The effect of inquiry based learning models on students’ critical thinking ability and self-efficacy in reaction rate material

N A Kamal\textsuperscript{1}, Suyanta\textsuperscript{2}

\textsuperscript{1}Pendidikan Kimia, Program Pascasarjana, Universitas Negeri Yogyakarta, Jalan Colombo No. 1, Karang Malang, Kecamatan Depok, Kabupaten Sleman, 55281, Yogyakarta, Indonesia

\textsuperscript{1}Jurusan Kimia, Fakultas MIPA, Universitas Negeri Yogyakarta, Jalan Colombo No. 1, Karang Malang, Kecamatan Depok, Kabupaten Sleman, 55281, Yogyakarta, Indonesia

\textsuperscript{*}nabihkamal58@gmail.com

Abstract. This research aims to distinguish students’ critical thinking and self-efficacy when learning with the inquiry based model and direct instruction model. The samples of this research were two classes of the eleventh grade and selected by random sampling technique. Two classes were selected as the samples, one class as the experimental class where the inquiry-based model was implemented and the other class as the control class where the learning was facilitated with the direct instruction model. The data of the students’ self-efficacy were collected through a questionnaire while the data of the critical thinking were obtained through a test on reaction rate. The researcher used MANOVA to analyze the differences of the students’ critical thinking and self-efficacy. The results reveal that there are significant differences in the critical thinking skills and self-efficacy and the effective contribution of inquiry-based learning and direct instruction to students’ critical thinking skills is 13.6\%, the effective contribution of inquiry-based learning and direct instruction to students’ critical thinking skills is 20.6\%, the effective contribution of inquiry-based learning and direct instruction to students’ self-efficacy is 8.9\% where experimental class was better than control class.

1. Introduction

Chemistry subject content cannot always be taught using the same learning model because it has different characters, so a teacher must be able to hold various learning models which are adjusted to teaching content later on. A learning model is needed to make students active in the learning process so as to improve the quality of students’ learning outcomes [1].

One of the most vital scientific attitudes that must be possessed by students is the ability to think critically. The ability to think critically is very prominent because it can assist students in completing sundry tasks given by teacher. Critical thinking is the activity of analyzing ideas or thoughts in more specific way, distinguishing them sharply, choosing, identifying, reviewing and developing them more perfect aim [2]. Having critical thinking skills can aid students achieve maximum learning outcomes. Progressively, students are conscious of the critical thinking process as they learn, they will be able to control their own goals, personality, and attention more [3].
Except critical thinking, another capability that is no less important is self-efficacy. Self-efficacy is very notable in developing students’ passion and enthusiasm for learning. Self-efficacy is a person’s belief in his ability to organize and complete tasks that affect his life [4]. Self-efficacy can also be interpreted as a person’s evaluation of the ability or competence of oneself in carrying out a task, achieving goals, or cope with a problem [5]. Self-efficacy greatly affects student learning outcomes in schools [6]. Students who have an attitude of self-efficacy and a positive assessment of themselves tend to display good achievements in a consistent and sustainable manner [7].

Chemistry content that is considered difficult by grade 11 SMA/MA is the reaction rate. The conventional learning process is currently carried out where teacher-centered learning makes students simply memorize formulas in order to be able to pass from the material. Continuously, it is feared that the ability to think critically and self-efficacy of students becomes less developed. Furthermore, the competence to think critically and self-efficacy of students who are less developed can make students do not have the ability to solve various problems and tasks by the teacher and do not have passion and enthusiasm in learning so that learning outcomes are less than optimal.

Based on these matters, there needs to be a corrective in learning process through learning models that are able to improve students’ critical thinking skills and self-efficacy. Learning model that has the potential to be able to upgrade students’ critical thinking skills and self-efficacy is inquiry-based learning model [8]. Therefore, learning by using an inquiry-based learning model is expected to be able to improve the ability of critical thinking and self-efficacy of students and can help high school/MA students in understanding chemical contents, especially the reaction rate. The reaction rate material is very important for students to practice their critical thinking skills and self-efficacy.

This study aimed to determine differences of critical thinking skills and students’ self-efficacy in learning with inquiry-based learning models and learning with instructional models on reaction rate.

2. Method
This study used non-equivalent group post-test only control design with experiment class taught by inquiry-based learning and control class taught with direct instruction. This research was conducted in the odd semester of academic year 2019/2020 on the reaction rate. The research in this study took place at class XI in one of the high schools/MA in the city of Yogyakarta. The instruments used in this study were the lesson plan, the student worksheet, the students’ critical thinking ability test and students’ self-efficacy questionnaire. Data on critical thinking skills and self-efficacy were obtained by using a test description of the reaction rate and self-efficacy questionnaire given after implementation in each class finish. The analysis technique used Pillai’s Trace, Wilks' Lambda, Hotelling’s Trace Roy’s Largest Root in MANOVA.

3. Result and Discussion

3.1. Result
The learning model’s utility will have an impact on student learning outcomes both from cognitive, affective and psychomotor aspects. In this research, the cognitive and affective aspects studied were the critical thinking skills and self-efficacy. The indicators contained in critical thinking skills are capability to plan, interpret data, analyze, solve problems, conclude and evaluate. Indicators of students’ self-efficacy found in this study include self-confidence, courage, independence, responsibility and positive attitude.

| Table 1. Manova Result of Critical Thinking Skills and Self-Efficacy |
|-----------------|-------------|----------|------------|----------------|--------|------------------|
| Effect          | Value       | F        | Hypothesis df | Error df | Sig.   | Partial Eta Squared |
| Pillai’s Trace  | 0.206       | 7.890b   | 2.000       | 61.000    | 0.001  | 0.206            |
| Wilks' Lambda   | 0.794       | 7.890b   | 2.000       | 61.000    | 0.001  | 0.206            |
| Hotelling’s Trace | 0.259    | 7.890b   | 2.000       | 61.000    | 0.001  | 0.206            |
| Roy’s Largest Root | 0.259     | 7.890b   | 2.000       | 61.000    | 0.001  | 0.206            |
As shown in Table 1, the significance value obtained in the four types of tests is 0.001, it meant that smaller than 0.05, it showed that there were significant differences between the ability to think critically and students’ self-efficacy in learning with inquiry-based learning and direct instruction learning on the reaction rate. Table 1 showed there is also a Partial Eta Squared value stated the magnitude the learning model effect on critical thinking skills and self-efficacy = 20.6%. This figure can be interpreted that learning model had an effect = 20.6% on the ability to think critically and students’ self-efficacy on the reaction rate. Then Between-Subjects test is performed which was a unity of the Manova test. This was used to test the effect of learning models on each dependent variable, including the ability to think critically and self-efficacy of each class.

Table 2. The Results of Between Subjects Test of Critical Thinking Skills and Self-Efficacy

| Dependent Variable   | Df  | Mean Square | F     | Sig.  | Partial Eta Squared |
|----------------------|-----|-------------|-------|-------|---------------------|
| Critical Thinking    | 1   | 1700.428    | 9.760 | 0.003 | 0.136               |
| Self-efficacy        | 1   | 1991.725    | 6.030 | 0.017 | 0.089               |

As shown in Table 2 the variable of critical thinking ability had a significance (Sig.) = 0.003 with a Partial Eta Squared was 0.136 or 13.6%. These results means that there were significant differences in the ability to think critically between students in the classroom implemented inquiry-based learning and students in the classroom implemented direct instruction learning with an effect 13.6%. In self-efficacy variable, the significance value (Sig.) obtained was 0.017 with a Partial Eta Squared = 0.089 or 8.9%. These results means that there were significant differences between the students’ self-efficacy with the inquiry-based learning class and students in the direct instruction learning class, the effect was 8.9%.

Table 3. Statistical Descriptive Data of Critical Thinking Skills and Self-Efficacy

| Data                    | The Average Class  |
|-------------------------|--------------------|
|                         | Inquiry-based learning | Direct Instruction learning |
| Critical thinking       | 70.98              | 60.68              |
| Self-efficacy           | 76.20              | 65.04              |

Table. 3 showed that the value of critical thinking class with inquiry-based learning higher than direct instruction learning.

Table 4. The Scores of Critical Thinking Ability Indicators’ Aspects

| Critical Thinking Indicators | Experiment Score | Control Score | Maximum Score |
|------------------------------|------------------|---------------|---------------|
| Planning                     | 43               | 39.5          | 80            |
| Data Interpreting            | 56.5             | 51.4          | 80            |
| Analyzing                    | 42               | 38.8          | 80            |
| Problem Solving              | 71               | 65.3          | 80            |
| Concluding                   | 71               | 65.3          | 80            |
| Evaluating                   | 71               | 65.3          | 80            |

Table.4 stated that score the experiment class higher than control class on all indicators of critical thinking skills.

Table 5. Categories of Students’ Self-Efficacy Indicators Aspect

| Self-Efficiency Indicators   | Experiment Score | Control Score | Maximum Score |
|------------------------------|------------------|---------------|---------------|
| Self-Confidence              | 16.6             | 14.3          | 25            |
| Optimistic attitude          | 12.9             | 11.3          | 25            |
| Independence                 | 12.4             | 11.7          | 25            |
The ability to think critically is very important for students to expand their thinking skills. Moreover, studying with inquiry-based learning could aid students understand the relationship between concepts in the reaction rate.

Inquiry-based learning model could encourage students' critical thinking skills by involving the students’ role in the classroom or laboratory [9]. It was because this model gave students the opportunity to raise their knowledge independently, especially at the data collecting and data processing step. Furthermore, each syntax in this model demanded students to evaluate the cognition built so that students might use it and get accurate knowledge.

Inquiry-based learning could increase critical thinking skills because in this model students had the opportunity in the data collecting and data processing steps. The ability to think critically is very important for students in solving a problem. Inquiry-based learning models can provide chance for students to think, communicate, and had problem solving skills [10]. These three things are got from the investigation or explore stages which passed by students. The results study from Lawson et al (2015) also show that critical thinking skills can be expanded using probing or investigating approach to set opportunities for them to practice their skills [11].

The inquiry-based learning model is a teaching strategy that aims to develop students' skills in dealing with problems using the methods worn by scientists through research, inquiry, analysis and investigation in the classroom. Thus, inquiry-based learning has a positive influence on students' critical thinking skills [12].

Students' critical thinking skills in the direct instruction learning model did not develop optimally. This is because learning with the direct instruction learning model is only teacher centered. The teacher acted a centre of information so students do not need to search for and find facts or concepts themselves. This results in the achievement of students' thinking abilities up to low level. That abilities acquired by students in the direct instruction learning are only limited to reading and memorization level [13].

The implementation of inquiry-based learning models can improve students' self-efficacy because this model requires students to explore more in collecting and processing data independently [14]. It has an impact on students' believe in the data they have obtained. In addition, inquiry-based learning are student-centered that makes them more active than learning with direct instruction learning [15]. The activeness of students in the learning process will have an impact on increasing their level of self-efficacy. The more active a student is in a learning process, the higher level of self-efficacy. Inquiry-based learning is one of the learning models based on constructivism theory [16]. The constructivism theory assumes that students are active thinkers who construct concepts and regard knowledge as the result of their thoughts and activities. Students will have higher self-efficacy when inquiry-based learning are applied compared to direct instruction learning [17]. Thus, inquiry-based learning models can improve students' self-efficacy, such as demonstrations, reading, experimenting, discussing, analyzing problems, solving problems and making conclusions.

Moreover, inquiry-based learning make students enjoy with the learning because they learn in an exploration environment that will practice their investigative skills [18]. It is able to create a more active learning atmosphere, increase students 'motivation and enthusiasm for learning so that students' self-efficacy can terrace. This learning model also emphasizes the knowledge and experiences of previous students so that they order students to be active in connecting new knowledge with their prior knowledge.

| Self-Efficiency Indicators | Experiment Score | Control Score | Maximum Score |
|---------------------------|-----------------|---------------|---------------|
| Courage                   | 16.0            | 13.2          | 25            |
| Responsibility            | 15.5            | 14.7          | 25            |
| Positive attitude         | 13.1            | 12.9          | 25            |

Table.5 stated that score the experiment class higher than control class on all indicators of self-efficacy.

3.2 Discussion

The ability to think critically in the experiment class which implemented inquiry-based learning was higher than control class with direct instruction learning. That was because every phase in inquiry-based learning encourages students to expand their thinking skills. Moreover, studying with inquiry-based learning could aid students understand the relationship between concepts in the reaction rate.
and experience. This makes learning more meaningful because it is able to develop students' knowledge and self-efficacy.

Contrast with the inquiry-based learning model that makes students centre learning. The direct instruction learning model is teacher centred. The teacher in the instructional learning model directly acts as a source of information so that students do not need to search for and find facts, principles, and concepts themselves. This resulted in students tending to be passive during the learning process. Learners become less enthusiastic and spirit in learning because students accomplish task when getting orders from the teacher only. The role of the teacher who acts as an information centre also makes students limited in finding information.

4. Conclusion
Based on the results of the research and discussion above, it can be concluded that there are significant differences in the critical thinking skills and self-efficacy where experimental class was better than control class.

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