

Learning Force Topics with Science Process Skills Approach and Using Guided Experiment Methods to Improve Students' Understanding of the Concepts

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This research aims to determine the effect of the science process skills (SPS) approach using guided experimental methods on the learning of force topics to increase students' understanding of concepts. The research was conducted in SMP Negeri 2 and SMP Negeri 11 Jayapura in the 2018/2019 academic year. This research is a quasi-experimental research design with Nonequivalent-group Pretest-Posttest Design. The experimental group was taught by using the SPS approach with the guided experimental method, and the control group was taught with conventional learning. Samples were taken by using cluster random sampling technique. Data analysis used normalised gain (N-gain) and independent t-test. The results of the research are as follows: (1) In the subtopic, the force and the change in N-gain of the experimental group is 0.39 and is classified as moderate and the control group is 0.16 and classified as low; (2) in the subtopics the various types of N-gain force, the experimental group is 0.56 is classified as moderate, and the control group is 0.43 and is classified as moderate; (3) There is a difference in understanding of concepts between the experimental group and the control group for the two subtopics being taught.

Key words: *science process skills, understanding of concepts, force.*

Introduction

Learning innovation is the application of innovative and constructive learning models (Trianto, 2007). The learning process of natural sciences must pay attention to the characteristics of natural sciences as a process and natural sciences as a product. The object

of natural science is the process of natural science and the product of natural science (Mendoza, 2009). Based on that, natural sciences learning is scientific work, while the object of natural science products is factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge (Monhardt & Monhardt, 2006; Wisudawati & Sulistyowati, 2015).

Learning innovation research has been carried out, such as the application of the process skills approach to improving learning outcomes. Rahayu & Susanto (2011) dan Dahniar (2006), researched science learning with a process skill approach to improve learning outcomes and creative thinking abilities. The results of his research showed there was an increase in learning outcomes and the ability to think creatively on the subject of heat for junior high school students. While Subagyo et al. (2009), researched learning with a science process skill approach to improve concept mastery on the subject of temperature and expansion, with a gain of 0.219. Some research results show that the application of the process skills approach in learning is proven to improve student learning outcomes.

Semiawan (1986) and Harlen (1999) states that science process skills as fundamental skills include observation, calculation, measurement, classification, space and time relations, making hypotheses, research planning, controlling variables, interpreting data, and inference while, forecasting, application, and communication. While science process skills consist of the skills of observing, communicating, classifying, measuring, inferring, and predicting (Dewi, 2008). Rambuda & Fraser (2004) report that the perception of geography teachers states that science process skills have important aspects of learning. Therefore geography teachers must conduct a number of simple experiments in the classroom to develop integrated science process skills further. Mastery of science process skills is a basis for understanding geography as a social or physical science. Basic science process skills are activities that include observation, classification, communication, measurement, prediction, inference, variable identification, making tables, making graphs, explaining the relationship between two variables, collecting and processing data, making hypotheses, defining variables, planning experiments, and experimenting.

Skamp (2004) and Crawford (2007) state that scientific work in science called doing science can be done, such as using equipment, taking measurements, collecting data, and communicating. In general, the steps of doing science include the following steps: 1) observing the symptoms that exist, 2) asking questions why the symptoms occur, 3) making hypotheses to answer the problems raised or explaining the reasons, 4) planning an experiment and doing experiments to test these hypotheses, and 5) conclude.

Students learn, in addition to building concepts, and also develop thinking skills. Many innovations in learning to improve conceptual understanding have been made (Dimiyati, 2006; Djamarah & Zain, 2006). Learning research with virtual media on vibration and wave

material can improve students' understanding of concepts (Padilla, 1990; Uno, 2008). Improved understanding of the physics concepts of the experimental group students is better than the control group both in the sub-material vibration and wave. A comparison of the increase in concept understanding shows that the N-gain of the experimental group is 0.6, and the control group is 0.17. The study was conducted using quasi-experimental experiments with pretest-posttest control group design in junior high school. The experimental group was given learning by virtual media, while the control group was given conventional learning (Yahya et al., 2019). The effectiveness of the use of virtual media can overcome the limitations of the lack of experimental tools. Sahara (2015) reports that the application of the concept teaching model approaching concept attainment can improve the understanding of concepts in business learning and energy of eighth-grade students of junior high school. Research was conducted using the classroom action research method, and the average understanding of students' concepts in the first cycle was 66.9 with classical learning completeness of 48.5%, and the average understanding of students' concepts increased in the second cycle by 79.2, with classical completeness learning of 87.9% of 33 students.

While the results of classroom action research conducted by Chusni (2016) show that the application of the guided inquiry approach with the pictorial riddle method can improve students' understanding of concepts as well as student learning motivation in junior high school physics lessons. This study uses classroom action research methods, with an increased understanding of students' concepts in the first cycle with an average of 42.93 to 50.71, and in the second cycle increased to 67.50 and in the third cycle to 80.71. Explorative, descriptive research conducted by Dani et al. (2019) by applying discovery-based learning through the talking stick method, can improve students' understanding of concepts of straight-motion. The study conducted by Ismawati et al. (2014) applies the learning model of conceptual understanding procedures (CUPs) to see an increase in students' understanding of concepts and curiosity. The research uses the control group pretest-posttest design experimental method, and the experimental class is taught with conceptual understanding procedures and the control class with a verification experiment. Data collection is done by interviews, questionnaires, observations, and tests. This study also looked at increasing student curiosity. The analysis used is normalised gain. Improved understanding of the concept of the experimental class was 0.67 in the medium category and 0.58 for the control class in the moderate category. Increased student curiosity of the experimental class was 0.21, in the low category, and the control class was 0.20, in the low category.

Learning innovations are also carried out for higher education, as conducted by Mariati (2012), reporting a research and development result that the application of basic physics learning models based on problem-solving can be more effective in improving metacognition skills and concept understanding. Subjects in implementing the model were 50 students. The method used in the implementation was a quasi-experimental design with a randomised control group pretest-posttest design. The data were analysed using normalised gain values.



N-gain results understanding concepts on the topic of particle kinematics in succession in the experimental group amounted to 0.61 and 0.63, in the moderate category. In contrast, the control group reached 0.44 and 0.39, in the moderate category.

Based on observations, the learning of the force topics that have occurred so far at SMPN 2 and SMPN 11 Jayapura has not yet provided optimal results. This is a problem that needs to get a solution immediately. Therefore, this study tries to apply a learning approach using science process skills with a guided experimental method on the topic of force. Some reasons for applying the science process skill approach include learning with the science process skills approach and enabling students to foster scientific attitudes, so students in the learning process can understand the concepts they learn so that learning outcomes can be achieved well. Meanwhile, the implementation of the guided experimental method is that learning is student-centred, while the teacher has prepared the experimental steps. Research conducted by Astuti et al. (2016), states that learning with the science process skills approach using the experimental method has an effect on the science learning achievement, and the guided experiment method is more effective than the modified open-ended experiment method.

This study aims to improve the quality of the learning process for force topics and see the effect of applying the science process skills approach using guided experimental methods to understanding students' concepts on force topics. Experiments carried out during learning are designed based on the context of student life, and the material is easy to obtain. This study also looked at how students' responses to learning were applied.

Methods

This research uses a quasi-experiment design that is a nonequivalent group pretest-posttest design. Students of the experimental group were taught by the science process skill approach using the guided experiment method, and the control group was taught by conventional learning. The experimental design was adapted from McMillan and Schumacher (2001):

Experiment group (EG)	:	0	X ₁	0'
Control group (CG)	:	0	X ₂	0'

The research population was grade VIII students of SMPN 2 and SMP 11 Jayapura. The sampling technique used is cluster random sampling. The description of the study sample is shown in Table 1.

Table 1. Description Of The Research Sample

Number	School Name	Total Student	
		Experiment Group	Control Group
1	SMPN 2	26	28
2	SMPN 11	18	16
	Total	44	44

Data collection instruments using the test: This test was used to collect data about understanding concepts. Data collection procedures were performed by pretest and posttest. The pretest was given before the learning was done, and the posttest was given after learning was complete.

Data analysis: (i) N-gain or $\langle g \rangle$: analysis was performed by calculating the average score of the pretest and posttest. To determine the increase in understanding of concepts or N-gain was calculated by the formula of (Hake, 1998):

$$\langle g \rangle = \frac{(\% \langle Sf \rangle) - \% \langle Si \rangle}{(100 - \% \langle Si \rangle)}$$

Where:

$\langle g \rangle$ is an increase in understanding of concepts, $\langle Si \rangle$ is the average pretest, and $\langle Sf \rangle$ is the average posttest.

Hake classified the gain into categories: (a) high if, $\langle g \rangle \geq 0.7$; (b) medium, if $0.7 > \langle g \rangle \geq 0.3$; and (c) low, if $\langle g \rangle < 0.3$. Analysis of the statistical average difference test was used, the t-test was used for normally distributed data and the Mann Whitney U test for data that was not normally distributed.

Results and Discussion

In the planning stage, researchers conducted a study of the school syllabus and the learning implementation plan that had previously been prepared by the teacher. Based on the syllabus, researchers made learning innovations by applying the science process skills approach using the guided experiment method. Arranging the instruments used to measure student learning outcomes is a matter of cognitive aspect tests and the students were subsequently tested. Before the teacher applied to learn, the researcher first acted as a model for each learning topic. As long as the researcher became a model, the teacher followed the course of learning from the beginning to the end of learning.

Learning by applying the science process skills approach using the guided experiment method is learning that was oriented to student activities by conducting experiments that were

guided by Student Worksheets that could support the learning process. In the initial stages of learning, a demonstration activity was conducted, which aimed to attract the attention of students. At the implementation of learning, students get Student Worksheets that have been adapted to the topic of the lesson; a group of students learned so that students could more easily find the concepts of the material being studied. At each meeting, both group and class discussions were held. In the process of group discussion, students were expected to process the experimental data and draw conclusions. A class discussion was conducted to discuss the results of each group. Then, students and teachers drew conclusions from the learning that had been done. At this second meeting, students looked more active than at the first meeting. Some students asked questions about things that were not yet understood. Students were also enthusiastic in responding to the results of discussions from other groups. At this third meeting, students looked quite active. The majority of students were active in discussions, both group discussions and class discussions. Some students also gave their responses after the other groups presented the results of their discussion. This was because students had started to get used to the learning strategy used.

In general, the implementation of learning by applying a science process skill approach using the guided experiment method worked well. The interaction between teacher and student looked quite good. Communication had been going both ways, teachers with students, and also students with students. In the implementation of learning, students were more directly involved and active in experimenting, so that they went deeper in their concepts and making connections between concepts that were stable with other concepts. Discussion activities at each stage of learning encouraged students who tended to be passive to be motivated to express their opinions because they had the same opportunity.

The results of the N-gain analysis, overall shows that the increase in understanding of the experiment group concept was better than the control group, as shown in Table 2.

Table 2. Results of N-gain Analysis Of Concept Understanding

Topic	Group	N	Average N-gain (g)	Δg	Distribution	Variance	p-Value
I	Experiment	44	0,39	0,23	Normal	Homogeneous	0,012 (Sig)
	Control	44	0,16		Normal	Homogeneous	
II	Experiment	44	0,56	0,13	Normal	Homogeneous	0,041 (Sig)
	Control	44	0,43		Normal	Homogeneous	

Information:

Topic I: Force and Changes; and Topic II: Various force.

The N-gain of the experimental group students for both topics was classified as moderate. In contrast, the control group students were classified as moderate for topics of various force and low for the topic of force and change. The difference between the two was due to the

different learning processes. Learning using the process skills approach with the guided experiment method made students more active and happy in learning. Through observation, it can be stated here: (a) students were more willing to ask questions and felt there was no pressure, (b) the teacher allowed students to discuss, (c) students were brave to express their ideas. Besides, examples of subject matter and experiments conducted by students were close to student life. Through worksheets, students learned actively by conducting experiments. The results were following the results of Subagyo's research (2009) that learning science with an approach to science process skills can improve conceptual understanding. Conversely, the control group taught by conventional learning was more dominated by the teacher, so students were less active.

The average N-gain difference test results indicate that the two groups of students were significantly different. It shows that learning using the science process skills approach with the guided experimental method was more effective than conventional learning. The results of the research were the same as those conducted by Yahya et al. (2019) that conceptual understanding was better in the experimental group compared to the control group. Likewise, the results of this study supported the results of research, which showed that learning outcomes could be improved by learning using experimental methods as reported by Wulandari et al., 2012; Fitriyanti et al., 2014; Anggesta et al., 2018; Sawaludin, 2013.

Conclusion

From the results of the analysis and discussion of the results of the study, it can be concluded that the understanding of student concepts can be improved by learning to use the science process skills approach with the guided experiment method. It was shown that: (1) In the sub-topic, the force and the change in N-gain of the experimental group was 0.39 and were classified moderate and the control group was 0.16 and was classified low; (2) In sub-topics, the various types of N-gain force, the experimental group was 0.56 and was classified as moderate and the control group was 0.43 and was classified as moderate; (3) There was a difference in understanding of concepts between the experimental group and the control group for the two sub-topics being taught.

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