JPII 5 (2) (2016) 164-170

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

SOCIOSCIENTIFIC ISSUES (SSI) IN REACTION RATES TOPIC AND ITS EFFECT ON THE CRITICAL THINKING SKILLS OF HIGH SCHOOL STUDENTS

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DOI: 10.15294/jpii.v5i2.7676

Accepted: August 6th 2016. Approved: September 24th 2016. Published: October 2016

ABSTRACT

The aim of this research was to investigate the difference in students' critical thinking which learnt cooperatively using different learning context. Quasy experimental postest only control group design was chosen as experimental design using two equivalent classes as the sample. The first class (15 MIA 5, n = 30) was taught using socioscientific issues (SSI) as the learning context and the second one (15 MIA 6, n = 30) was not. The research instrument was a test consisted of 16 items of multiple choice questionsdeveloped based on Ennis' critical thinking indicators. This instrument have been validated and its reliability approved with r = 0,765. Students' post-test scores were analyzed using t-test with SPSS 16 for Windows. The result showed that statistically students' critical thinking skills betweentwo classes was significanly different (Asym. Sig = 0,037). Students who taught using SSI have higher score (73,96) than the one wasn't (66,04). Result shows that using socioscientific issues (SSI) as learning context has significant effect on high school students' critical thinking skills.

Keywords: cooperative learning, socioscientific issues, critical thinking skills

INTRODUCTION

As the central of science, chemistry is a fundamental science for science itself, technology, and industry (Mahdi, 2014; Chang, 2011), thus it is important to learn. In the 21st century, these fields have been growing very rapidly throughout the world (Friedman, 2007). Incredible advances in science and technology provides a lot of changes in people's life quality. The development of nanoscience and discovery of alternative energy sources create new hope for the survival of human life. But on the other hand, there are some developments which lead to the new problem that threatens life. Nuclear leaks, environmental pollution, and global warming are the example of the problems face by the world globally. These problems can not be solved by individuals, but the cooperation between individuals who think of themselves as a global community are expected to reduce the risk of problems arising. To resolve these problems, it needs people who have the well-understanding of scientific ideas, intellectual ability, creativity, reasoning, and the concern for the issues and problems occur in nature. By this issue, they can preserve the environment, health, and can take the decisions on social policy for global society (Rahayu, 2014). People who already have these skills said to be people who have the scientific literacy. Therefore, the creation of a science literate-society is needed in modern society in this century.

In recent decades, the level of scientific literacy of the world community becomes a hot topic in the study of science education world. One of

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the international assessment programs that make science literacy as its conceptual foundation is PISA organized by the OECD (Organization for Economic Cooperation and Development). Based on data collected by the OECD (2015), the results of PISA assessment show the level of scientific literacy of Indonesian students are alarming. In 2006, Indonesia was ranked 53rd out of 57 countries, in 2009 was ranked 38th out of 40 countries, and on the order of 64 of the 65 countries in 2012. According to these data, students' science literacy in Indonesia is on the order of 2 to 4 from the bottom than other countries. This is possible due to the science learning process applied in Indonesia are still fixated on content that requires students to memorize and to perform complex calculations instead of referring to the context that requires students literacy (Strategic Plan, 2009). This exclusion has also pointed out that the purpose Indonesian education is not in accordance with the demands with all its problems. Yet on the other hand, the realization of science literate-community is one of the main goals of science education (NRC, 1996; Norris & Philips, 2003).

To overcome these problems, Indonesia needs to evaluate the educational curriculum. The implementation of Curriculum 2013 is one of Indonesia's efforts to catch up from the other countries in the field of education, especially in science. Pursuant to Rule 64 Ministry of Education and Culture in 2013, the competence that must be mastered by students in science learning are the development of a scientific attitude (curiosity, critical, logical, analytical, creative, honest, and responsible), analyzing and solve problems, and to apply knowledge in various fields of science and technology. The learning objectives are in line with the objective of creation in science literate-community (Kemendikbud, 2013). Therefore, the implementation of Curriculum 2013 in Indonesia is expected to form a literate-community which os capable of solving the global problems.

Critical thinking skills are a key component of scientific literacy (Lederman, Lederman, & Antink, 2013) .As an important skill to be developed in the 21st century learning, mastery of critical thinking skills students are expected to realize the creation of community berliterasi sains. Ennis (1993) defines critical thinking as a reasonable reflective thinking and focus on decision about what people believe or what to do. Watson and Glaser in Nezami *et al*. (2013) describes critical thinking as a combination of knowledge, attitudes, and skills of individuals that includes the ability to understand, identify hypotheses, menginferensi, analyze, and evaluate the reasonable opinion. The description in accordance with the characteristics of critical thinking expressed by Facione (2013), that the skills of interpretation, analysis, inference, evaluation, explanation, and self-regulation. The various skills are interconnected so that can not be separated from one another.

One effort to train the critical thinking skills to students as well as to address the relevance of chemical materials with everyday life, learning in the context of certain chemicals can be a solution. In connection with the development of scientific literacy, socioscientific issues (SSI) is the appropriate context to achieve the expected goals. SSI selected as a context for learning because it can be used (1) to make science learning more relevant for students; (2) directing the learning outcomes, such an understanding of the nature of science; (3) improving dialogue argumentation; (4) improving the ability to evaluate scientific information; and (5) developing scientific literacy (Sadler & Zeidler, 2004: 4). Generally, cases including SSI generated a lot of debate so it will not have an easy solution (Kolstø *et al.*, 2006). This is because SSI is not just fixated on the concepts of science, but involves the moral and ethical implications (Lee *et al.*, 2014) .With provides an opportunity for students to discuss and debate issues of SSI controversial, their critical thinking skills will increasingly improve (Domenech & Márquez, 2013). It represents the excess of SSI that can not be found in conventional learning which tends to be teacher as the center of learning.

The purpose of constructivist approach based on student as the center of learning is to make student to be actively involved in the learning process. By involving them in this activity, they will have a greater opportunity to train their critical thinking skills. One model of learning that support the learning process is a cooperative learning model. This model has certain limitations that set it apart to group learning in general. Johnson & Stanne (2000) states that cooperative learning uses small groups of student, then students can collaboratively share their ideas, learn together, exchanging ideas, and are responsible for the achievement of learning outcomes individually or in groups. Through cooperative learning, students are encouraged to cooperate to the fullest with all members of the group for the group's success is determined by the success of each individual as a member of the group. According to Johnson & Johnson (in Ferder & Brent, 2007), the five basic elements of cooperative learning are required for the successful achievement:

(1) positive interdependence (positive interdependence); (2) the direct interaction / face (promotive interaction); (3) individual responsibility (individual accountability); (4) the effectiveness of the process group (group processing); and (5) skills of interaction among individuals and groups (social skills). By actively involved in the discussions during ongoing cooperative learning, students can interact to bring effective problem-solving strategies on socio scientific issues served with all aspects involved in it. Thus, the critical thinking skills of students can develop. Some research indicates that cooperative learning effect on students' critical thinking skills, such as research conducted by Klimovienė *et al.* (2006), Nezami *et al.* (2013), and Valdezet al (2015).

One of the chemistry learning materials in class XI is closely related to everyday life and contains a lot of socio scientific issues is the rate of reaction. Some of the topics raised in the SSI for example learning about the use of nuclear power as a source of electrical energy, the impact of the use of calcium carbide in ripening fruit, alcoholic drinks controversy, and cigarette industry in Indonesia. Through cooperative activities, the students discuss to provide feedback on the issue and take the most effective solutions to problems that will arise as a result of the decisions. By discussing such socio scientific issues, it is expected that the student's critical thinking skills will be trained. Therefore, the following research objectives is to use the context of socio scientific to measure its effect on the high school students' critical thinking skills.

METHOD

The following studies used an experimental method, i.e. a quasi-experimental design with posttest only group design (Creswell, 2012: 310) with a scheme as illustrated in Table 1 below.

Table 1. Study Design

	Pretest	Treatment	Posttest
Experimental class	–	X	O_1
Control class	–	–	O_2

Information:
X: Cooperative Learning with SSI context on the topic of reaction rate
O_1: posttest experimental class that learned cooperatively with SSI context
O_2: posttest control class that learned cooperatively without SSI context

Samples used in this study were two classes X in one of the high schools in Malang and it was selected by convenience sampling technique. Based on the results of normality and homogeneity test, the second class was a class with a normal distribution of student ability and also a homogeneous class. Additionally, both classes have the equal initial capability seen from the Chemistry subject grade at the previous material. Both classes was applied to have the cooperative learning model. One class (15 MIA 5, n = 30) was selected as the experimental class that learned with the context of the SSI and another class (15 MIA 6, n = 30) without SSI context application. The hypothesis for the following research states that there is no difference in the students' critical thinking skills in both experimental class and control class.

Based on the study design, the variables used in the study include the following independent variables, control variables, and the dependent variable. The independent variables in this study is the use of socioscientific issues learning context. The learning without context is expected to generate critical thinking skills different with context. The dependent variable in the following research is the critical thinking skills, while the control variables are the breadth and depth of learning materials i.e. reaction rate, the duration of learning and cooperative learning strategies.

Measurement instruments use critical thinking test consisting of 16 items of multiple choice questions that are developed based on indicators of critical thinking by Ennis (2011). Eight indicators from Ennis developed into an instrument of test item includes (1) defines the term and consider using the definition of the appropriate criteria; (2) ask and answer questions that require an explanation; (3) focused questions; (4) to interact with others; (5) induction; (6) observe and consider the results of observation; (7) show or make assumptions; and (8) to deduce and assess the results of deduction. These indicators were selected based on the compatibility with the materials and learning activities that allow for critical thinking skills training in the classroom. The test instrument has been validated and tested in order to obtain the level of reliability of the instrument amounted to 0,765. The test results were analyzed using the two-class t-test with SPSS 16 for Windows. The results of the quantitative analysis was used to identify, analyze, and explain the difference in critical thinking skills of students of both classes on reaction rate material.

Learning topics on the rate of reaction was carried out in a meeting with one test. Both

classes studied the reaction rate study material cooperatively with the same level of breadth and depth. Each of the students in both classes obtain student worksheet (LKS) containing discussion and questions to guide their understanding on the material. The essence of each question on the worksheet for each class aims to help students in constructing the knowledge. In addition to meeting these objectives, the questions on the experimental class was designed to train the critical thinking skills in students explicitly. This is different from the control class that only engaged in cooperative activities to train the students' critical thinking skills. Figure 1 below is an example of student worksheets from each class.

In addition, the experimental class involving SSI as a context for learning lead the students to not only discussing about concepts relating to the reaction rate and the problems associated with this concept, but also doing the activities. They were also actively involved in discussions about the four cases related to the reaction rate, namely (1) Controversy of PTLN in Indonesia; (2) Carbide, Fruit Maturation accelerator; (3) The controversy of the alcoholic beverages; and (4) Dilemma of Cigarette Industry in Indonesia. These issues were respectively presented at the first, fourth, sixth, and seventh meeting according to the reaction rate studied. For example, after studying about law and orderof reaction rate at the sixth meeting, the students discussed the controversial articles on the rules of distribution of alcoholic beverages. In this article, they discussed the reason why alcoholic beverage consumption is banned in terms of science that involves the reaction of zero-order and first-order reaction. Therefore, after learning about the law concept and the order of reaction rate, the students were better able to understand the article. In terms of the social, students were asked to submit their opinions about the impact of easing the rules of distribution in alcoholic beverages. Students were also asked to answer the critical thinking questions related to the articles presented. Thus, the critical thinking skills of students increased explicitly. Figure 2 below is one example of SSI article presented on learning.

RESULTS AND DISCUSSION

The average grade of critical thinking skills test on both classes can be seen in Figure 3 below. Figure 3 shows that the average grade of students that learned in the context of SSI (MIA class 5) was higher than students that learned without context of SSI (MIA grade 6). The value of these two classes then quantitatively analyzed using t-test with SPSS 16 for Windows. The results of the

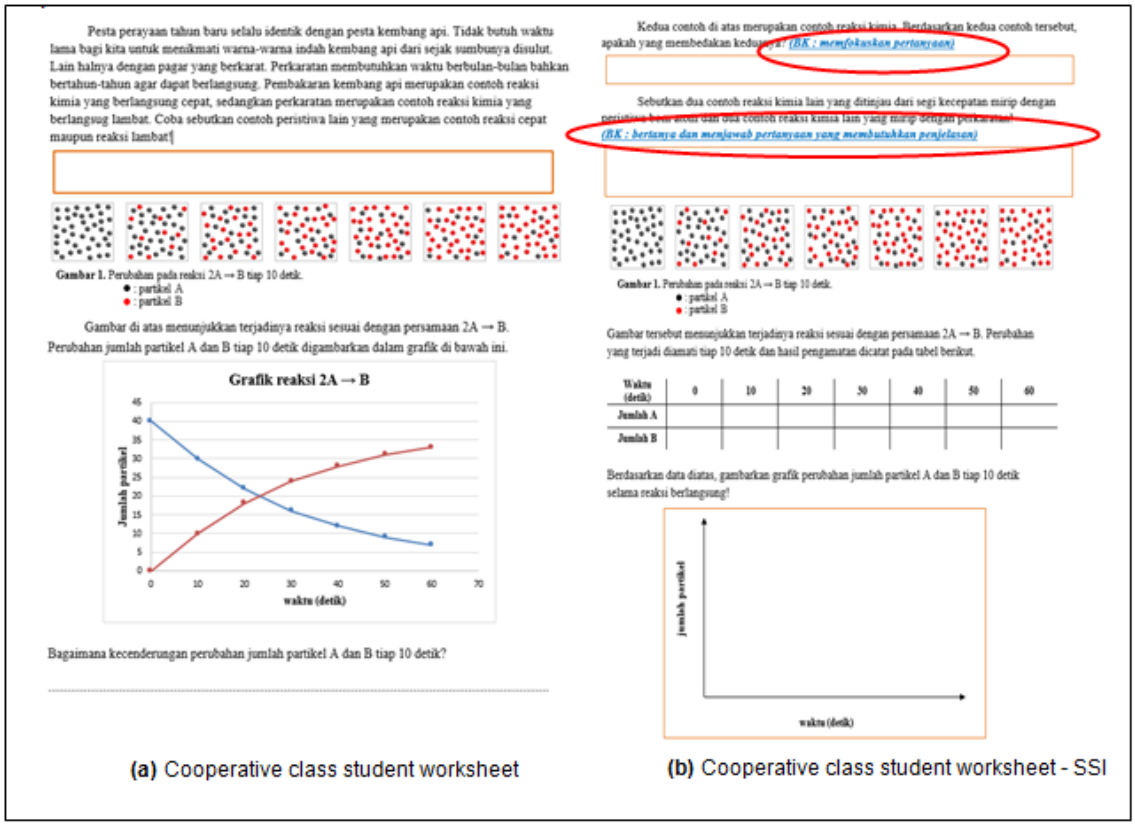

Figure 1. Student Worksheet Example

Figure 2. Student Worksheet Example

analysis are presented in Table 2.

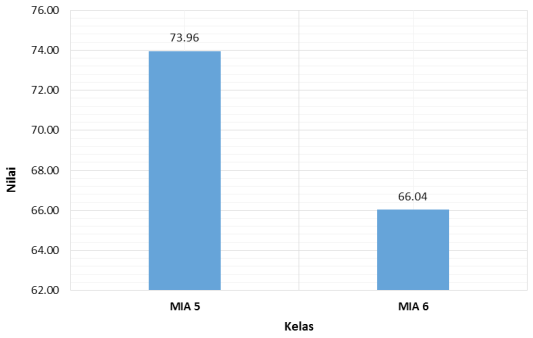

Figure 3. Average grade of the students' Critical Thinking Skills

Levene's test was used to determine the homogeneity of the sample group tested. The analysis showed that Levene's test value at 0.868 which indicated that the sample is homogeneous (Sig.> 0.05). Therefore, further analysis to compare the two groups of students was parametric comparative analysis the independent sample t-test. The results of t-test analysis showed a significance value at 0.037 (Sig.> 0.05). The data showed that the critical thinking skills of students between the two groups differed significantly.

In the following study, two classes employed the cooperative learning model, i.e. constructivist learning paradigm and student-centered cooperative learning (student-centered). According to the constructivist paradigm, students are more actively construct or build their own knowledge. The cooperative learning includes a social constructivist model that emphasizes the importance of the relationship between students and instructors (Valdez *et al.,* 2015). The activities are designed for cooperative learning which involves students to working in groups. Teachers serve as the instructors during the learning process. The discussion activities occur during learning process allows peer tutoring among students in the group. Thus, students are not overburdened during the learning process and they can promote the active participation and reduce the dominance of teachers. By this activity, students tend to have more opportunities to think critically.

In addition of using cooperative learning model, students' critical thinking skills can also be trained by socioscientific issues (SSI). Even though context as learning models with the same level of breadth and depth of the material, but the results of the analysis showed no significant difference on the critical thinking skills among both classes. Classroom which employed the SSI context in learning had higher average grade than the classroom without SSI context. SSI-applied classroom students tend to have more opportunity for discussion or debate activities. With the same model of learning, both groups of students have

Table 2. Results of t-test analysis on the grade of critical thinking skills with SPSS 16 for Windows.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
BerpikirKritis	Equal variances assumed	.028	.868	2.130	58	.037	7.91667	3.71592	.47844	15.35489
	Equal variances not assumed			2.130	56.339	.038	7.91667	3.71592	.47377	15.35956

the same opportunity to discuss and construct the reaction rate knowledge. During the process, the students' critical thinking skills honed through questions posed to the students' worksheets. However, the experimental class that learned in the context of SSI, the worksheet contains four articles in accordance with the concept of reaction rate including: (1) The controversy of PTLN in Indonesia; (2) Carbide, Fruit Maturation accelerator; (3) The controversy of Alcoholic Beverage Sales Rules; and (4) Dilemma of Cigarette Industry in Indonesia. Selection of these issues was based on the fact that the issue has been commonly growing in the community, but it poses a dilemma in making decisions related to the issue. By these articles, it is expected that students have more opportunities to exchange their ideas, either through group discussions or through classroom discussion. This leads to increase the critical thinking skills of students.

Based on several studies, the integration of SSI in learning can improve critical thinking skills, including research conducted by Tal & kedmi (2006) and Eggert *et al.* (2012). According to Ratcliffe & Grace (2003), the use of SSI as a context for learning can train students' critical thinking skills through three important aspects, namely (1) the students need to understand and describe the problem situations involving SSI; (2) the students formulate a number of problem-solving solutions that enable on the situation that has dpelajari; and (3) students need to re-evaluate the decisions they have made before the decision is communicated within the forum. The process trains students to think more carefully and to be more reflective in making decisions. Students do not just use one source for consideration, but pay attention to other sources before the final decision is taken. Because SSI involves science and social issues, the students need to pay attention to the impact that would arise from the two sides. For example on the issue of the first SSI on the use of nuclear power as a power plant in Indonesia. According to science, the use of nuclear power plants will be profitable. In addition to its fast reaction, the high energy that can be utilized as well as the lack of pollution generated a profit from the construction of the plant. However, the level of public anxiety of impending nuclear leaks as it has been widely reported in the media of social constraint of the nuclear power plant. In addition, the amount of funds needed for the construction of the initial installation of nuclear power plants is also a problem that needs to be considered. To formulate the solution of these problems, the students not only the profits in terms of science, but the social aspects also need to be considered. Solutions to problems are not specific and are multisolusi will train students to think critically.

CONCLUSION

The implementation of socioscientific issues (SSI) as a context for learning has a significant influence on the critical thinking skills of high school students. In this learning application, the controversial issues arise as the characteristic of SSI induce the students to be more actively discussing and debating to train their critical thinking skills.

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