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Students' Generic Science Skills in Chemistry Learning Using Inquiry-Based Learning

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***Abstract*—Generic skills are skills needed for various fields of work and life. In this research, the generic skills discussed are generic skills in the field of science, called generic science skills. This research aims to analyze the effect of inquiry-based learning on students' generic science skills in chemistry learning. It was quasi-experimental research with the post-test only design. The population was the eleventh-grade science students of state high school 5 Yogyakarta, Indonesia. The sample in this research was taken by random sampling technique as many as two groups, namely the experimental group and control group. The students in the experimental group learned through the inquiry-based learning, while students in the control group learned through the conventional learning. The data on the student's generic science skill were collected through the generic science skill observation. The data were analyzed by using one-way ANOVA with SPSS version 23.0. The results showed that students who used inquiry-based learning in the assessment process have increased generic science skill better than those used conventional learning. Thus, the conclusion of this research was that the implementation of inquiry-based learning has a significant effect on the increase in generic science skills.**

Keywords—inquiry-based learning, generic science skills, conventional learning, senior high school, chemistry

I. INTRODUCTION

The importance of the role of education in improving the human resources. Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential [1]. Nevertheless, based on the results of the 2016 Human Development Report, Indonesia's Human Development Index in 2015 was ranked 113 (down from 110 in 2014). This shows the quality of education in Indonesia is alarming. The causes of the low quality of education in Indonesia include problems of effectiveness, efficiency, creativity, and standardization of teaching/learning, so that the potential of students has not been fully developed [2].

Learning activities are carried out with characteristics: a) interactive and inspirational; b) fun, challenging, and motivating students to actively participate; c) contextual and collaborative; d) provide sufficient space for the initiative, creativity, and independence of students; and e) according to the talents, interests, abilities, and physical and psychological development of students [3]. The result of several studies conducted on students, especially in chemistry learning showed that the activity, participation, interest, enthusiasm, and motivation of student was lacking; teacher-centered; unpleasant and boring, so that thinking chemistry is a difficult subject [4-6].

Learning models that involve students actively in finding and discovering their knowledge, one of which is inquiry-based learning. The task of the teacher as a facilitator and guiding the course of learning. Inquiry learning model requires students to think critically and analytically in solving a problem [7]. Inquiry-based learning help students develop intellectual discipline and skills that are qualified to improve questions and search answers that are hidden from the curiosity of students. In the guided inquiry-based learning the teacher provides a formulation of the problem of the investigation, and the students design an investigation and produce an explanation [8]. However, the implementation of the guided inquiry-based learning is rarely carried out by the teacher. Based on the results of several studies, especially in chemistry learning shows that the learning model used by teachers is less varied, students are less involved in finding concepts/knowledge, teacher-centered learning, and the use of instructional media is less than optimal such as laboratory use [4-6].

Chemical learning activities with practicum. Basic competencies that must be achieved are designing, conducting, and concluding and presenting the results of the experiment [9]. However, the results of the study indicate that the practicum is still verification and cookbook. In general, practical activities aim to prove the truth of the concept. The dominant practical activity is the activity of collecting and analyzing data, making conclusions, answering questions related to the results of the practicum and its application, and compiling a lab report. The practicum procedure is guided by a guide book that is presented systematically. Students do not design their own trial procedures. Students who design their own experiments to be carried out will develop their skills higher when compared to students who follow the procedures in the practical manual. Verification practical activities and cookbooks do not develop an understanding of concepts and various skills possessed by students [10, 11].

One of the skills that must be possessed by students is generic skills with the development of generic skills of students so that other skills will develop such as critical and creative thinking skills, students will have the ability to think and act based on their chemical knowledge [12]. General skills are skills needed for various fields of work and life. Generic skills are basic abilities that are general, flexible, and oriented as provision for learning higher knowledge or serving the tasks of the broader field of science / work, not

only in their fields of expertise but also in other fields. Every education sector has the role of helping students develop their generic skills [13-15]. Generic skills in chemistry learning can be categorized into 10 components namely direct observation, indirect observation, awareness of scale, symbolic language, logical framework, logical consistency, causal law, mathematical modelling, logical inference, and abstraction [16, 17]. However, based on the research conducted, the generic science skills of high school students are far from satisfying (still low) in adaptive group lessons such as chemistry, physics, mathematics, social sciences, computers, and information processing and entrepreneurial skills [18]. Chemistry lessons with students' low understanding of chemical equilibrium material [19].

This shows that students' generic science skills have not been developed in learning activities. Therefore this study applies inquiry-based learning to improve students' generic science skills in chemical equilibrium material. This is the reason why this research was conducted.

II. Research Method

A. Research Design and Participants

This research used the quasi-experimental research with the post-test only design. The form design is shown in Table 1 [20]. The population of this research included the eleventh-grade science student of state high school 5 Yogyakarta, Indonesia. The sample was collected using the random sampling technique. The sample included 60 students; 30 students as the experimental group and 30 students as the control group. The students in the experimental group learned through the inquiry-based learning, while students in the control group learned through the conventional learning. This research was conducted in the even semester on academic year 2018/2019. The application of the model in the experimental and control groups as many as 6 meetings starting in November 2018.

TABLE I. Research Design

Group	Treatment	Post-Test
Experiment	Inquiry-Based Learning	Generic Science Skills
Control	Conventional Learning	Generic Science Skills

B. Data Collection

The data of this research were the scores of the students' generic science skills were collected through the generic science skill observation consisting of nine items have been validated. The generic science skills observation sheet was developed from indicators Brotosiswojo [14]. The nine items indicators assessed in this research is direct observation, indirect observation, awareness of scale, symbolic language, logical framework, logical consistency, causal law, mathematical modelling and logical inference.

C. Data Analysis

The data were analyzed using one-way ANOVA with the help of SPSS version 23.0. The inferential analysis was conducted with a 5% significance level. The normality of data distribution was tested using the Shapiro-Wilk Test. The homogeneity of variance data was tested using the Levene's Test of Equality of Error Variances.

III. Results and Discussion

A. Results

The generic science skills of the students who learned using the inquiry-based learning were better than those obtained through the conventional learning. The average score of generic science skills of the students who learned through the inquiry-based learning (experiment group) was 90.84, while the student who learned through the conventional learning (control group) was 86.16. The distribution of the student's generic science skills is shown in Table 2.

TABLE II. The Distribution of Students' Generic Science Skills

Group	A score of Generic Science Skills			
	Sum of Samples (N)	*Minimum*	*Maximum*	*Mean*
Experiment	30	80.56	99.08	90.84
Control	30	75.00	98.61	86.16

The normality of the data distribution of the generic science skills of the students in the experimental group and control group were tested using the Shapiro-Wilk Test. The homogeneity of variance data was tested using the Levene's Test of Equality of Error Variances. The summary of the result of the normality and homogeneity test are shown in Table 3.

TABLE III. The Summary of The Result of Normality and Homogenity

Group	Test of Normality			Test of Homogeneity	
	Shapiro-Wilk			*Levene Statistic*	*Sig.*
	Statistic	*df*	*Sig.*		
Experiment	0.959	30	0.299	0.542	0.465
Control	0.973	30	0.633		

Based on Table 3, the data on the score of the student's generic science skills of the experimental and control group are normally distributed. This is evidenced by the value of significant from normality test > 0.05 which are equal to 0.299 (experiment group) and 0.633 (control group). Homogeneity of variance data is homogeneous. This is evidenced by the value of significant from homogeneity test > 0.05 which is equal to 0.465. Based on the characteristic of the data above, the data on the score of the student's generic science skills can be analyzed using the one-way ANOVA. The summary of the result of analysis using the one-way ANOVA is shown in Table 4.

TABLE IV. The Summary of The Result of One-Way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	328.068	1	328.068	9.104	0.004
Within Groups	2090.005	58	36.035		
Total	2418.073	59			

Based on Table 4, the value of significant from the one-way ANOVA test is 0.004 < 0.05, meaning that the generic science skills of the students who learned through the inquiry-based learning are significantly different from those of the students who learned through the conventional learning. The generic science skills of the students who learned through the inquiry-based learning are better than those of the students who learned through the conventional learning.

B. Discussion

The research showed that the generic science skills of the student who learned through the inquiry-based learning were better than those obtained by the students who learned through the conventional learning. Implementation of inquiry-based learning has a significant effect on increasing generic science skills of students in chemistry learning. This is evidenced by the value of significant from the one-way ANOVA test < 0.05 which is equal to 0.004, shown in Table 4. Besides, based on the analysis as presented in Table 2 shows the average of generic science skills in experiment group is higher than the control group, that are 90.84 in experiment group and 86.16 in control group. The data obtained are normally distributed and homogeneous so that the data can be analyzed using one-way ANOVA with the help SPSS version 23.0, shown in Table 3. Inquiry learning has a positive effect on generic science skills because the stages of inquiry-based learning involve students actively and develop skills [7].

The learning stage in the inquiry-based learning give opportunities for the students to develop critical thinking, analytical thinking, and generic science skills in finding answers to a problem [7, 21]. The stages of inquiry-based learning are identification and determination of the scope of the problem, planning and predicting results, investigations for data collection, interpretation of data and developing a conclusion, and reflection [8, 22]. The first stage, identification and determination of the scope of the problem. Student are faced with problems to attract the students' attention or generate their interest in the pose the problems. This problem is used as the learning stimuli for the students so that they learn actively. The second stage, planning and predicting results. Student are given the opportunity to collect literature, design an investigation, and formulate a hypothesis. The teacher directs students who need guidance in the preparation of the design of investigations and experiments. Third Stage, investigations for data collection. Students are given the opportunity to do a practicum in accordance with the design made to obtain data. In this phase, they learn meaningfully, practice and develop the scientific attitude. The fourth stage, interpretation of data and developing a conclusion. Student discusses with the group to get a conclusion from a problem by analyzing the data obtained. The fifth stage, reflection. Students are given the opportunity to apply new knowledge found. The students are given guidance and feedback from the teacher. Besides, the teacher also evaluates their achievements.

Many studies have discussed about inquiry-based learning. The results of the study show that inquiry-based learning is better than conventional learning. The results of the application of inquiry-based learning are improving understanding of chemical concepts, science process skills, problem-solving skills, building self-confidence, independence, increasing depth of student knowledge and overcoming misconceptions [21, 23-26]. Inquiry-based learning involves students actively in finding and discovering their knowledge, while educators as facilitators and guide the course of learning [7]. Inquiry-based learning is more successful if students have the opportunity to learn and practice designing experiments and recording data [8]. Therefore, the inquiry-based learning could motivate laboratory activities and help students understand the chemistry material [7].

The inquiry-based learning was associated with environmental phenomena that are appropriate with their prior knowledge help them construct new knowledge [25, 26]. The inquiry-based learning gives opportunities for the students to design investigation such as designing practicum. Designing practicum activities, the students are challenged to analytical and critical thinking on how to solve their problems, so the generic science skills will develop [7, 12]. The designing practicum is one of the inquiry activities to practice and develop the students' metacognitive skills and develop wider learning skills including the generic science skills [21, 24-26]. Generic skills are skills needed for various fields of work and life [13]. Therefore, generic skills need to be developed.

Generic skills are basic abilities that are general, flexible, and oriented as provision for learning higher knowledge or serving the tasks of the broader field of science / work, not only in their fields of expertise but also in other fields [14]. Generic science skills as competencies at the basic level are used across different fields of work [27, 28]. Every education sector has the role of helping students develop their generic skills [15]. Generic science skills are the ability to think and act based on their chemical knowledge [12]. Generic skills, namely planning and experimental design; interpretation of experimental data; numeracy and computing skills; report writing skills; presentation skills; information retrieval skills; problem-solving skills; cooperation skills; time management and organizational skills; and the ability to learn independently [29]. Generic skills are classified into: a) basic skills, such as: reading, using numbers, technological skills; b) skills related to people, such as: communication skills, teamwork skills, leadership skills; c) conceptualization or thinking skills, such as: managing information, solving problems, thinking innovative, creative; d) personal skills and attributes, such as: enthusiastic, responsible, honest; e) skills related to the business world, such as: innovation skills, company skills, business awareness; and f) skills related to the community, such as citizenship skills [30]. In this research, generic skills in chemistry learning can be categorized into 10 components namely direct observation, indirect observation, awareness of scale, symbolic language, logical framework, logical consistency, causal law, mathematical modelling, logical inference [16], and abstraction [17].

The learning model used by teachers is less varied, the teacher uses conventional learning. The conventional learning does not give opportunities to the students to design practicum. The students conducted practicum according to the practicum stages in their worksheet so that they did not understand clearly every stage of the practicum conducted. This has led to less developed generic science skills. Conventional learning is teacher-centered learning, students are less involved in finding concepts/knowledge, and the use

of instructional media is less than optimal such as laboratory use[4-6].

Although the generic science skills of students who learned through inquiry-based learning were better than those obtained by the student who learned through conventional learning, the results were not optimal. This was caused by many obstacles in the implementation of inquiry-based learning. The obstacles found in the implementation of the inquiry-based learning were as follows. a) Most of the students were not ready to learn the subjects although they had been given tasks to do the problems in the worksheet before learning. b) It was difficult in growing the positive habit of the students to be active, as the learning results from the learning experience before tend to make the students passive. The students must be habituated to follow inquiry-based learning so that they can develop generic science skills to the fullest.

IV. Conclusion

The generic science skills of the students who learned through the inquiry-based learning were better than those obtained by the students who learned through conventional learning. Implementation of inquiry-based learning has a significant effect on increasing generic science skills of students in chemistry learning. This is evidenced by the value of significant from the one-way ANOVA test < 0.05 which is equal to 0.004. The generic science skills developed at chemistry lesson and the topic of chemical equilibrium is direct observation, indirect observation, awareness of scale, symbolic language, logical framework, logical consistency, causal law, mathematical modelling and logical inference.

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