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THE EFFECT OF INQUIRY BASED LEARNING ON THE REASONING ABILITY OF GRADE VII STUDENTS ABOUT HEAT CONCEPT

PENGARUH INQUIRY *BASED LEARNING* TERHADAP KEMAMPUAN PENALARAN SISWA KELAS VII PADA MATERI KALOR

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh Inquiry Based Learning terhadap kemampuan penalaran siswa kelas VII pada materi Kalor. Penelitian ini merupakan penelitian eksperimen semu dengan rancangan non-equivalent post-test only control group design. Dua kelompok siswa kelas VII dilibatkan sebagai sampel penelitian, dimana kelas eksperimen menerima perlakuan Inquiry Based Learning sementara kelompok lainnya bertindak sebagai kelas kontrol yang menerima proses pembelajaran sesuai dengan ketentuan kurikulum yang berlaku di sekolah tempat penelitian dilaksanakan. Data yang dikumpulkan dalam penelitian ini adalah kemampuan penalaran siswa yang diperoleh dari hasil tes kemampuan penalaran. Data dianalisis dengan menggunakan statistik deskriptif dan statistik parametrik Independent t-test. Hasil penelitian menunjukkan bahwa terdapat perbedaan kemampuan penalaran yang signifikan antara kelas eksperimen dan kelas kontrol Kelas eksperimen menunjukkan kemampuan penalaran yang lebih baik dibandingkan dengan kelas kontrol.

ABSTRACT

This study aimed to analyze the effect of Inquiry Based Learningon the reasoning ability of grade 7 students about heat concept. This study is a quasi-experimental research design with non-equivalent post-test only controls group design. Two groups of seventh grade students were included as samples, which receive the experimental class of Inquiry Based Learning treatment while the other group acted as a control group who received the learning process in accordance with the applicable provisions of the curriculum. The data collected in this study is the students reasoning ability which obtained from the test of reasoning ability. Data were analyzed using descriptive statistics and statistical parametric t-test. Results of independet research shows that there are significant differences in reasoning abilities between the experimental class and control class. In this research, the experiment class perform more better reasoning skills than the control class.

Keywords: Inquiry Based Learning, reasoning ability, heat.

INTRODUCTION

Mastery and understanding of the importance of science encourage their adjustment in the paradigm of learning science; where scientific literacy is the ultimate goal of science education to prepare human resources to compete in the 21st century (Dani, 2009). Scientific literacy is currently considered as the main objectives and learning outcomes that are important in science education standards in various countries, including Indonesia. Lawson (2009) argues scientific literacy as instructional objectives typically include students' understanding of NOS (Nature of Science) and reasoning (reasoning).

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Reasoning is one aspect of the intelligence of human beings (human intelligence). According to Bruner (Lohman & Lakin, 2009) reasoning is the process of making conclusions or inferences based on available information. Reasoning is a thought process that is important in learning, because reasoning is connecting with all the thought process that made learning such as problem solving and decision making. Improving the ability of reasoning (reasoning ability) of the learners, especially in science learning is one way that can be taken to improve thinking skills level (high order thinking) as well as the skills of the 21st century which are expected to be achieved through education. So the reasoning ability of learners is one of the important points to be improved during the learning process to be able to help them achieve their defined goals.

Reasoning involves cognitive processes, in which cognitive processes are influenced by two important mechanisms: cognitive and metacognitive factors (encoding and acquisitions or electoral strategy). Encoding involves attention to relevant information that is the basis of all reasoning. The strategy used involves the approach used to search for new knowledge and synthesize existing knowledge (Morris et al., 2012). Many things can be done in order to improve students' reasoning ability; one of them is through the implementation process of learning. Learning process gives students the opportunity to dominate the role of students in the learning process will be able to support students in developing their cognitive structures and also understand the process of acquiring their cogniton. This is the basis for developing students' reasoning ability. One model of learning that can be used is Inquiry Based Learning (IBL).

National Science Education Standards (NSES) states that there are two important aspects of the inquiry into the teaching of science, namely; a) scientific inquiry refers to the way in which scientists study nature and provide explanations based on evidence that they derive from work (research) them; and b) the activities of students in which they develop their knowledge and understanding of scientific ideas and also an understanding of how scientists study nature (Bell, 2010). Engaging students in the inquiry process is very important because it helps students develop scientific literacy and science process skills. Thus, learning by inquiry has a great potential to develop students' reasoning ability (reasoning ability).

This study was conducted to determine whether the Inquiry Based Learning can really have an impact on students' reasoning ability on the material of heat.

METHODS

This study is quasi-experimental researches by using non-equivalent post-test only control group design. Quasi-experimental was used because not all the variables and experimental conditions can be set and strictly controlled, such as randomization cannot be done to the students who will be used as samples. Thus, the selection of the sample will be done with the class randomizes, in other words it is impossible to manipulate all relevant variables (Cohen et al., 2000). Design post test only (not using data pre-test) was chosen for this study was aimed to observe the effect on the ability of reasoning IBL students between the experimental class and control class after the treatment was given, and not to analyze the improvement of students' reasoning abilities after a given treatment.

The population of this study is a private junior high school student of grade 7 in Denpasar, with a total sample of 66 students. The sample was divided into two groups, namely experimental and control group. Experimental group consisted of 32 students, while the control group consisted of 34 students. Experimental group received an IBL treatment IBL, while the control group received the traditional learning program. IBL treatment was also accompanied by the provision IBL worksheet which is then used by the students in doing laboratorium activities. The worksheet is designed so that students are required to be able to know what they needed to do experiments and to determine how to perform these activities. Thus, students can use it to learn independently in discovering and building knowledge.

A the and of learning program, all students were given a test of reasoning ability (as a post test) to measure the students' reasoning ability. The test was consists of 10 items essay, which has been validated by the three valuators. Previously, test of reasoning ability was tested by involving 86 respondents. Based on the results of the tests performed, it is known that test reasoning ability is reliable with a reliability test score of 0.881. Data collected through this reasoning ability tests were analyzed descriptively. As

for the research hypothesis testing, parametric statistical of independent sample t-test were used. Independent t-test was chosen because the data analyzed consisted of two groups of samples in which between one group and another unrelated (independent sample).

RESULTS AND DISCUSSION

In order to answer the research problem, the data were analyzed descriptively and then be tested stastically using independent t-test. Description of students' reasoning were cosists of frequency distribution, the description of the average value (M), and standard deviation (SD) of in each group.

Based on test results data of reasoning ability, students' reasoning scores of the experimental group ranges are in between 22-44 from a maximum score of 50. The reasoning score of control group ranges in between 19-38, with a maximum score of 50. The graph of frequency distribution reasoning ability of experimental group is presented in Figure 1 and in Figure 2 for control classes are presented.

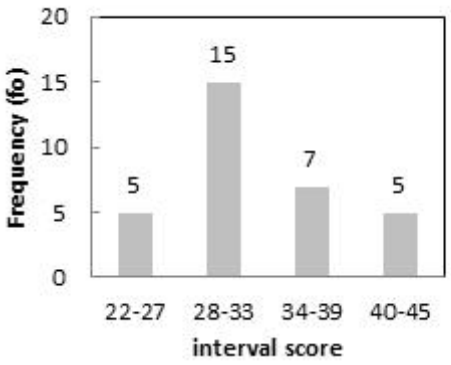

Figure 1. Graph of frequency distribution of the experimental group score of reasoning ability

Based on the graph in Figure 1, it is known that most of students' reasoning ability scores in the experimental group is in the interval of 28-33, with a percentage of 47%; students who's score are in the interval score 22-27 and 40-45 have the same percentage of 16%, while students who's score are in the 34-39 interval score is 22%. Based on the graph shown in Figure 2, the students' score of reasoning ability of the control group at the interval score of 25-30 has a percentage of 47%. Students who's score are in interval of 19-24 score has percentage of 21%, and the students who were in the range 31-36 score has a percentage of 32%.

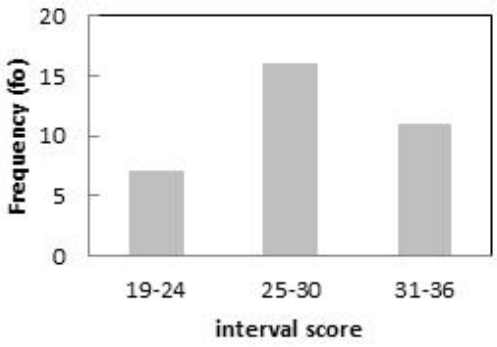

Figure 2. Graph of the frequency distribution of control group score of reasoning ability

The average score (M) and standard deviation (SD) reasoning ability of students in each group are presented in Table 1.

Table 1. The mean scores and standard deviations data of reasoning ability

Group	M	SD
Experiment	32,31	5,637
Control	28,26	5,017

Table 2 and Table 3 below show a distribution frequency and percentage of experimental and control group ability based on the result of the conversion to Benchmark Reference Rate, which aims to determine qualification of students reasoning abilities.

Table 2. Distribution frequency and percentage of reasoning ability of experimental group

Score	Qualification	f_o	percentage
x ≥ 40	very good	5	16%
40 > x ≥ 34	good	7	22%
34 > x ≥ 27	fair	16	50%
27 > x ≥ 20	poor	4	13%
x < 20	very poor	0	0%
total		32	100%

Judging from the average score of reasoning abilities experimental group reaches 32.31 (Table 1) it appears that 47% of the total number of students in the experimental group have the reasoning ability scores around the average score, 38% of the number of students who have the ability scores reasoning above average, and the number of students who sco-

re below the reasoning ability on average by 16%. In the control group, the average score was at 28.26 reasoning ability (Table 1), where 47% of the number of students in the control class has the reasoning ability scores around the average score, 32% of the number of students who have the ability scores reasoning above average, and the number of students who score at the reasoning ability is below average at 21%.

Table 3. Distribution frequency and percentage of reasoning ability of control group

Score	Qualification	f_o	percentage
x ≥ 40	very good	0	0%
40 > x ≥ 34	good	5	15%
34 > x ≥ 27	fair	18	53%
27 > x ≥ 20	poor	10	29%
x < 20	very poor	1	3%
total		35	100%

Based on these results the percentage of students who score reasoning abilities around the average score in the second class are equal, i.e. by 47%. However, there are differences in the percentage of students who have the reasoning ability is above average between experimental and control group, where the number of students of experimental group with reasoning ability above of average score is more than the control group, while the number of students of control group who have reasoning ability below the average the control class more than the experimental group.

Based on the frequency distribution in Table 2 and Table 3, it appears that no student who has the reasoning ability of qualified very less, half of the students have reasoning skills with qualified fair, nearly a quarter of the number of students who have a good qualification, students who have qualified very good reasoning ability were 16%, and 13% poor qualified. Table 3 shows the distribution of reasoning ability of control group, where 3% of the number of students qualified reasoning ability is very poor, 29% qualified poor, more than half of which have fair qualification, 15% qualified good, and no student has the reasoning ability with qualification of very good.

Based on the comparison of the average score reasoning ability between the experimental and control group, it is seen that the average score of the experimental group is higher than the control group. Besides the number of students who score reasoning ability is above average in the experimental group is also more when compared with the control group, and students who have the reasoning ability with good and very good qualifications in the experimental group is also more than the control group. This shows that the experimental group descriptively following study the IBL has better reasoning skills than students in the control group.

To determine whether differences in reasoning ability scores between the experimental and control group really statistically significant, it is necessary to test statistics using Independent t-test. Results of statistical tests will then be used to answer the hypothesis proposed in this study. Proceeding the independent t-test, requirements analysis were done. Test requirements analysis consists of two things, namely test for normality of data on the entire unit of analysis and test the homogeneity of variance between groups (the experimental group and

Table 4. Summary of normality test results

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	statistic	df	Sig.	statistic	df	Sig.
Score Exp	.116	32	.200*	.961	32	.301
Score Con	.103	34	.200*	.966	34	.366

Table 5. Summary of homogeneity test results

Score	Levene statistic	df1	df2	Sig.
Based on Mean	.431	1	64	.514
Based on Median	.321	1	64	.573
Based on Median and with adjust df	.321	1	62,656	.573
Based on trimmed mean	.405	1	64	.527

Table 6. Summary of t-test results

	T	df	Sig (2-tailed)
Equal variances assumed	3,086	64	0,003
Equal variances not assumed	3,025	62,055	0,003

control group). Summary of normality and homogeneity test results are presented in Table 4 and Table 5.

Based on Table 4, it appears that data on the experimental grop and control group normally distributed with statistical values of Kolmogorov-Smirnov and Shapiro-Wilk showed figures with a significance level greater than 0.05. So, overall the data of both of group are normally distributed.

Based on Table 5, it appears that all the statistical Levene value showed the significance of above 0.05. This means that the variance between the groups are homogeneous, meaning that differences mean that occur in hypothesis testing really comes from the difference in treatment on the group.

Because the data has been qualified analysis, it can be followed by testing hypotesis using Independent t-test. Summary t-test results are presented in Table 6.

According to data about the influence of independent variables (IBL) on the dependent variable (reasoning), then the statistic values obtained t = 3.086 with 0.003 significance numbers. Making decision to reject or except H_0 can be done by comparing the sig. with ½ α (0,025). Significant number generated after testing is of 0,003, where the number is smaller than ½ α (0.003 <0.025). Thus it can be determined that H_0 is rejected. In other words, there is a difference between the reasoning ability between experimental and control group. Based on the results of the hypothesis testing, there are significant differences between the reasoning ability of students who learn by using IBL and students who study without using IBL. Thus, the difference in the ability of reasoning was significantly (p <0.025) influenced by the learning model used in the learning process.

Based on the mean in each group, it appears that the average score of students who use the IBL strategy have the reasoning ability greater than that of students who did not use IBL strategy. The results of this study have shown that there are differences between the reasoning ability of students to learn using the IBL and IBL students who do not use the views from the mean in each group.

Based on the test results of the t-test, it is seen that the influence of the learning model reasoning skills students have statistical value t = 3.086 with a significance value of 0.003. Significant number obtained is smaller than the significance level ½α (0,025). Thus, it can be concluded that there are significant differences between students who learning using IBL and without using IBL. Group of students who learning by using IBL has an average of reasoning ability higher than group of students who learn without using IBL. This means that the reasoning ability of students to learn by using IBL demonstrate reasoning ability better than any group of students who are studying without using IBL. It can be concluded that the IBL is significantly influence to the improvement of students' reasoning ability, compared with the learning model which is applied to the control group.

The difference occurs because of the difference in treatment which was used in each class. Reasoning ability as has been described in the literature review is a process of making conclusions or inferences based on available information, reasoning involves the cognition of a complex that includes organizing step of a strategy that is planned such that, the set goals can be achieved (Süβ, et al., 2002). Theory of cognitive development illustrates that the development of reasoning ability is stable, and has a definite stages. This led researchers in the field of taxonomy formulate cognition process skills, developing the ability of the more concrete (observe, classify, and measure) to the ability of a more abstract (making hypotheses, designing experiments, and critical of the theory) (Hammer, 2004). So, to help the development of reasoning ability of students, then students should be engaged in learning activities that support the development of reasoning ability. Given the general level of development is considered valid and then it can be used as consideration in the preparation of the curriculum in order to develop students' reasoning abilities. One way that can be used to optimize the development of reasoning ability is to use IBL in learning. In essence IBL is a teaching approach that aims to optimize learning by involving students in the process or activity that is usually done in scientific research. Activity or process shall include; observing, hypothesizing, define issues, propose, design and conduct experiments,

and communicate the results and conclusions based on the evidence obtained. An involvement activity as mentioned previously requires students play a dominant role in the learning process. Through IBL students will be taught to make inquiries, make decisions, designing or making a plan, carrying out experiments, discuss and submit its findings and can provide answers and explanations when engaged in inquiry activity. So, through the refraction of the students can not only train their independence in building knowledge, but also be able to develop their skills both thinking skills (reasoning, problem solving, and creative thinking) as well as process skills.

Knowledge is constructed through a process of inquiry will have a deeper significance than just a transfer of knowledge from teacher to student. Significance of this will make the knowledge obtained by the students during the learning process longer stored in the student's head, so that when students need it, such knowledge can easily be recalled. Of course it will affect the students' reasoning ability, where the knowledge of the students will be useful when students perform reasoning in the learning process. As stated by Gobet & Waters (2003), that increased knowledge is the basis of improving the quality of reasoning that we do. So, with a good basic knowledge students will also be able to do reasoning well and vice versa with good reasoning, students will be able to do a better knowledge acquisition.

Meaningfulness of concepts learned, leads to a positive attitude of students towards science subjects itself. This positive attitude will (1) growing a high motivation to students to follow the science, because students are actively involved in the learning process; (2) the students have the motivation and the ability to understand the concepts presented by the teacher, so that it will help students to improve their reasoning ability.

The use of the 5E model of inquiry in this research is also contributing to differences in reasoning ability between the experimental class and control class, the experimental class in which students learn by using IBL model 5E inquiry. 5E inquiry which the model can adapt the five essential components of the inquiry according to NSES (National Science Education Standards) which includes; 1) students are involved with the inquiry-oriented science (scientific), 2) students give priority to evidence, which gives them the opportunity to develop and evaluate explanations to answer scientific (scientific), 3) Students make an explanation of the evidence to answer the question of scientific, 4) Students evaluate their explanations to make alternative explanations, particularly for explanations reflect scientific understanding, 5) Students communicate and justify their explanations (Wilson, et al., 2010). For each phase of the 5E model (engagement, exploration, explanation, elaboration, and evaluation), in which each stage in the implementation of the model students will perform reasoning taking into account the information and knowledge that he has had. Teachers no longer serve as a source of knowledge, but rather act as a motivator and facilitator of student learning. So that it will contribute to the improvement of students' reasoning abilities. Control class received a scientific approach to learning, where learning approach used in accordance with the mandate of the 2013 curriculum implemented in schools where research is conducted. The scientific approach used in the control class focuses on the process of 5-steps (observe, to question, to reason, to try and make networking) is a learning approach that should be applied to all subjects, especially in science lessons. The approach used in canoes to help students to develop not only skills but also skills thinking process. When viewed in theory there is nothing wrong with a scientific approach that was carried in the curriculum in 2013, but in fact the implementation of learning approaches are not performed optimally. Although using a scientific approach, the learning process is done in the classroom tend to teacher-oriented center, which is still the dominant role of the teacher in the learning process or it can be said teachers act as the main source of knowledge during the learning process. This might occur because the teachers are still not accustomed to using a scientific approach to learning and also because not all of the activities 5-steps must be done in a study session. So it only encourages teachers to use in part 5-steps in learning activities, where it contributes to the dominant role of the teacher in learning. The dominance of the teacher as a source of knowledge in the learning process to make the process led a unidirectional flow of information from the teacher to the student. So, the students the opportunities to further explore their knowledge to be more limited. Students become passive learning, because learning focuses on the activities of teachers in presenting the material. This makes students tend to memorize concepts or formulas are gi-

ven, without further understand and review of concepts given. Less students understanding to the assigned material will affect the ability of the student's own reasoning. Students, who have less understanding of the concepts being taught, will have difficulty in deciding what he should do with learning. These things will lead to the achievement of reasoning ability of students to less than optimal.

The results obtained in this study are also consistent with the results of research conducted by Gillies et al., 2013 where it is known that the use of inquiry-based learning can improve students' reasoning ability. When students are taught explicitly how to make scientific questions that can guide them in the process of investigation, make hypotheses, and make conclusions related to the topic being investigated in the process of inquiry, students will involve in the discussion process class or group to justify the explanation that they made to the topic which is being investigated, so it will help students to develop reasoning abilities and in making the analogy that represents their understanding of a concept.

CONCLUSION

Based on the above explanation, it is evident that the IBL very influence the experiment group in terms of students' achievement reasoning ability. Although the IBL has a positive influence on students' reasoning ability by differences in the average score reasoning ability, but these differences cannot implemented optimally. Considering half of the total number of students in the experimental class scores that were around the average score, where students who have the reasoning ability scores around the average score qualified as fair. On the other hand, the percentage of students who qualified as fair of reasoning ability in the experimental group is almost equal to the total percentage of the control group. Students are seemingly unfamiliar with given IBL worksheet. The worksheet used primarily practicum, presenting all the steps that must be done in detail, such as what to use and how to perform a procedure. So that students will tend to follow the steps in the worksheet. The worksheet used in IBL for trial activity requires them to understand the problem with finding information known and to be known from a given problem. Furthermore, students are also required to be able to design measures that will be used to apply the concepts that have been studied to provide an explanation or make conclusions. Then students must also undertake the elaboration by seeking alternative explanations as well as to evaluate the implementation process of inquiry which is carried out, so that students can build their knowledge through the process of inquiry to the topics investigated in the learning process.

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