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Experiment Learning Method Based on Inquiry to Increase Understanding of Generic Science Concepts and Skills of Primary School Students in Grade 5 (five)

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Abstract. This research aims tocarried out using the match only pretest-posttest control group method in grade 5 elementary school students. The data was collected using pre and post tests related to generic science understanding and skills and also using a questionnaire to determine student responses to the use of inquiry methods. The results showed that the test results (N-gains) conceptual understanding were 56.40% for the experimental group with the moderate category and 28.28% for the control group with the low category. The highest percentage of generic science skills occurred in the experimental group on direct observation indicators around 87.50% with a high category. The low percentage of generic science skills in the experimental class in the logic framework indicator is around 33.54% with a low category. While the highest percentage of generic science skills occurred in the group on direct observation indicators around 40.63% with the medium category. The low percentage of generic science control class skills on logic frame indicators is around 14.38% with low categories. Students give a positive response to the implementation of inquiry learning methods. In conclusion, the implementation of learning using the inquiry method can significantly increase student understanding and generic science skills.

Keywords: inquiry-based inquiry, concept understanding, generic science skills

1 Introduction

Entering the 21st Century of knowledge, the 21st century, education is faced with increasingly severe challenges, one of these challenges is that education should be able to produce human resources who have the full capacity to face various challenges in life. Holding on to the characteristics of education in the 21st century various main competencies that must be possessed by students include learning and innovating skills, mastering media and information, and life and career abilities (Abidin, 2014: 9-11). There is also a vision of education in the 21st century that is more based on the paradigm of learning is learning to think oriented to logical and rational knowledge, learning to be oriented to how to overcome problems, learning to be independent, oriented towards character building, and learning to live together oriented to being tolerant and cooperative attitude.

The generic ability of science, according to Brotosiswoyo (Suyono, 2009: 6) in science can be categorized into 8 indicators, namely: (1) direct and indirect observation; (2) understanding of scale; (3) symbolic language; (4) obedient logic framework of natural law; (5) logical inference, (6) the law of causation; (7) modeling; and (8) developing concepts.

Based on direct observations at one of the elementary schools in Purworejo, students' understanding of concepts is still low. This is evident from the habits of students who are only able to memorize without understanding their origin and application. In addition, the average

value of students, especially in the material Heat and Displacement has not yet reached the Minimum Mastery Criteria (KKM). The low understanding of students is influenced by many factors, one of which is the learning method applied by the teacher not in scientific inquiry. Teachers tend to apply conventional learning methods that are teacher-centered where the learning methods are still traditional or mechanistic. With this learning method the teacher puts more emphasis on the practice of doing the questions or drill and practice. Thus students are not accustomed to solving problems, especially the application of concepts that occur in their lives. In other words, the understanding of concepts and generic science skills is not awakened. Therefore the average value of students, especially in the material Heat and displacement needs to be improved by changing the learning method.

Natural Sciences is a lesson that is based on experimental observation so that learning is more appropriate when using the experimental method. Many Natural Sciences teachers use experimental learning methods, but the experiments carried out are still of a verification nature that is to prove a concept or principle that was discussed earlier. Experiments like this are exactly like recipes that just follow the procedure so that evidence will be obtained according to the concepts and principles that have been discussed. This is consistent with the results of a case study research conducted by Darmawan (2012) at one of the schools in Sabang City. The results of these studies conclude that learning Natural Science using experimental methods is still lacking. In addition, the experimental activities are still verification, where the teacher reasoned that the experimental activities carried out to prove the theory that has been studied previously. Worksheets prepared by the teacher are still verification.

The verification method of experimentation needs to be innovated to take place in an atmosphere of scientific inquiry (scientific inquiry). Experimental learning methods that take place in an atmosphere of inquiry are called inquiry-based experimental methods. With this learning method it is hoped that there will be an increase in students' understanding of concepts and generic science skills because it is in line with the recommendations of relevant research that has been done previously as research conducted by Suma (2010) concluded that inquiry-based learning is more effective than traditional learning in improving scientific understanding and reasoning .

Research conducted by Suriyani (2012) concluded that there is an influence of inquiry learning models on generic science skills and student learning outcomes. Research conducted by NurHidayat, et al (2010) can be concluded that the application of science learning with guided inquiry-based experiments can attract students to be active during the learning process so as to improve student learning outcomes. Research conducted by Budiman (2010) concludes that inquiry-based practicum learning more motivates students in learning can also improve student performance better than verification practicum learning. Research conducted by Saptorini (2008) concludes that the application of inquiry-based analytical practicum learning models can increase the mastery of generic science skills of prospective chemistry teachers to the level of achieving high and medium N-gain prices.

The main problem that will be examined in this research is whether inquiry-based experimental learning methods can improve the understanding of concepts and generic science skills of elementary school students on the heat and transfer material. This study aims to improve the understanding of concepts and generic science skills of elementary school students through the application of inquiry-based experimental learning methods.

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2 Methods

This research was conducted using a quasi-experimental method. The quasi experiment used was the "the matching-only pretest-posttest control group" design. The research design as presented in table 1.

Tabel 1. Desain Penelitian

Kelompok	Pretest	Perlakuan	Posttest
E (Ekspeimen)	O	X	O
K (Kontrol)	O	C	O

Information:
O: Pretest and posttest to measure the understanding of concepts and generic science skills.
X: Treatment of the experimental class, i.e. the application of inquiry-based experimental learning methods.
C: The treatment of the control class, i.e. the application of an experimental learning method is verification.

In this study used instruments designed to collect data in accordance with the research design. The instrument is an integrated concept understanding test with generic science skills and a Likert scale questionnaire to determine student responses to inquiry-based experimental learning methods implemented. In order to obtain good test questions, the questions were assessed as validity, reliability, level of difficulty, and distinguishing features. Increased understanding of concepts and generic science skills before and after learning activities are calculated using the formula:

$$< g >= \frac{\% < Spost > - \% < Spre >}{100 - \% < Spre >} x\ 100\%$$

(Hake, 1999)

Information :
S_{pre} = Initial test score
S_{post} = final test score

This normalized gain is interpreted to express an increased understanding of the concept of heat and its transfer and generic science skills with the following criteria as in Table 2.

Tabel 2. Level category gain ternormalisasi

Batasan	Kategori
$< g >> 0,7$	Tinggi
$0,3 \leq < g > \leq 0,7$	Sedang
$< g >< 0,3$	Rendah

Sumber: Hake, 1999

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The results of the comparison of increasing understanding of static fluid concepts and the generic skills of the experimental class and the control classare calculated using parametric statistics if normally distributed and non-parametric if data are not normally distributed.

3 Discussion

Description of Increased Understanding

The concept of heat and its displacement Achievement of the average score of pretest, posttest, and normalized gain (N-gain) in the form of a percentage for understanding the concept of heat and its displacement in the two classes of research as shown in Figure 1.

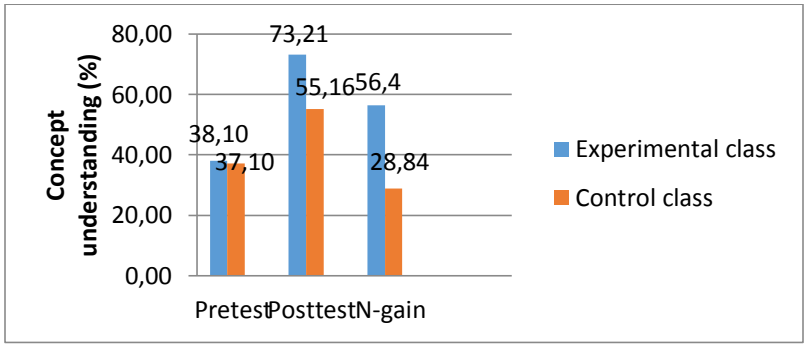

Figure 1. A comparison diagram of the mean pretest, posttest and N-gain understanding of student concepts

Based on Figure 1, the mean percentage of pretest scores of the experimental class was 38.10% of the ideal score, while the average percentage of the pretest scores of the control class was 37.10% of the ideal score. Furthermore, based on data acquisition the average posttest score for the experimental class was 73.21% of the ideal score, while the posttest average score for the control class was 55.16%. Increasing students' understanding of concepts before and after learning is very closely related to normalized gain (N-gain). Based on Figure 1 it can be seen that the average percentage of N-gain scores for the experimental class was 56.40% with the medium category and the control class was 28.84% with the low category. Quantitatively, the increased understanding of the concept of the experimental class is higher than that of the control class. The t-test results concluded that there was a significant difference between the N-gain value of the experimental class and the control class. This means that the use of inquiry-based experimental learning methods is more effective in increasing understanding of static fluid concepts than verification experiment learning methods.

Improved understanding of the concept shows that the highest N-gain value occurs in the experimental class. This is consistent with the characteristics of inquiry-based experimental learning methods where students are required to design all or part of an experimental procedure, decide what data to take, and to analyze and interpret data. Students will show more curiosity and a sense of responsibility for their own experiments which lead to a significant increase in students' understanding of concepts. This indication is in accordance with the opinion of Hofstein&Lunetta (2004) which states that inquiry based experiments can play an important role in education. This is due to the need to involve students with physical

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actions and social negotiations in the learning process of science. Thus students are better trained because they themselves experience scientific activities in the learning process.

Descriptions of Improving Understanding of Concepts Based on Sub-Concepts of Heat Sub-concepts and Their Displacement

Understanding of concepts based on the sub concepts of heat sub concepts and their displacement measured in concept understanding consists of three sub concepts, namely Conduction, Convection, and Radiation. Comparison of N-gain concept understanding for each concept label can be seen in Figure 2.

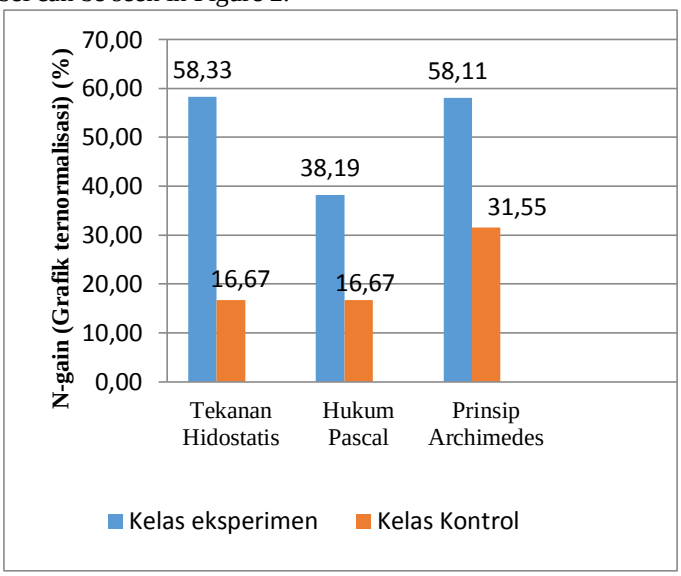

Figure 2. Comparison diagram of N-gain concept understanding for each sub-concepts of the experimental class and control class

Based on Figure 2 shows that the percentage of N-gain understanding of concepts based on the highest sub-concept in the experimental class occurred in the conduction sub-concept of 58.33% with the medium category and the lowest occurred in the convection sub-concept of 38.19% with the medium category. Whereas in the control class the highest concept of understanding occurred in the sub concept of radiation by 31.55% with the moderate category and the lowest in the conduction and convection sub concepts by 16.67% with the low category

The high N-gain acquisition occurs because the instrument of understanding test concepts in the conduction sub concept can be observed through observation during demonstration and experimental activities. The activity took place in the inquiry-based experimental learning method. Besides this sub concept is quite easy and simple. While the verification experiment learning method does not take place in demonstration activities, but directly on the experimental activities based on the guidelines in the worksheet.

This condition causes the students who get learning through the verification experiment learning method does not experience the demonstration stage directly so that the

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increase in understanding of sub-conduction concepts is lower than students who get learning through inquiry-based experimental learning methods. The acquisition of N-gain sub-concept of conduction which is quite low in the control class is also caused by some students getting better pretest scores than posttest scores. Although the average percentage gain of N-gain understanding of the concept of convection experimental class is higher than the control class, the acquisition of the value is the lowest compared to other sub concepts in heat and displacement. This condition is due to the ability of students to analyze experimental data that is not optimal.

This has implications for obtaining the lowest average percentage of N-gain compared to other sub concepts in heat and displacement. In addition, some experimental class students received the same pre-test scores as the post-test scores and one student received a pretest score that was better than the post-test scores. This causes an increase in understanding of sub concepts convection lower than other sub concepts. In the control class there are some students who get better pretest scores than posttest scores.

Generic Description of Generic Science Skills

Indicators of the generic science skills developed in this study include direct observation, indirect observation, causal law, the principle of obedient logic, and logical inference. Comparison of N-gain of each indicator of generic science skills between the experimental class and the control class as shown in Figure 3.

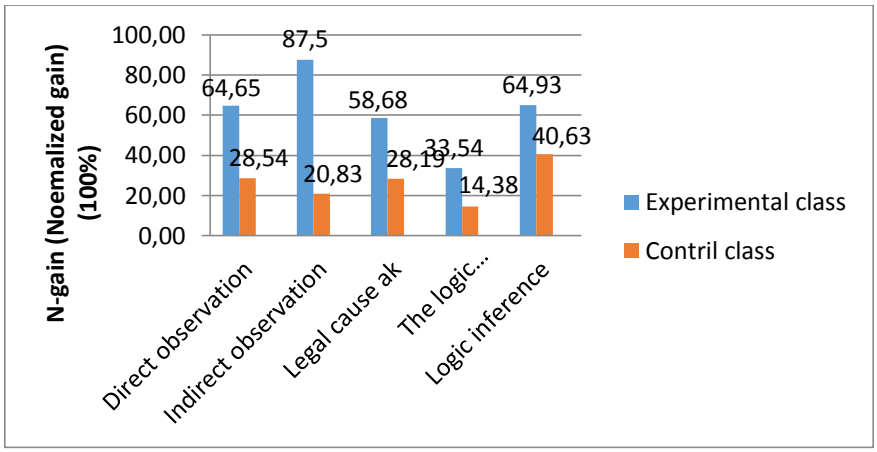

Figure 3. N-gain comparison diagram for each generic science skill indicator between the eksperimental class and the control class

Based on Figure 3 it can be seen that the highest N-gain percentage of generic science skills in the experimental class occurred in the indirect observation indicator of 87.50% with a high category and the lowest occurred in the principle of obedient logic framework indicator of 33.54% in the medium category. Whereas in the control class the highest percentage of N-gain generic science skills occurred in the logic inference indicator of 40.63% with the medium category and the lowest occurred in the principle of obedient logic framework indicator by 14.38% with the low category.

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Figure 3 shows that the percentage of N-gain percentage for each indicator of the generic science skills of the experimental class students was higher than the control class. Thus it can be concluded that the use of inquiry-based experimental methods is more effective in increasing the generic science skills of students in the heat and displacement material compared to the verification experimental method.

The highest increase in generic science skills occurred in the indirect observation indicator due to the students' habit of using experimental equipment and collecting experimental results. This is consistent with the opinion of Brotosiswoyo (2011) that indicators of success in indirect observation are: (1) using tools / objects as sensory aids in observing natural experiments / phenomena; (2) gathering facts of experimental results or natural phenomena; and (3) looking for differences and similarities. In inquiry-based experimental activities, sensory aids are very role in producing experimental data and facts. Fulfillment of the equipment in accordance with the characteristics of the experiment led to inquiry-based experimental activities running very well. In addition, students are trained through indirect observation to interpret the data generated to make conclusions in order to prove the hypothesis they made. Based on this indirect observation will guide students to learn to think deductive hypotheses (Liliasari, 2005), so that after going through this learning process students can understand the concepts they learn. This condition has direct implications for the improvement of indirect observation indicators.

The acquisition of a low N-gain score in the control class is due to many students who get the same pre-test scores as the post-test scores. The low acquisition of N-gain value of generic science skills on the principle of obedient logic framework indicators shows that the inquiry-based experimental learning method based on this research has not been maximized to improve the indicator. The indicators of the success of the principle of obedient logic framework have not been optimally achieved so that the improvement of the principle of compliant logic framework is not in line with expectations. Indicators of success of the principle of obedient logic framework according to Brotosiswoyo (2011) is: (1) looking for a logical relationship between two rules and (2) explaining something or natural phenomena through predetermined laws. Demonstration activities and experiments in inquiry-based learning methods conducted by students are not optimal in uncovering the logical relationship between the two rules. This condition has an effect on the low increase in the indicator of the principle of compliant logic framework. In addition, some students in the experimental class got the same pretest scores as the posttest scores and one of the students got the pretest scores better than the posttest scores. While in the control class there are some students who get better pretest scores than posttest scores.

Student Responses to the Implementation of Inquiry Based Experiment Learning Methods

Based on student responses obtained from questionnaire distribution data, it can be concluded that students give positive responses (agree) to the application of inquiry-based experimental learning methods to the heat and displacement material as shown in Table 3.

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Table 3. Student Responses to the Implementation of Inquiry-Based Experiment Learning Methods

No	Indicator	Average Score	Average (%)	Category
1	The inquiry-based experimental learning method applied greatly helped me overcome difficulties in understanding the concept of heat and its displacement	3.29	82.29%	Agree
2	The inquiry-based experimental learning method that has been applied is very suitable for learning the concepts of heat and displacement	3.71	92.71%	strongly agree
3	In delivering heat material and its transfer, the learning methods that have been applied need to be maintained	3.29	82.29%	Agree
4	Learning methods that have been applied are very effective, because they can find their own concepts	3.25	81.25%	Agree
5	The LKS that was used really guided me in carrying out the practicum	3.29	82.29%	Agree
6	In conveying the heat and displacement material, it is better for teachers to teach more with inquiry-based experiments	3.46	86.46%	Strongly Agree
7	In delivering heat and material, it is better for the teacher to teach more by adjusting the questions to be tested	3.42	85.42%	Strongly Agree
8	The knowledge of the concept of heat and its displacement obtained through the inquiry-based experimental method that has been applied turned out to be more durable, because I felt I discovered the concept myself.	3.13	78.13%	Agree
9	Learning the concept of heat and its displacement with inquiry-based experimental learning methods that have been applied greatly motivated me to study physics	3.33	83.33%	Agree
	Average	3.35	83.80%	Agree

Based on the facts in accordance with table 3, students agree with the statement that the inquiry-based experimental learning method really helps them overcome difficulties in understanding the concepts of heat and displacement. Through inquiry-based experimental learning methods, students are given the opportunity to design and observe for themselves any symptoms that arise through experimental activities related to the concept of heat and displacement. Thus the difficulties experienced so far can be overcome through inquiry-based experimental activities.

The students strongly agree with the statement that the inquiry-based experimental method is very suitable for learning the concepts of heat and displacement. The concept of heat and movement is very closely related to the daily lives of students and the natural

phenomena of the concept of heat and displacement can be demonstrated through experimental activities. According to their characteristics, students can design, observe, and analyze their own concepts of heat and displacement through the application of inquiry-based experimental methods. Thus students discover for themselves the concept of heat and displacement and can find their own answers to natural phenomena.

Most students also agree with the statement that inquiry-based experimental learning methods are very effective because they can find their own concepts. This is because students are challenged to practice using learning resources and working in groups to improve high-level cognitive skills, including analytical and critical thinking skills. The statement is in line with Bruner's opinion that students acquire investigative knowledge because they are involved in the discovery process. Besides learning with the inquiry approach accelerates the memory process. Knowledge gained from the results of one's own thoughts will be easier to remember.

The majority of students agree with the statement that the knowledge of heat and its transfer obtained through inquiry-based learning experiment methods is more "durable". This is due to the need to involve students with physical actions and social negotiations in the learning process of science. Thus students are better trained because they themselves experience scientific activities in the learning process. Besides this method accelerates the process of memory because the knowledge obtained from the results of their own thoughts will be easier to remember and more "long lasting". This opinion is in line with Bruner's statement that with the inquiry learning model, the subject matter obtained by students will be more durable, easier to remember, easier to apply in different conditions, can lead to learning motivation and can practice open thinking skills.

Most students agree with the statement that the learning of the concept of heat and its displacement using inquiry-based experimental learning methods greatly motivates students in learning physics. This opinion is in line with research conducted by Budiman (2010) based on the results of a questionnaire analysis found that students' motivation towards inquiry-based practicums showed good results. Budiman concluded that the inquiry-based practicum approach motivated students to study Newton's Law II compared to the verification practicum approach. In various aspects of motivation studied such as: a) Attention, b) Relevance, c) Confidence, and d) Satisfaction shows good results.

4 Conclusion

Based on the results of research and data analysis conclusions can be made as follows; (i) The first conclusion is that inquiry-based experimental learning methods can significantly improve understanding of heat concepts and their changes compared to verification experiment learning methods. This is indicated by the average percentage of N-gain of the experimental class applying the inquiry-based experimental learning method of 56.40%, while for the control class applying the verification experiment learning method of 28.84%. (ii) The second conclusion is that inquiry-based experimental learning methods can significantly improve students' generic science skills. This is indicated by the average percentage of N-gain of each indicator of the generic skills of the experimental class higher than the control class. (iii) The third conclusion is the students' response to the application of

inquiry-based learning methods to the concept of heat and the displacement positive response (agreed). Inquiry-based learning methods are attractive to students because students make it possible to explore symptoms and formulate problems, formulate hypotheses, design and implement ways of testing hypotheses, organizing and analyzing data, drawing conclusions and communicating them (Lawson in Wiyanto, 2006).

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