 2013). Lesson study's activity which is based on loyalty principles and mutual learning can construct learning community, students' learning activity, students' interaction, as well as learning materials improvement (Rochintaniawati et al., 2019). In the reflection stage, the lecturer will get input from various competent stakeholders. This is about learning instruction that is directed at how the students learn (Chenault, 2017). Therefore, a lesson study can enhance the learning quality of students' cognitive achievement as well as critical thinking.

Critical thinking skill affects a student's character later in the workplace (Murawski, 2014). In addition, in the learning activity, the students analyze any articles related to the course materials. The articles could be taken from journals which are analyzed before the class

started, then they are presented in front of the class. This activity could train students to use critical thinking to solve life problems (Fuad, Zubaidah, Mahanal, & Suarsini, 2017). This research aims at knowing students' critical thinking enhancement base critical analysis-intervened lesson study on Biological instructional technology course.

Methodology

Research Design

The research method used is Classroom Action Research (CAR) based on lesson study. It has four stages - planning, acting, observing, and reflecting (Kunlasomboon et al., 2015; Pelton, 2010) – and which are done in four cycles.

Participants

This research was done in the Department of Biological Education, in the Faculty of Teacher Training and Education, at Universitas Muhammadiyah Bengkulu, Indonesia, during a Biological Instructional Technology course in 2017/2018. The subject of this research was 28 students in semester III A. This critical analysis-intervened lesson study involves 6 people; one as a model lecturer and the other five people as the observers.

Instrument

The data collection uses a critical thinking observation sheet and a critical thinking test.

Table 1: Indicator of Critical Thinking (Ennis, 2015)

No.	Aspects of Critical Thinking	Indicator
1.	The ability to formulate a problem	1. The question relates a specific problem to subject discussion on a general principal
		2. The students do elaboration
2.	The ability to synthesize	3. The students accommodate other's point of view and suggestions to develop new ideas
		4. The students find and relate problems which are relevant
3.	The ability to recognize and solve a problem	5. The students provide an innovative model and argument
		6. The students ask for clarification
4.	The ability to recognize and solve a problem	7. The students try to understand
		8. The students give various ideas and alternatives
5.	The ability to evaluate	9. The students are able to evaluate problems
		10. The students are able to analyze the results of problem evaluation

Data Analysis

The data analysis in this research uses descriptive analysis. The average value of students is calculated using the formula:

$$N = \frac{x}{y}$$

N : average value (mean)

x : value obtained

y : maximum value = 4

Table 2: Criteria of Critical Thinking (Arikunto, 2010)

Average Value	Criteria
3.34 – 4.00	Very Good
2.34 – 3.33	Good
1.34 – 2.33	Quite Critical
1.00 – 1.33	Very Low

Results

The result of this research revealed data related to students' critical thinking ability from cycle 1 to cycle 4 as seen in the following table.

Table 3: The Result of Students' Critical Thinking Ability

Critical Thinking Ability	Amount of Students			
	Cycle 1	Cycle 2	Cycle 3	Cycle 4
Very Low	5	5	2	1
Quite Critical	21	17	16	16
Good	2	6	10	11
Very Good	0	0	0	0
Total	28	28	28	28

Table 3 shows the improvement of students' critical thinking ability from cycle 1 to cycle 4. It reveals that the students' critical thinking ability is good (critical), improved from 2 students in cycle 1, and became 11 students in cycle 4.

Specifically, the result of the observation sheet of students' critical thinking ability in cycle 1 to cycle 4 can be seen in table 4.

Table 4: The Result of Students' Critical Thinking Ability

No.	Aspects of Critical Thinking	Indicator	Mean Score				Note
			Cycle 1	Cycle 2	Cycle 3	Cycle 4	
1.	The ability to formulate a problem	1. The question relates a specific problem to subject discussion on general principal	1,32	1,64	1,79	1,96	Quite Critical
		2. The students do elaboration	1,39	1,54	1,96	2,20	Quite Critical
2.	The ability to synthesize	3. The students accommodate other's point of view and suggestions to develop new ideas	1,54	1,79	1,93	2,10	Quite Critical
		4. The students find and relate problems which are relevant	1,39	1,79	1,68	1,82	Quite Critical
3.	The ability to recognize and solve a problem	5. The students provide an innovative model and argument	1,32	1,61	1,86	1,93	Quite Critical
		6. The students ask for clarification	1,21	1,32	1,68	1,70	Quite Critical
4.	The ability to recognize and solve a problem	7. The students try to understand	1,29	1,39	2,10	2,11	Quite Critical
		8. The students give various ideas and alternatives	1,21	1,32	1,93	1,93	Quite Critical
5.	The ability to evaluate	9. The students are able to evaluate problems	1,68	1,79	1,90	1,85	Quite Critical
		10. The students are able to analyze the result of problem evaluation	1,61	1,61	1,82	1,82	Quite Critical
Mean			1,39	1,58	1,87	1,95	Quite Critical

Table 4 shows that each stage of the students' critical thinking ability increased from cycle 1 to cycle 4. It can be concluded that the students' critical thinking ability increased, on average, based on the observation – about 1.35 to 1.95 – which is in the quite critical category.

The result of students' tests from critical thinking aspect cycle 1-4 can be seen in the following table.

Table 5: The Result of Students' Critical Thinking Test in Cycle 1-4

No.	Aspects of Critical Thinking	Mean Score				Note
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	
1.	Ability to formulate a problem	1,21	1,21	1,21	1,50	Quite Critical
2.	Ability to synthesize	1,14	1,18	1,57	1,60	Quite Critical
3.	Ability to recognize and solve a problem	1,57	1,57	2,00	2,00	Quite Critical
4.	Ability to draw conclusions	1,39	1,64	1,82	1,85	Quite Critical
5.	Ability to evaluate	1,42	1,40	1,86	1,89	Quite Critical
Mean		1,35	1,69	1,69	1,78	Quite Critical

The above graphic, table 5, shows that the students' critical thinking ability increased based on critical thinking aspects for each aspect. The result of the students' critical thinking, written tests also increased on average from 1.35 in cycle 1 to 1.78 in cycle 4.

Discussion

The concept of the 'lesson study' has been applied in Japan for more than 100 years, and is a collaborative and prolonged teacher training model that aims to enhance teaching quality. The essence of lesson study is that lecturers learn from each other and students get authentic learning (Suzuki, 2016).

A lesson study consists of three stages: planning, doing, and seeing (Sato, 2012). In the planning phase, the lecturer and the observer discuss the material, media, and learning strategies that is going to be implemented in the classroom (Cahyono & Suwarsi, 2014). This research conducted four cycles in planning. In the first planning phase, the model lecturer delivered a learning program under the topic, 'Types and Classification of Media'. The

model lecturer told the students that learning activity would be group discussion: each group was asked to work on an Article Analysis under the topic “the Nature of Media and Props from the Book entitled, “Kreatif Mengembangkan Media Pembelajaran” (Creative in Developing Learning Media) written by Dr. rer. nat. H. Rayandra Asyar, M.Si.. After the model lecturer explained the lesson plan, the observer lecturer gave their response: 1) the lecturer asks how to do the observation sheet?; 2) is the critical analysis made individually or in groups?; and 3) what are the critical thinking test indicators?

In the second planning phase, the model lecturer explained the learning program under the topic ‘Types and Classification of Media’, the article of learning media that would be analyzed critically. The model lecturer told the students they would work in a group discussion, with each group asked to work on article analysis about Types and Classification of Media from a book by Dr. rer. nat. H. Rayandra Asyar, M.Si, entitled “Kreatif Mengembangkan Media Pembelajaran” (Creative in Developing Learning Media), and published by Gaung Persada Press Jakarta. Then the model lecturer delivered the lesson plan and the observer gave their response: i.e. 1) the lecturer asked how to observe students during the process of giving critical analysis. The lecturer has to pay attention to what the students’ write and do. Secondly, the lecturer must observe the students’ ability to evaluate, and thirdly, when to undertake critical analysis.

During the third planning phase, the model lecturer explained the learning program under the topic Learning Strategy of Biological Field Study, in the form of Lesson Design, article of learning material that would be analyzed critically. The model lecturer explained that the learning activity would be in group discussion; each group was asked to work on Article Analysis under the topic, Learning Strategy of Biological Field Study. After the model the lecturer delivered the lesson plan and the observer gave a response: i.e., 1) the observers had to understand the observation sheet to allow them to observe the students; 2) the observer had to pay attention when students ask questions and give a response; and 3) the students had to have all the articles analyzed critically.

In the fourth meeting of planning phase, the model lecturer explained the learning program under the topic, Types and Classification of Biological Media, in the form of Lesson Design, the article of learning material that would be analyzed critically. The model lecturer informed the students that they would have a group discussion, in which each group was asked to work on Article Analysis under the topic Types and Classification of Biological Media. After the model lecturer explained the lesson plan, the observer gave a response: i.e.; 1) which biological media was appropriate for the biological learning instruction; 2) students should be asked to formulate questions or answer questions; and 3) the observer should have students’ critical analysis in order to allow them to understand the learning materials.

This planning phase produces a learning program that is expected to enhance the students’ critical thinking. The model lecturer and the observers have to understand the learning materials, instructional stages as well as how to observe students’ critical thinking ability

(Towaf, 2016). The planning phase determines the enhancement of students' critical thinking ability through this learning program (Rahayu et al., 2012). The model lecturer and the observers share the idea of completing the instructional design to enhance the students' critical thinking ability (Alkharusi, Sulaimani, & Neisler, 2019). Furthermore, the model lecturer did a simple simulation about the learning process to be conducted in the class (Winarsih & Mulyani, 2012).

It can prove that critical analysis-intervened lesson study can enhance students' critical thinking ability (Fujii, 2016) as well as increase their ability to do reflection (Trapero, 2013). The students' ability in writing, using critical analysis is also able to improve their critical thinking ability (Jensen, 2011). The students do critical analysis towards biological materials as a prerequisite of autonomous learning (Magsino, 2014). Biological learning instruction has to augment visual and verbal writing activity to build high quality generation (Şahin & Gezer, 2014). From the gender aspect, among the university students, girls tend to be better in learning biology than boys (Ochonogor, 2011).

Based on other studies, students will need to sharpen their critical thinking ability: the more they are forced to think, the more they develop their critical thinking ability (Khasanah et al., 2017). This is because anyone who faces various problems will be able to develop their critical thinking ability (Kopzhassarova et al., 2016). Biological instruction process tends to train students to memorize or solve problems which force them to merely think at a lower level, such as knowledge and understanding. In this globalization era, students are encouraged to solve real life problems, therefore they need to practice to think critically: i.e, during the learning process (Pratiwi et al., 2016).

Critical thinking involves thinking in a right manner to know the real world, being responsible, asking appropriate questions, collecting pertinent information, and using logical reasoning to have reliable conclusions (Fisher, 2011). There are five critical thinking abilities: 1) analyzing (Bustami et al., 2) synthesizing (Ennis, 2015), 3) recognizing and solving problems (Bashith & Amin, 2017), 4) drawing conclusions (Jahedi et al., 2014), and 5) evaluating (Ardana & Arnyana, 2013).

This Biological instructional technology course used 'lesson study'. The activities involved having discussions that were collaborative and continually based on loyalty and mutual learning principles to build a learning community (Fahara, Bulnes, & Quintanilla, 2015).

The core principle of lesson study is enhancement of learning quality gradually by learning from the students' experience and others in conducting learning activities (Pujianti, Hartati, & Nurani, 2020). Students' work in the process of teaching and learning plays an important role, as well as student-to-student interaction, student-to-teacher interaction, and also student-learning material and environments. In the acting phase (learning implementation), students face difficulties in communication with other people, but by using lesson study these can be solved since there is dialogue and collaboration in the lesson study (Haryoto & Narimo,

2013; Sato, 2012). Group work is better than individual learning, just as cooperative instruction is better than a competitive one (Sato, 2014).

The enhancement of students' critical thinking is inseparable from the advantages of lesson study. It makes students more open-minded (Groves et al., 2013). Lesson study is able to make students think as part of the learning process (Zhou, Xu, & Martinovic, 2016). In addition, lesson study can help students to develop a collaborative culture that is distinctive of a 21st century leader (Chenault, 2017). A survey in Greece showed that if the lecturer participated in the lesson study, the lecturer will be able to create good planning (Kanellopoulou & Darra, 2018). Moreover, lesson study can increase the students' instruction process and cooperation (Leong et al., 2016). Observation during learning activity is a main power in lesson study (Myers, 2012). The notes from the observers during the learning process will be able to monitor the strategy used as material for discussion to improve the following cycle (Doig & Groves, 2011).

This action stage in the lesson study is a learning activity that is monitored by the 'observer'. The Planning stage motivates the lecturer to share his/her teaching experience to acquire good instructional planning (Mon et al., 2016). The 'reflection stage' plays a significant role in developing a teacher's professionalism (Saric & Steh, 2017; Sumarti et al., 2015).

Direct instructional observation in the lesson study gives advantages for lecturers as well as educators (Jagals & Van der Walt, 2018; Lawlor, 2012). Assessment of the learning development and learning outcomes is not only seen from the test results sheets and lesson plans, but also from the learning process directly (Simsek & Kılıcı, 2010). Classroom observation during the learning process will be more accurate and comprehensive. In addition, the use of video in the learning process complements rather than substitutes (Rakhmawati, 2010).

Creating a critical analysis of an article involves getting students to look for articles in journals about learning material, and then making the following components. First is the title of the book, as well as the author, publisher and topic. The students write down the author's name, year and title of the book or article, city, and publisher or web site source. Second is the purpose of the writer. The students write the author's purpose is in creating the article, explaining what the article contains. Third is the concept that emerged from the article; they write down the concepts contained in the article. These concepts are explained concisely and clearly. Fourth is a unique and interesting fact. The students explain any interesting facts in the article briefly. The fifth is the question that arises from the article. The students devise a question from the article. The sixth is the tentative answer to the question – a temporary answer to the question asked from the article. Seventh is self-reflection: that is, looking at both positive and negative things related to student's personal life.

Critical analysis activities will be able to train students' writing skills (Shaarawy, 2014), increase reading interest and stimulate their critical and analytical thinking (Susilo, 2009).

Debates and questions during the discussion allow students to be able to develop their critical thinking skills (Gholami, Yunus, Mohd, & Kamarudin, 2019).

Conclusion

From the implementation of lesson study in critical analysis intervention in the Biological instructional technology course, it can be concluded that there is an enhancement in students' critical thinking ability obtained from critical thinking observation sheets and critical thinking tests. In addition, the team of lecturers (both model lecturer and observer) has been able to design an instructional lesson study and create instruments in the form of critical thinking observation sheets. For any future lesson study research, it is suggested that small groups consisting of 2 to 3 students be formed so that each of them is able to focus on developing critical thinking skills. Moreover, students should be given the articles individually, thus allowing the observers to assess their critical thinking skills.

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