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The Effect of Inquiry Based Learning With V-Diagram on Students Science Process Skills in Provision Solution Materials

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ABSTRACT

Process skills are very important to be trained for students in the learning process because process skills have a role to help students in developing their minds, provide opportunities to make discoveries, improve memory, and help students learn scientific concepts. The purpose of this research was to determine the effect of inquiry-based learning on students' science process skills in the buffer solution material. The research method used a quasi experiment with a research design Posttest Only Control Group Design, which consists of an experimental class and a control class. The results showed that inquiry-based learning with V-diagrams had a higher score of student science process skills than those using inquiry-based learning alone. Generally the inquiry-based learning with V-diagrams is more effective than inquiry-based learning for students' science process skills.

1. Introduction

Education in schools has the aim of developing students' potential to be able to have knowledge, skills, and attitudes to learn as a form of stable behavior change in learning and to develop their potential to have religious-spiritual strength, self-control, personality, intelligence, noble character, and the required skills themselves, society, nation and state.

The quality of education in Indonesia is still low, so efforts are needed to build people's lives and change people's mindsets so that Indonesia can progress and develop in achieving educational goals. One way is to improve the quality of human resources through the learning process in schools. Thus the teacher must be able to present meaningful learning so that the expected educational goals can be achieved. One of the factors for the low quality of education in Indonesia is that the learning process in class is still focused on the teacher. One of the abilities

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a teacher must have is the selection and use of appropriate learning models that can stimulate student interest to be active in the teaching and learning process.

Inquiry-based learning helps students develop inquiry skills, which are the basic skills of the 21st century (Kong, et.al., 2014). Inquiry-based learning is defined as learning by asking questions, and by researching, and as a learning process by analyzing knowledge and transforming data into useful knowledge (Perry, et.al., 2001). Inquiry-based learning is a learning method that is based on constructivist theory and which is effective in student learning and in developing higher order thinking skills. In this method, students go through processes such as making observations, gathering evidence, making assumptions, conducting experiments, testing possible explanations and interpreting findings using techniques used by scientists in scientific research (Pedaste, et.al., 2012).

Students work like scientists in inquiry-based learning and discover answers to questions and problems that intrigue them through their own research. Therefore, the use of this method especially in science classes will increase students' motivation, solve their creative problems, achieve real information and permanent learning (Lord, et.al., 2006). The use of learning models is highly recommended in teaching. The key is to initially present social influences such as modeling and gradually shift to self-influence, that is, when students internalize the skills and strategies shown by the model (Schunk, 2012). One recommended learning model uses inquiry-based learning models for classroom learning.

This study uses the steps of the inquiry learning model according to (Sanjaya, 2009). This is because the inquiry learning model according to Sanjaya (2009) has a step orientation, step orientation is an important step in the learning-based inquiry model. The stages of the inquiry-based learning model consist of orientation, namely steps to foster a responsive learning atmosphere or climate where the teacher makes students ready to carry out the learning process, formulates problems, namely steps to take students to problems that contain puzzles, submit hypotheses, collect data namely the act of capturing the information needed to test the proposed hypothesis, testing the hypothesis, namely the process of determining the answer that is considered acceptable according to the data or information obtained based on data collection. Student confidence in the answers given is the most important thing in testing hypotheses, and formulating conclusions, namely the process of decrypting the findings obtained based on the results of hypothesis testing. The step in formulating this conclusion is the final step in applying an inquiry approach to learning.

Scientific inquiry has been highly recommended for application in middle and secondary school science since the last century. Some of the common obstacles to applying inquiry in Chemistry include insufficient knowledge of Chemistry and the nature of science, a lack of pedagogical skills, inadequate access to appropriate curriculum materials, and teachers teaching outside their area of expertise (Roehrig, et.al., 2004). Science inquiry has been verified as an effective learning approach to improve conceptual understanding and critical thinking skills for high school students in Thailand (Yasukham, et.al., 2011).

Based on the background description in this study, the purpose of this research was to determine the effect of inquiry-based learning on students' science process skills on the buffer solution material.

2. Methodology

This research was a quasi-experimental research with Posttest Only Control Group Design (Creswell, 2016). Since the classes were formed at the beginning of the semester by the school administration, it was not possible to randomly assign students to the experimental and control groups. But classes were randomly assigned to control and experimental groups. The experimental design patterns are shown in Table 1:

Table 1: Study Design

Group	Treatment	Posttest
Experimen	Experiment X	A ₁
Control	Control X	A ₂

This research was conducted at SMA Negeri 14 Pekanbaru for the 2018/2019 academic year. The research time is April-May 2019. The subjects of this study were students of class XI SMA Negeri 14 Pekanbaru for the 2018/2019 academic year. The research sample was class XI IPA, while the object in this study was the science process skills of students in chemistry subject matter of buffer solution.

The sample was taken by using the cluster random sampling technique. The data was collected by using the method of documentation, interviews, and science process skills test questions. The data collection process in this research are:

- a. A literature review was carried out regarding the independent and dependent variables.
- b. Specific objectives are examined and determined.
- c. A test science process skills are developed keeping in mind the test development steps.
- d. A pilot study is carried out to develop valid and reliable tests
- e. A lesson plan based on Inquiry Based Learning with V-diagrams and Inquiry Based Learning was prepared
- f. The research sample was determined in public schools.
- g. The main study duration is five weeks. First, a science process skills test was given to the group as a pre-test in the first week by one of the researchers.
- h. While IBL with V-diagram activities was carried out in the experimental group, IBL instructions proposed by the regular program were carried out in the control group. The treatments lasted four weeks in two groups. There are four hour chemistry lessons each week. In other words, the class instruction of the group is four 45 minute sessions per week. During the treatment, the prepared lesson plans were considered in each group. The concept of something related to everyday life and a buffer solution that is covered as part of the regular classroom curriculum in the course of

chemistry. On the other hand, in the control group, lesson plans prepared based on the regular science curriculum were followed by the teacher for four weeks.

- i. At the end of the study, a science process skills test was given as a post-test

The quantitative and qualitative descriptive statistical data analysis techniques were used to analyze the effect of the IBL V-diagram on science process skills using the SPSS-20 program. Normality and homogeneity tests were controlled using descriptive statistics. In this study, researchers have used various types of statistical techniques. Mean test, standard deviation test and ANOVA test. This test is used to test the effect of the application of inquiry-based learning with V-diagrams on students' science process skills in the buffer solution material. Student responses are used to understand whether the teaching methods in both groups have been applied correctly.

3. Results and Discussion

The vee diagram instrument is used to make a relationship between "thinking" and "doing" science process skills of students that occur while students are doing lab work in the laboratory. The instrument from the Vee diagram can be seen in Figure 1.

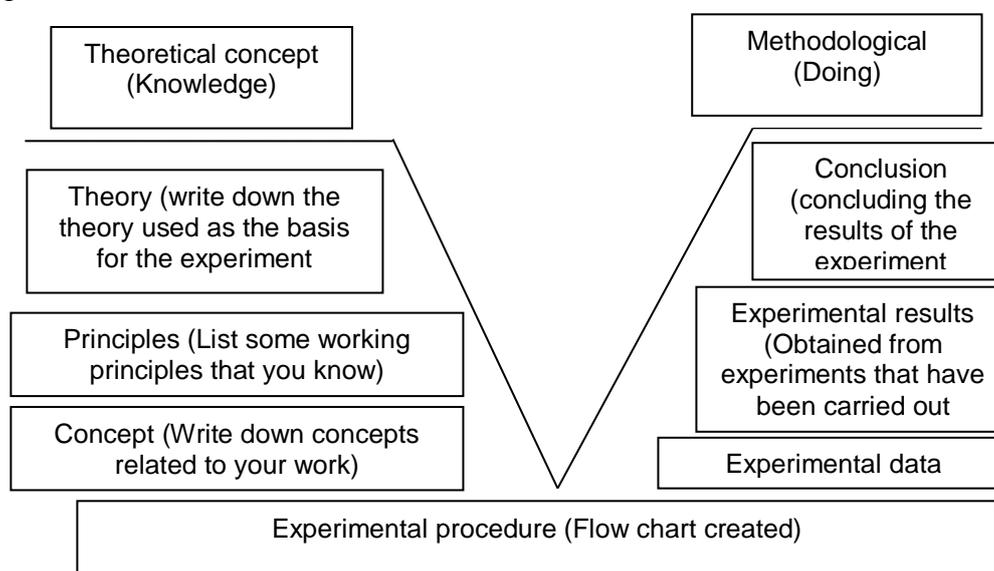


Figure 1: Modified Vee Instrument Diagram

The Vee diagram is basically a pedagogical, or heuristic, technique in which learning occurs through student-directed, constructivist, inquiry-based discovery (Roehrig, et.al., 2004). Vee diagrams are a very suitable tool for enabling students to understand how events, processes, or objects are related in a meaningful way because their overall objective is for students to understand the interactions between what is known and what is not yet known and understood in scientific or

mathematical investigations (Gowin, et.al., 2005). The Vee diagram, which derives its name from its diagrammatic form, structurally and visually connects the methodological aspects of an activity with its fundamental conceptual aspects by focusing on the important role of concepts in learning and memory.

In order to understand whether the data obtained from the achievement tests showed a normal distribution or not and the variance was homogeneous, a descriptive quantitative statistical analysis was carried out. To test whether the scores of science process skills are normally distributed. The normality test was carried out on both the experimental and control groups, namely to find out whether the population was normally distributed or not. The normality test of the conceptual understanding test scores and the science process skills test scores were analyzed using the Kolmogorov-Smirnov test. The results of the normality test are presented in Table 2.

Table 2. Normality Test Results

No	Variabel	Value of Significance		Conclusion
		Experiment	Control	
1	Science Process Skills	0,780	0,533	Normal

The results of the normality test for understanding concepts and process skills in both the experimental and control classes show a significance value greater than 0.05, so H_0 is accepted. These results indicate that the scores of both the experimental and control classes are normally distributed. KPS data were analyzed using analysis of variance (ANOVA), which previously tested the normality test and homogeneity test. The results of the normality test with the Kolmogorov-Smirnov test, the significance value for science process skills for the experimental class is $0.780 > 0.05$ and the science process skills for the control class are $0.515 > 0.05$, it is concluded that the students have class control and the experimental class is normally distributed.

The results of the homogeneity test with the Levene Test, the significance value for the science process skills test is $0,515 > 0.05$. It can be concluded that the science process skills of the control class and the experimental class have the same variants. Table 2, shows that the experimental group performed better than the control group as indicated by the mean values and standard deviation but cannot test whether these observed differences are significant or not.

Table 3. Means, Standard Deviations of the Experiment group and Control of the Post-Test Value of Science Process Skills

Value	Variabel	Sum of squares	df	Mean Square	F	Sig
Postes	Science Process Skills	332.220	1	32.043	10.368	0,002

Table 4. ANOVA analysis of the difference in mean post-test scores between the experimental and control groups on science process skills

Value	Variabel	Sum of squares	df	Mean Square	F	Sig
Postes	Science Process Skills	332.220	1	32.043	10.368	0,002

To test the research hypothesis, the researcher used ANOVA as analysis. In Table 4. One-way ANOVA analysis data is used to test the difference in post-test scores between the experimental and control groups on science process skills. Table 4 shows that the significant value between the experimental and control groups is $(0.002) < (0.05)$. This means that there is a significant difference in the mean scores of students who are taught using inquiry-based learning with V-diagrams and who are taught using inquiry-based learning for science process skills. It was concluded that inquiry-based learning with V-diagrams was more effective than inquiry-based learning for students' process skills on the buffer solution material with a significant value of $0.002 < 0.05$.

The purpose of this study was to determine whether the use of Inquiry Based Learning (IBL) with V-diagrams on the buffer solution material would affect science process skills in class XI students. The teacher / researcher compared the results of 5 weeks of teaching using the IBL model with the V-diagram and the use of the IBL model on science process skills, then the posttest was used to measure students' abilities towards science process skills. Student attitudes and other notes were used to document student involvement in research. At the end of the lesson, which is week 5, students using the IBL model with the V-diagram showed an increase in the science process skills test. This study states that there is a significant influence between inquiry-based learning and V-diagrams rather than the IBL model on science process skills of class XI students on the buffer solution material of post-test scores. The average score of science process skills in the group of students learning through inquiry-based learning with V-diagrams was 84.56 higher than that of the group of students learning with inquiry-based learning, which was 81.00 (see Table 3). According to Olufunmiyi and Afolabi (2010), KPS allows students to investigate creativity, problem solving, reflective thinking, originality and discovery, which are essential ingredients for the development of science and technology from any country. The scientific method facilitates students to gain knowledge in a scientific way such as using scientific methods starting from observation, formulating questions, making hypotheses, collecting data and concluding. According to Tekes & Gonen (2012), V diagrams are tools that help make laboratory reports more effective and student-centered. V-diagrams are more organized and systematic than ordinary experimental reports. The use of V diagrams is very helpful for students to explain the main ideas that pay attention to the knowledge base and the process of compiling knowledge in carrying out practicum in the laboratory. Using the V diagram, students are required to recognize the concepts, principles and theories that underlie their laboratory work, so the conclusions they make will be in accordance with existing theories.

ANOVA analysis resulted in an Fcount of 10.368 with a value of $0.002 < 0.05$ (see Table 4). It can be concluded that the null hypothesis (H₀) is rejected, meaning that there is an effect of the science process skills of the group of students who learn to use Inquiry Based Learning with V-diagrams which is different from the group of students who learn only based on inquiry learning. These findings were obtained through experimental procedures parallel to those obtained in previous studies (Nwagbo, 2006). According to Hwang, Wu, Zhuang, et al. (2013), that the experimental group students who learned through inquiry-based mobile learning were more successful and had less cognitive load than the control group students who studied in traditional teaching methods. Koksall & Berberoglu (2014) found that guided inquiry learning improved students' understanding of science concepts and their science inquiry skills when compared to traditional teaching methods. In addition, at the end of the application, the researchers also found that the attitude of the experimental group students towards science was higher than that of the control group students. Delen & Kesercioglu (2012) stated that science process skills are very important for students as a condition for using scientific methods in developing science and are expected to gain new knowledge or develop knowledge they already have. Students' science process skills in the experimental class are better than the control class because student involvement in inquiry-based learning provides experience and familiarizes students with scientific work to develop science process skills to process and discover their knowledge. The V-diagram also contributed to this research. The vee diagram helps students to connect the concepts they get. According to Kadriye (2018), V-diagrams and traditional formats are compared as guides for laboratories. It was found that students who used V-diagrams were more successful in organizing experiments, analyzing data and making generalizations, showing results clearly and in their thinking and learning processes. V-diagrams are effective as techniques that contribute to meaningful learning in addition to their use as test reports. While students are preparing for the test topic and in the conceptual diagram section, it will be beneficial for students to use these tools and techniques in the conceptual diagram section as conceptual maps, conceptual networks, meaning analysis charts and mental maps. In this way, students will be able to relate concepts related to the pre-experiment / test topic and learn by doing / through experiences during the test. The use of tools such as conceptual maps, mental maps and meaning analysis charts in the V-diagram conceptual section ensures that the V-diagram includes all of this material, and therefore contains a lot of material in this respect (Tekes, et.al., 2012).

4. Conclusion

Based on general descriptions, hypothesis testing, and discussion, researchers can propose the following research conclusions:

- a. The science process skills of student groups who learn through inquiry-based learning with V-diagrams are higher than the group of students. students learn by inquiry-based learning only. This is evidenced by the test
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results obtained from descriptive data with the experimental class with an average of 84.50 and the control class with an average of 81.00.

- b. There is an inquiry-based learning effectiveness with a V diagram and only inquiry-based learning on students' science process skills in a buffer solution. This is shown from the analysis of the results of the one-way Anova test with F count 10.368 with a significance of 0.002 <0.05. This is shown from the analysis of the results of the one-way Anova test with F count 10.368 with a significance of 0.002 <0.05.

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