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THE EFFECT OF 5E LEARNING CYCLE INSTRUCTIONAL MODEL USING SOCIOSCIENTIFIC ISSUES (SSI) LEARNING CONTEXT ON STUDENTS' CRITICAL THINKING

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ABSTRACT

The aim of this study was to investigate the effect of 5E learning cycle instructional model using socioscientific issues (SSI) learning context on students' critical thinking skills of acid-base. This study used quasi-experimental posttest only control group design. The sample consisted of three classes, which were XI MIA-4class (n = 32) that learned using 5E LC model, XI MIA-5 class (n = 33) that learned using 5E LC+SSI, and XI MIA-6 class (n = 32) that learned using conventional method. The samples were choosen by convenience sampling technique. The test instrument consisted of 15 multiple choice items which were valid and reliable (r = 0.806). The data were analyzed using one way ANOVA test and LSD posthoc test. The results of this study indicated that the students who learned using 5E LC+SSI model showed greater levels of critical thinking skills ($\overline{x}$ = 74,95) than both the student who learned using 5E LC model ($\overline{x}$ = 74,17) and the student who learned using conventional method ($\overline{x}$ = 68,96). Based on statistics analysis, there was significant differences on students' critical thinkings between students taught using conventional method and students taught either using 5E LC+SSI model and 5E LC model. However, there was no significant differences on students' critical thinking skills between students taught using 5E LC+SSI model and the students taught using 5E LC model.

Keywords: socioscientific issues, 5E learning cycle model, critical thinking skills, acid base concept

INTRODUCTION

Critical thinking has been a very popular term in education world these few years (Fisher, 2007). Developing critical thinking skill is one of the main point in education (Lubezki *et al.*, 2004),including in science education (Bailin, 2002; Akarsu *et al.*, 2013). Norris (1985) in (Klimoviene *et al.,*2006) defined critical thinking as a rational decision towards something believable or unbelievable. Ennis (2011) stated that critical thinking is reflective and logical thinking that focused on decision that has to be believed or done. This way, critical thinking is a thinking skill that someone used to create a logical decision.

Critical thinking is an important thinking skill to be developed. This is because critical thinking not only act in student's success in educational part but also in their work, either in social or interpersonal context (Birjandi & Bagherkazemi, 2010). Besides, Facione (2011) contended that critical thinking skill acted to train someone in taking a wise decision that can fix their own future so they can contribute in their social life indirectly, not to be a burden in their society. This is strengthened with Pithers & Soden (2000) who

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stated that critical thinking skill become an important skill to be owned by the students as an effort to answer the challenge from the government and bussinessmen who need a smart-thinker fresh graduate so they can face the globalization with economic competition that grow endlessly.

Most of the teachers think that thinking skill, including critical thinking skill, can be taught indirectly through a learning that emphasize in content and information. But, the effectivity of teaching thinking skill this way in a long term is doubted because most of the students didn't undestand the critical thinking meant (Fisher, 2007). This is supported by the fact in the field which showed that many learnings still conditioning their students in rote learning (Rendhana & Liliasari, 2008). In this kind of learning, the students usually just absorb the information given by their teacher to be remembered again while doing their test, so the learning become less effective and won't give any chances for students to elaborate their critical thinking ata all.

Critical thinking skill is a skill that can be trained (Bailin, 2002). The effort to train critical thinking skill is by implementing a learning model that centered in the students, especially learning model that related to intelectual development like learning cycle. The phases in learning cycle model xeperiencing many development, one of them is learning cycle 5E(LC 5E) developed by Bybee *et al.* (2006). The phases that included in LC 5E are engagement, exploration, explanation, elaboration, dan evaluation. Some research showed that LC 5E model can increase student's critical thinking skill (Budprom *et al.*, 2010;Sulistyowati *et al.*, 2014).

Chemistry is unpopular and irrelevant subject in student's vision because chemical learning usually just emphasizing in concept mastery without showing the relation between the concept that they learn with their daily life. (Hoolbrok, 2005). This caused the student's low interest and motivation in learning chemistry. The effort that can be done toward this problem is by relating chemical concept with daily life concept, one of the way is by using socioscientific issues (SSI) learning context. This is in step with Sadler & Zeidler (2005) that stated that SSI learning context makes science learning become more relevant to student's life.

Socioscientific issues (SSI) is a problem that related to social issues that heppened in society that cover concept and technology and their relation to science (Sadler, 2004). SSI is a mix between social issues that involved moral component and ethic and the relevation with science (Callahan, 2009). Thus, SSI is a problem that related to social issues and connected to science and involving moral component and ethic. The issues provided in SSI is controversial issues like global climate change, genetic engineering, alternative energy, research about cell stem, and the others that demanded the attention of the society, not only scientists in specific experties (Fowler *et al.*, 2009).

The implementation of SSI in science education can push the students to be involved in a dialog, discussion, and debate actively that can provide challenges to the students to evaluate their knowledge and give a chance to rebuild their concept mastery related to the concept that they learned from their own experiences and social phenomena. Besides, the implementation of SSI in science learning will ease the achievement of science education's aim towards the effort of increasing high level thinking ability, discussion skill, scientific argumentation, inquiry learning, and science facts understanding (Nuangchalerm, 2010). Roberto & Bernando (2012) revealed that implementation of SSI in science education can help the students to develop their critical thinking skill by a discussion about controversial topic and social-science. This opinion is supported by the result of Burek's research (2012) that showed the implementation of SSI in education can increase the critical thinking skill.

One of the chemistry material that appropriate to be taught with SSI is acid-base. In acid-base material, there are some issues that included to SSI, one of them is acid rain. rain water is basically acid, but the acidity can increase as the air pollutant level increase (Dubey, 2013). Pollutant which can come from waste gas like sulfur dioxide and nitrogen oxyde mostly caused by human activity in industrial activity, power plant and vehicles. Acid rain has negative effect toward the environment, like destroying water animal, destroying plants, causing peeled paint and causing steel corrosion in buildings, bridges, and stone statues.

According the commentary above, we know that LC 5E instructional model using SSI learning context hipothetically can increase student's critical thinking skill. Thus, if learning cycle 5E instructional model is using socioscientific issues (LC 5E+SSI) context is planned, we hope that student's critical thinking skill can be developed. The aim of this research is to know the effect of learning cycle 5E instructional model using socioscientific issues (LC 5E+SSI) learning context towards student's critical thinking skill in acid-base material.

METHOD

The research was conducted in one of the senior high scool in Malang on second semester in school year of 2015/2016. This research using quasi-experimental posttest only control group design. The design of this research is shown in Table 1.

Table 1. Research Design

Group	Treatment	Posttest
Class Experiment I	X_1	O
Class Experiment II	X_2	O
Control Class	-	O

(Creswell Adaptation, 2012)
Information:
O: observation (measurement)
X_1: learning using LC 5E+SSI model
X_2: learning using LC 5E model

Sampling used in this ressearch is using convenience sampling technique. Classes that used in this research are XI IPA 4 (n = 32) as Experiment Class II that was taught by using LC 5E instructional model, class XI IPA 5 (n = 33) as Experiment Class I that was taught by using LC 5E+SSI instructional model and class XI IPA 6 (n = 32) as control class that was taught by using conventional method.

The research instruments consist of treatment instruments and measurement instrument. Treatment instruments consist of sylabus, lesson plan, student's activity sheet and discussion observating sheet. Measurement instrument is critical thinking skill test that consists of 15 multiple choices item. Expert's validation result stated that the instruments are valid. The next measurement instrument was tested to know the validity value of the items and the test reliabilty. According to the result, 15 critical thinking test items are valid and reliable (r = 0,806). The learning observation activity was done by three researchers. Critical thinking skill data that has been obtained from the research were analyzed statistically using one way ANOVA with posthoc test using LSD, while the data about learning activity were qualitatively analyzed with percentage.

RESULT AND DISCUSSION

Hipothesis test statistically needs normality and data homogenity to know whether the statistic method that used is parametric statistic or nonparametric statistic. Thus, before the hipothesis test was done, the researcher must do the precondition test that consist of normality test and homogenity test.

Critical Thinking Data's Normality Test

The result of experiment and control class student's critical thinking skill data normality test can be seen in Table 2.

Hipothesis Test

According to the result of precondition analysis test in Table 2 we know that experiment class and control class student's critical thinking skill data distributed normally and homogenically. Thus, hipothesis test was done with statistic parametric method which was one way ANOVA. Hipothesis that submitted:
H_0: There is no difference in student's critical thinking skill that have been taught by using LC 5E+SSI instructional model, LC 5E instructional model, and conventional model in the main material of acid-base.
H_1: there is a difference in student's critical thinking skill that have been taught by using LC 5E+SSI instructional model, LC 5E instructional model, and conventional model in the main material of acid-base.

The result of one way ANOVA test toward student's critical thinking skill point in experiment and control class can be seen inTable 3.

Posthoc test Using LSD

Posthoc test using LSD towards student's critical thinking skill point in experiment and control class can be seen in Table 4.

The Percentage of Right Answer in Critical Thinking Skill Test

The Percentage of Right Answer in Criti-

Table 2. The Result of Critical Thinking Skill's Normality Test and Data Homogenity

Class	Kolmogorof-Smirnov Test	Conclusion	Variable	Levene Test	Conclusion
	Signification Value			Signification Value	
Control	0,131	Normal	Critical Thinking Skill	0,168	Homogen
Experiment I	0,334	Normal			
Experiment II	0,189	Normal			

Table 3. The Result of one way ANOVA Test Critical Thinking Skill

Variable	Rata-Rata			one way ANOVA	Conclusion
	Control	Experiment 1	Experiment 2	Significant Value	
Critical Thinking Skill	68,96	74,95	74,17	0,038	Thereis a difference in student's critical thinking skill

Table 4. Posthoc test Using LSD Critical Thinking Skill

Class	LSD Test			Conclusion
	Significant Value			
	Control	Experiment 1	Experiment 2	
Control		0,018		There is a difference in student's critical thinking skill
Experiment I			0,754	There is no difference in student's critical thinking skill
Experiment II	0,041			There is a difference in student's critical thinking skill

Table 5. The Percentage of Right Answer in Critical Thinking Skill Test

Critical Thinking Indicator	Item Number	Right Answer (%)		
		Control	Experiment I	Experiment II
Doing induction	1, 2, 3	82,29	83,84	83,33
Doing deduction	4, 5, 6, 7	71,09	71,97	71,88
Interact with others	8, 9, 10	72,92	81,82	81,25
Doing evaluation	11, 12	37,50	39,39	39,06
Identify assumption	13, 14, 15	69,79	86,87	84,38

Table 6. Persentase Aktivitas Diskusi

Activity	Discusion Activity (%)	
	Experiment I	Experiment II
The seriousness in following the subject	73,74	73,61
The student's activeness in gathering information	71,38	70,83
The activeness in giving idea and problem solving solution	72,05	70,49
The activeness in asking and answering question	73,40	72,57
The ability to give an opinion	72,05	71,53
Communication ability	74,07	70,14

cal Thinking Skill Test in experiment I, experiment II, and control class can be seen in Table 5.

The Percentage of Discussion Activity

In this research, observation towards student's activity only done in elaboration phase. The percentage of discussion activity in experiment I and experiment II class can be seen in Table 6.

The acid-base learning have been done in eight meetings. The 1st to 7th were done to deliver the material, while the 8th was to do the test. The lesson in experiment class, either in experiment I or II, were done in groups consist of 4-5 persons. The order of the material in experiment class is acid-base characteristic, acid-base theory, acid-base power, acid-base pH indicator, concept and pH calculation, acid-base indicator and neutralize reaction. In experiment class, the first meeting was began with internship. The internship

procedure in experiment class was conducted by the students with the help of the teacher.the students were asked to discuss to create a procedure that appropriate with the aim of the internship, the problems and equipments and ingredients that have been served. This inquiry-based internship can led the students to build their concept independently. This is supported by Parappilly *et a.l* (2013) that stated that inquiry-based internship is fit to constructivistic theory that aimed for students can build concept.

The learning in experiment class I (LC 5E+SSI) were done with LC 5E instructional model. In engagement phase, the teacher served daily life fact that related to the concept that will be leaned to gain the student's interest and motivation. In exploration phase, the students were asked to discuss the student activity sheet that has been served in groups. The students were allowed to explore their literature. In exploration phase, the teacher only acted as facilitator and gave help to student who faced difficulties in group discussion. The helps that provided are guide questions that will help students to build their own concept independently. In explanation phase, the teacher asked the student's representative to present the result of their group discussion and asked the other groups to give responses toward the presentation of servinbg group. In this discussion, the teacher assessed how far the student's understanding towards the material learned. Besides, the teacher also gave strengthening in the concept by doing question and answer to the students so the students can understand the concept that they just learned in that meeting. In elaboration phase, the students were asked to read article consists soscioscientific issues in the activity sheet then discuss the critical thinking questions that related to the soscioscientific issue. The critical thinking qustions were arranged based on the critical thinking indicator developed by Ennis (2011). There are 12 indicators that have been developed, but in this research the researcher only used five indicators. Those indicators were selected based on the appropriation to the soscioscientific issues served. Those indicators are (1) doing induction; (2) doing deduction; (3) interact with others; (4) doing evaluation; and (5) identifying assumption. Next, the teacher asked group representative to present their answer and askd the other groups to give responses. After that, the teacher gave feedback towards the discussion. Evaluation phase was done in in the process by making small notes to rate the ability of each group in understanding the material. SSI discussion wasn't done in every meeting, but only in 1st, 4th, and 7th meeting. SSI provided in 1st meting was about carbonated beverages and the dangers, in 4th meeting was about pollution caused by tofu industrial waste, and in 7th meeting was about acid rain and acid ground caused by fertilizer.

The same with the learning in experiment class I, the learning in xperiment class II (LC 5E) also done with LC 5E instructional model. The difference between those two classes lies in elaboration phase in the 1st, 4th and 7th meeting. In 1st meeting's elaboration phase, the students were asked to do an internship to know the character of acid-base solution in our daily life. In 4th meeting's elaboration phase, the students were asked to do an internship to know the solution's pH value in the daily life, while in 7th meeting's elaboration phase, the students were asked to do the exercises that related to neutralization.

Learning in control class was done by conventional model. Conventional model is a learning method that usually used by the teacher. The arrangement of the control class's materials are acid-base theory, acid-base characteristic, acid-base power, concept and pH calculation, pH of acid-base solution, acid-base indicator and neutralize reaction. In class learning, material delivery was done by spech method that continued by doing exercises. In laboratorium learning, internship was done to prove the concept with the internship steps that provided by the teacher.

Based on the posthoc test using LSD in Table 5, we know that there is a difference in student's critical thinking skill that has been taught with conventional method and LC 5E instructional model. Student's critical thinking skill that has been taught with LC 5E instructional model is better than those who taught with conventional method. This find is strengthening the previous studies that stated LC 5E instructional model can increase student's critical thinking skill (Budprom *et al.*, 2010; Sulistyowati *et al.*, 2014). It is because the common conventional method that used by the teacher only done in one way so this will not give any chance to the students to train their thinking skill, including critical thinking skill. This kind of learning usually still emphasize in low level thinking skill. This is supported by Bassham *et al.* (2010) that stated school learning generally still emphasize low level thinking skill where students only received the material passively then remembered it when they are doing their test. Besides, Hastuti *et al.* (2013) also stated that school learning generally still emphasize in product achievement in cognitive form without noticing the process, character and thinking skill.

LC 5E instructional model is an inquiry-

based learning model (Turkmen, 2006). LC 5E instructional model consists of phases that allowed the students to act actively in the learning process. In learning process, the students are challenged to solve the problems related to concept in their activity sheet by group discussion. It is different from conventional method, learning by using LC 5E instructional model will make the students actively involved to build their concept independently with the help of the teacher. Besides, LC instructional model, including LC 5E, was developed based on the Piaget's intelectual development theory like assimilation, accomodation and organization that fit with exploration, explanation and expansion phase that give a chance to the students to train their intelectual system so they can increase their critical thinking skill (Budprom *et al.*, 2010).

Table 5 also shows that there is still a difference in student's critical thinking skill that taught by using conventional method and LC 5E+SSI instructional model. The student's critical thinking skill that taught by using LC 5E+SSI instructional model is better than those who taught by using conventional method. According to Dawson (2015), SSI implementation in the learning process makes the learning process become deeper and meaningful compared to conventional method. It is because the students are more involved in the learning process and the students will also know the concept relevance that they learn and the relation in life. Besides, SSI also combine the scientific concept with challenging problems so it become an effective way to involve the students in discussion that will affect student's ability in ddecision making and critical thinking (Christenson *et al.*, 2014). Furthermore, Burek (2012) stated that moral dilema presentation and ethic in SSI potentially make the students use their critical thinking skill so they can analyze and synthetize scientific information that they need to strengthening their opinion related to socioscientific issue that they face. Thus, the student's critical thinking skill will improve.

Table 5 shows that there is a difference in student's critical thinking skill that taught by using LC 5E and LC 5E+SSI instructional model. It is caused by some factors, which are:

Discussion in SSI working less optimal. This was caused by the studen't study pattern that centered in the teacher so the students are not used in the learning system that involved them actively in discussion and debate.

Five critical thinking indicators that become the references to develop the critical thinking test item are common and frequently used indicator in learning process. Critical thinking test items that have been developed are not so vary because only referenced to five critical thinking indicators.

But, if we see from the average of the test result in Table 3, the average value of the students that taught by using LC 5E+SSI instructional model is higher than the average criitical thinking value of the those who were taught by using LC 5E. Besides, the student's right answer percentage in each critical thinking indicator that has been shown in Table 5 shows that the right answer percentage of the students who were taught by using LC 5E+SSI instructional model is higher than those who were taught by using LC 5E instructional model.

Moreover, if we see from the observation result of the students that shown in Table 7, we know that the student's activity is higher in those who were taught by using LC 5E+SSI than those who were taught by using LC 5E. This fits to Zeidler & Nichols (2009) who stated that student's involvement in a discussion about socioscientific issues will push the students to be active in dialogs, discussions and debates. Debates functioned to increase the understanding of the socioscientific issues and push the students to develop their critical thinking skill as a way to make a better decision (Siribunnam *et al.*, 2014).

CONCLUSION

Based on the result of the research, we can conclude that LC+SSI instructional model affect the student's critical thinking skill in acid-base material. The student's critical thinking skill can be taught by using LC 5-SSI instructional model ($\overline{x}$ = 74,95) which is higher than LC 5E instructional model ($\overline{x}$ = 74,17) or the conventional method ($\overline{x}$ = 68,96). The result of the statistic analysis shows that there is no significant difference in the critical thinking skill between those who were taught by using LC 5E+SSI instructional model and LC 5E model. It is caused by some factors, which are: (1) Discussion in SSI working less optimal. This was caused by the studen't study pattern that centered in the teacher so the students are not used in the learning system that involved them actively in discussion and debate. (2) Five critical thinking indicators that become the references to develop the critical thinking test item are common and frequently used indicator in learning process. (3) Critical thinking test items that have been developed are not so vary becau-

se only referenced to five critical thinking indicators. But, some finds make it clearer that LC 5E+SSI instructional model give a better result than LC 5E model as seen from the average value, student's right answer percentage in each critical thinking indicators and student's discussion activity percentage. Thus, we can conclude that LC 5E+SSI instructional model gives a better effect toward critical thinking skill.

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