



THE INFLUENCE OF INQUIRY-BASED SCIENCE ISSUES LEARNING ON PRACTICAL SKILLS OF JUNIOR HIGH SCHOOL STUDENTS IN ENVIRONMENTAL POLLUTION TOPIC

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ABSTRACT

Inquiry-based science issue approach facilitates the development of scientific skills through research activities on surrounding science issues. The purpose of this research was to understand the influence of Inquiry-based science issues on practical skills of Junior High School students. This research employed quasi-experimental research method, equipped with pre-test, post-test non-equivalent control group design. The sample of sixty junior high school students in Yogyakarta was picked for this study. The instruments used were observation sheets on practical skills, practical skills test, and instructional learning sheets. The data collected were analyzed using N-Gain, percentage, and Analysis of Covariate (ANCOVA) at 0.05 significance level. The result revealed that Inquiry Science Issues was more effective in fostering students' practical skills than the scientific approach. There was a significant effect of treatment on students' practical skills while no interaction between approach and prior knowledge of students. Moreover, the data of practical skills through the observation sheets in the experimental class had higher percentage compared to the control class, 80.36%, and 70.61% respectively.

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INTRODUCTION

Nature of Science (NOS) is an important element in the implementation of science learning. This element should be understood by either teachers or students. The understanding of NOS is very important to develop some aspects of science that help students comprehend science well including content understanding, scientific work, positive characters, and scientific attitude (Faikhamta, 2013). It is further explained that studying Science would provide three kinds of science skills and understanding for students: science principles, science concepts, reasoning

skills and performing scientific procedures, and understanding the nature of science as a specific form of human effort (National Research Council, 2000).

Science is a process of studying the universe. The process is done through scientific activities in the form of data collection through observation and inference through investigation (Lederman et al., 2014). The data collection is followed by a theory review which is then adopted to explain the observed or investigated phenomena. Thus, teaching science as its essence is a way of investigating which of the approach facilitates students to practice as well as cultivate the required skills to conduct investigations (Demirdö et al., 2016). Science learning involving students in

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inquiry activities by integrating skills, knowledge, and attitudes would help students to understand the concepts of Science (Zeidan & Jayosi, 2014; Gormally et al., 2009). Students would process messages to gain knowledge, skills, and values of Science through Inquiry (Setiawan et al., 2016).

Inquiry learning could give students the opportunity to apply the procedures used by scientists to identify problems, ask questions, present research steps, provide persistent explanations, make predictions, and arrange explanations that support the experience (Ambarsari et al., 2013). The inquiry is one of the investigation-based approaches, which is a way to ask questions and look for a proof of a problem to find accurate information. Inquiry-based learning will help students to develop rational ways of thinking, critical thinking and scientific skills, and scientific literacy (Villardón-gallego, 2016). In addition, inquiry learning does not only encourage the ability to think but also the ability to work and communicate scientifically (Savitri et al., 2017). According to the National Research Council (2000), scientific literacy is the ability to understand scientific concepts and processes that are essential for making decisions related to personal as well as social issues. To solve problems or issues, teachers need to involve students in investigating the problems during a science lesson. Inquiry-based learning will improve students' problem-solving skills resulting in students' development of high-level thinking skills, discussion skills, investigation, and understanding of science facts (Cahyarini & Rahayu, 2016).

Investigations are brought to Science class through Inquiry-based science issues approach. The inquiry-based learning facilitates students to solve it through investigation, resulting in the development of their thinking and reasoning skill (Pratiwi et al., 2016). The characteristics of Inquiry-based science issues learning can be seen from the students' orientation of raising scientific questions concerning a certain issue. The students then formulate problems, state hypothesis, gain proofs, test the hypothesis, and conclude the result to answer the determined questions.

Previous research found that in learning science process struggles with the cognitive aspect without considering the skills aspect. The facts found that students have not been able to select the tools used in the experiment correctly; in addition, they have not been able to perform the procedure well and have not communicated the image data or graphics, not exactly in making in-

terpretation of experimental results. Meanwhile, those skills are indispensable for the achievement of practical skills that are part of the skill aspect in the science learning outcomes. The approach of inquiry-based science issues is expected to help students grow their practical skills since they conduct investigations through practicum activities. Practical skills in science learning are related to the skills possessed by the students to be able to discover the concept of science through observation, experiment, or investigation. Abraham (2012) stated that practical skills are skills that can increase students' competence in performing various scientific activities involving the activity of manipulating variables and observing the real objects. The four categories of practical skills include procedural and manipulative skills such as planning investigations, and selecting the right tools and materials while safety comes first. Observational skills are related to appropriate observations and measurements while drawing skills deal with the process of organizing data through tables and graphs, drawing the tools, sketching, and giving a description of the image. Moreover, reporting and interpretative skills include the process of recording, interpreting and reporting results accurately.

During the investigation, students can practice using tools and materials, and follow the procedures with safety concerns. Students can practice observing, gathering information, and performing accurate measurements using relevant tools and appropriate units. After obtaining the data, students can practice determining the appropriate method to organize the data of the investigation that has been put in tables or graphs (Zafra-gómez et al., 2015). Through the inquiry process, the students also contribute their ability to analyze and interpret the results of their investigation by identifying patterns and relationships appeared in the data. Through instruction with Inquiry science issues approach, students will conduct an inquiry to solve problems through practicum activities, where this activity will bring up the students practical skills. Thus, the four categories of practical skills can be applied and developed through the process of inquiry learning. Therefore, the purpose of this research is to investigate whether or not there is any influence of the application of Inquiry-based science issues on Practical Skills of Junior High School students in Environmental Pollution topic, which is a familiar and factual one.

METHODS

This research used quasi-experimental design. The adopted research design was non-equivalent control group design. This design used in consideration that intact classes seems impossible to have completely randomized the subject (McBurney et al., 2010). The study conducted in SMP 1 Paliyan Yogyakarta in the even semester, the academic year of 2016/2017 in April 2017. The population in this study was all students of grade VII, SMP N 1 Paliyan. One class took as an experimental class and the other as a control class. The experimental class was a class taught with the Inquiry-based science issues approach, while the control class was taught with the Scientific Approach. The instruments employed in this research including learning activity observation sheets, practical skill observation sheets, and questions on pretest-posttest of practical skills that have been examined empirically to find out its validity and reliability. The questions have been declared valid, with high reliability of $r_{11} = 0,69$.

Data were analyzed using N-Gain, percentage while inferential statistic such as Analysis of Covariate (ANCOVA) was used using pretest scores as a covariate to test the hypothesis at 0.05 significance level (Çetin, 2013). The hypotheses proposed in this study are:

H_0 : There is no influence of Inquiry-based science issues on practical skills of the Junior High School students.

H_a : There is an influence of Inquiry-based science issues on practical skills of the Junior High School students.

RESULTS AND DISCUSSION

In this research, a hypothesis test was carried out to know whether or not there was an influence of Inquiry-based science issues on practical skills of the Junior High School students at SMP 1 Paliyan. The control class applied

the scientific approach and experimental class adopted the inquiry-based science issues approach. During the learning process, the researchers observed the implementation of both approaches at both classes.

The observation sheets were used to observe the learning process and came up with these three activities as presented in Table 1.

Table 1. Percentage of Learning Performance

	Activity 1	Activity 2	Activity 3
Experimental class (<i>inquiry-based science issue</i>)	100%	100%	100%
Control class (<i>Scientific approach</i>)	98%	98%	100%

Based on the observation results obtained from both classes, the average was 100%. The value indicated that all teachers' activities and students' activities had been done successfully. The lessons were designed to foster the students' practical skills. The approach of inquiry-based science issues refers to a learning process that exposes the students to science issues on environmental pollution topic and facilitates students to solve them through investigation (Zion & Mendelovici, 2012). This is parallel with the research by Dewi & Prasetyo (2016) who found that this approach successfully improves students' practical skill to solve problems. There are six inquiry learning stages; problem orientation, formulating problems, formulating hypotheses, gathering evidence, testing hypotheses, and making a conclusion (Simsek & Kabapinar, 2010). In this study, the orientation focused on science issues. Therefore, the first stage was the orientation on science issues, formulating problems, formulating hypotheses, gathering evidence, testing hypotheses, and forming a conclusion, as presented in Table 2 based on the result.

Table 2. The Learning Stages of *Inquiry-based Science Issues*

Inquiry stages	Teachers' Role	Students' Role
Orientation on Science issues	Giving reading sources containing science issues adapted to the topics and learning objectives.	Taking a close look at the science issues presented.
Formulation questions	Asking the students to discuss and identify conflicts arose on the issues.	Discussing to identify the emerging conflicts on science issues.
Formulating hypotheses	Based on the observed issues, the teacher guided the students in raising questions based on the issues presented.	Formulating questions based on the explored issues.

Gathering evidence	Guiding the students in formulating simple hypotheses based on the examined questions by encouraging the students to have discussions with their friends	Collecting relevant information related to the examined questions to formulate hypotheses.
Testing hypotheses	Helping and guiding groups in performing tasks and organizing the data.	Formulating simple hypotheses.
Making a conclusion	Supporting and giving the students opportunity to have discussions in finding the relation and pattern of the obtained data	Understanding the work procedures.

The inquiry-based science issues approach puts teachers as problem providers. Furthermore, Llewellyn (2011) stated that in addition to determining problems or questions, teachers should provide advice on what tools and materials should be used while encouraging students to design safe work procedures to solve problems. The students then carry out the work procedures, obtain data, and formulate explanations and conclusions from the data obtained. During the lesson, the teachers act as a facilitator who monitors the students and guides them when they need. The teachers' role is as a facilitator ensuring the students have no difficulties in performing activities. Guidance is given in the form of questions instead of direction about what students should do. Through questions, the teachers assist the students in solving questions or problems as well as provide assistance in formulating explanations for the investigation results (Demirdö, 2016). Practical skills emphasized in every activity have four categories, which are (1) procedural and manipulative, (2) observational, (3) drawing, and (4) reporting and interpretative. Those are expected to appear in each activity (Kumar, 2009). The data of practical skills were collected using observation sheets presented in Table 3.

Table 3. The Achievement Data of Practical skills through the Observation Sheets.

Practical Skills Aspects	Experiment Class (%)	Control Class (%)
Procedural and manipulative skill	79.32	69.25
Observational skill	86.82	75.84
Drawing skill	77.99	69.32
Reporting and interpretative skill	77.33	68.82
Average	80.36	70.81
Category	Very Good	Good

The results of observation sheet analysis show that after the inquiry-based science issues approach applied, the experiment class students' mastery of practical skills was better than the control class and the highest component in both classes was the observational skill aspect. The data of practical skills taken using test are presented in Table 4.

Table 4. The Data of Practical Skills through Test

	Average Score		N-Gain score	Category
	Pre-test	Post-test		
Experiment class	60.25	84.25	0.6	high
Control class	60.07	75.74	0.4	moderate

As seen in Table 4, experiment class had a high category in N-Gain score, means that the achievement of practical skill was better than the control class which applied Inquiry Science Issues. Students could solve the problem of science issues by investigating while they developed each aspect of practical skills. Inquiry Science Issues was more effective in fostering students' practical skills than the scientific approach.

As a prerequisite hypotheses test, normality and homogeneity tests indicated normally and homogeneously distributed data. The result of normality data was sig (2 tailed) 0.94, $p > 0.05$, while homogeneity data was sig (2 tailed) 0.333, $p > 0.025$, means that the posttest data in the experiment class were normal and homogeneity invariance. Therefore, a parametric test was conducted to test the hypotheses as presented in Table 5.

Table 5. The Results of *Analysis of Covariance*

Source	df	F	Sig
Corrected Model	2	10,629	.000
Pre-test practical skills	1	7,096	.010
<i>Inquiry-based science issues</i> Approach	1	14,162	.000
<i>Corrected Total</i>	59		
R Squared = .272 (Adjusted R Squared = .246)			

The above analysis shows that the significant number of the approach was 0,000 in which the value was less than 0.05, therefore, the H_0 was rejected. Thus, it concludes that there was an influence of Inquiry-based science issues approach on practical skills. Its influence could be simultaneously observed from the significance of the Corrected Model, having the sig value 0.000 < 0.05, thus, the H_0 was rejected. Therefore, it concludes that the Inquiry-based science issues approach influenced practical skills simultaneously. It infers that the practical skill aspect was related to the inquiry-based science issues in learning. The stage of gathering evidence facilitated the students to practice procedural and manipulative, observational and drawing skills. The stage of testing hypotheses helped the students practice reporting, interpreting, and drawing skills. In addition, the stage of formulating conclusions facilitated the students to practice reporting and interpreting skills.

An inquiry science issues learning helps students to actively involve in learning and practicing practical skills directly through investigations. The inquiry science issue learning includes the students' active roles in developing their understanding of the topics learned and developing practical skills. Moreover, the inquiry-based learning would improve the thinking skills by investigating problems or issues (Duran & Dökme, 2016). The students collect evidence and use it to explain the phenomena they are studying. In addition to building an understanding of the studied topics, students also have the opportunity to practice skills and cultivate their attitudes (Erdogan, 2017).

The category of practical skills in the form of procedural and manipulative skills trained through the stage of collecting evidence. Before collecting the data, the students have to look at the work procedures, make a selection of tools and materials, and learn to use them. This is in line with Llewellyn (2011) who explained that before the students undertake an inquiry process, they need to gather the required tools and materials, then read and follow the work procedures.

The data collection stage in inquiry-based science issues learning provides students the opportunity to gather the tools and materials needed for the data collection process. The students could also practice using the tools appropriately for their usefulness. Moreover, they would practice choosing the tools by observing its condition so that the selected tools are not disabled or even harmful. Through this stage, they would rehearse to conduct an investigation according to the ap-

propriate steps. In addition, they are also directed to always pay attention to the stay safe in working with chemicals (Abrahams & Millar, 2008.)

The above activities gave an opportunity for students to learn to choose the tools and use it according to its purpose. Busaidi & Lock (2017) stated that the students practice to assemble tools according to work procedures and release them carefully and are facilitated to learn how to operate the practicum tools. Furthermore, they are trained to always pay attention to safe work procedures in conducting an investigation. This means that they have the opportunity to continue to practice their practical skill aspect in the form of procedural and manipulative skill.

Millar (2010) stated that research confirms that students are better at using equipment and carrying out practical procedures if they had opportunities to practice doing these, rather than just being shown how to do them. This is in line with the research result indicating that the procedural and manipulative skill category emphasizing on the tool operation and the implementation of safe work procedures developed well after the students were given the opportunity to practice directly and continue to practice through inquiry-based science issues learning.

One of the practical skill aspects, the observational skill, was assigned through the stages of collecting evidence on inquiry-based science issues learning. The students required to collect data appropriately. This is in accordance with the statement of Llewellyn (2011) that during an investigation process, students need to collect data appropriately. In addition to obtaining data through observation, communicating the observational data, working procedures, and analysis results are the important parts of the scientific process (Bass et al., 2009). Therefore, skills in making tables, diagrams, graphs, and sketches become an important thing in communicating the obtained results.

Skills in creating tables, picture series, graphs, sketches, and diagrams honed through the stages of collecting evidence on inquiry-based science issues learning. After obtaining the observational data, students must organize the data into tables and diagrams. This means that the students have the opportunity to continue to rehearse practical skills in the form of drawing skill. Harlen (2014) revealed that the most important way to develop skills in communicating data in the form of images, tables, graphs, or diagrams is to provide ideas about how to record certain kind of information using tables, drawings with labels and symbols.

The fourth aspect of practical skills is reporting and interpreting skill. This includes skills in recording observations according to the data obtained, classifying and interpreting observations, and making appropriate conclusions. Skill in recording observations is required while collecting evidence. The stage of collecting evidence in inquiry-based science issues learning involves the students' active roles in collecting tools and materials, observing, collecting data, and recording observations. The teacher ensures that the students record their observations and guide them to record the observations according to the facts found. Time allotment for the students to record observations is also important. This is parallel with Bass et al. (2009) that during the activity, providing sufficient time for the students to record their findings is really essential. Therefore, by using inquiry science issues, students could improve their practical skills by doing experiments to solve problems especially science issues

CONCLUSION

The process of learning science is still struggling with the cognitive aspect without considering the skills aspect. The approach of inquiry-based science issues is expected to help students grow their skills aspect in particular practical skills since they conduct investigations through practicum activities. Practical skills in science learning are related to the skills possessed by the students to be able to discover the concept of science through observation, experiment, or investigation. The inquiry-based science issues approach puts teachers as problem providers by involving science issues. The learning stages of inquiry-based science issues include six stages: orientation to science issues, formulating problems, formulating hypotheses, gathering evidence, testing hypotheses, and concluding. Besides, the data of practical skills on the observation sheets derived from the experimental class had a higher percentage than control class on Procedural and Manipulative skill, Observational skill, Drawing skill, Reporting and interpretative skill, compared to the control class'. The results of hypotheses testing were significance (0,000) <0.05 which means that there was a significant influence of inquiry-based science issues learning on practical skills of Junior High School students in Environmental Pollution topic. The result revealed that Inquiry Science Issues was more effective in fostering students' practical skills than the scientific approach. There was a significant effect

of treatment on students' practical skills while no interaction between approach and prior knowledge of students.

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