Improving Students' Performance by Using Science Process Skills in The High School's Physics Curriculum Grade X in Indonesia

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Abstract

Teaching Physics in high schools is very challenging, especially where the teachers' understanding of the concept and teaching methods is still limited. It needs an effort to make the teaching more exciting experience for students. This study, therefore, aims to investigate the application of Science Process Skills (SPS) as the scientific skills that can be used to develop and increase science process skills and understanding of the Physics subject through laboratory activity. This study utilizes experimental design by involving students grade X from Senior High School (SMA) 1 Banda Aceh academic year 2018/2019 as a sample. It follows the competency standard of the 2013 Indonesian Curriculum. This study found that there is a positive correlation between the content of the Physics syllabus and the science process skills. This condition has contributed positively to the learning achievements of students. The result of pre-and post-test shows the result of post-test has improved after applying this approach. Hence it is recommended that SPS can be promoted as a tool to improve the ability of students in understanding the science concept within Physics, as well as other science subjects.

Keywords: Science Process Skills (SPS), Physic Curriculum, Grade X, Indonesia

INTRODUCTION

Learning is a process or activity that aims to provide experience and knowledge to students, so there is a change of the way of thinking (cognitive), attitude (affective), and acting (psychomotor). Physics is a science that examines the interaction between energy and matter that is the basis of natural science. In the learning process of physics in the secondary high school in Indonesia, students are expected to not only master theoretical concepts of Physics but also able to use scientific methods to prove the physics concepts derived from the theory.

Nowadays, one of the most discussed issues in science education is about science process skills (Hodosyová 2015). Science process skills are skills which are methods used by scientists to study or investigate a problem, an issue, a question or a scientific phenomenon that happened during the process of learning (Germann 1991). Science Process Skills (SPS) are aiming to develop the sensitivity of students toward learning experience by using scientific methods (Ratnasari 2018). The methods have been widely known as part of a science curriculum in school. The process skills as an approach in the learning process that focuses on the activity and creativity of students to develop the physical and mental abilities that have been owned to a higher level in processing the acquisition of learning (Hamalik 2009). A Process Skills Approach, those process skills are approaches that lead to the development of physical and mental abilities, which are essentially possessed by students in a form of potential that has not been clearly disclosed (Semiawan 1992). By developing physical and mental

abilities, students will be able to discover and develop their own facts, concepts, cultivate and develop the attitudes and values demanded. Process skills are an approach to learning, where students have the opportunity to interact with concrete objects up to the discovery of concepts.

In the learning process many components that influence learning outcomes, among others: the objectives, materials or materials learned, learning strategies, students and teachers as the object of learning, learning media and support the learning process (Praptiwi 2012). These components are interrelated with each other so that the weakening of one component will hinder the effective achievement of the learning objectives. Another view of learning with inquiry approaches that can involve students actively using scientific processes and scientific and creative sciences such as finding answers to the questions asked (Kristianti 2012).

Learning science should not only focus on the knowledge aspect, but also focus on the learning process. Physic as part of science learning should be able to present the everyday phenomenon that can teach and encourage students to think more critically and creatively. The skills gained in science-based activities are called the 'science process skills/SPS.' The science process skills are part of scientific work involving process skills and scientific attitudes. This is one of effective methods that can be used in learning physics as it can be used to stimulate the three aspects of learning (cognitive, psychomotor, and affective) simultaneously (Wiwin and Kustijono 2018).

SPS and scientific attitudes in the physic lesson can be interrelated. SPS can help students to feel the nature of science. This skill can be sufficiently obtained when students conduct practicum activities that focus on the improvement of science process skills and scientific attitudes (Darmaji 2018). Practicum is one of the approaches to enable students to learn a concept directly through observations and experiments while improving student skills. (Duda 2019). The primary aim of science process skills is to support the student's work to discover, verify, investigate and prove the scientific approach. The science process skills, concepts are useful to understand of all science subjects (Hodosyová 2015). It has been proved by a diversity of studies that learning by using inquiry in the laboratory has been known effective in developing students' science process skill during the learning process (Khan and Iqbal 2011). The laboratory activities can address these skills by helping students to develop the background knowledge, identify problems, develop relevant variables, improve experiment design and make a better conclusion (Germann 1991). For instance, a study conducted with high school students used inquiry approach in the laboratory has improved students' understanding of topic electrochemistry and student attitude toward the laboratory (Sesen and Tarhan 2013). Using the inquiry learning in the laboratory can provide a way students intellectual skills (thinking skills) that related to reflective thinking processes, as known as SPS (Yuniyanti 2012).

METHODS

This study utilizes classroom research in the education field under the frame of the 2013 curriculum. The study was conducted in SMA 1 Banda Aceh in April 2019. The sample of this study included 30 students in total grade X from SMA 1 Banda Aceh in the academic year of 2018/2019.

The methodology includes an experiment by using an inquiry approach and content analysis of the physic lesson of curriculum 2013 as an obligatory standard for teaching in Indonesia for the basis of this study. The experiment by using an inquiry approach used as a method to improve students' understanding of topic matter and energy in physics. While the content analysis means to understand the range of written texts in physic lesson grade X the curriculum 2013, the instrument included the pre-test and post-test and document on the Physic syllabus published by The National Curriculum Centre the Ministry of Education has obtained for the analysis purpose and presented in the table and narrative formats.

RESULT AND DISCUSSION

Pre-test and post-test

The pre- and post-test items in the topic matter on energy that has been validated by the expert were distributed to the 30 students. The analysis of the data was analyzed using SPSS.

TABEL 1. The result of pre-test, post-test

	Pre-test	*Post-test*
Maximum Score	95	95
Minimum Score	15	60

TABLE 1 shows a significantly different from the minimum score in pretest and posttest, while posttest had similar maximum score.

TABEL 2. T-test

		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1	Posttest	82.33	30	10.317	1.884
	Pretest	60.33	30	25.728	4.697

For the pre-test obtained from this study, the average learning outcome or mean is 60.33. While for the value of the post-test obtained of the average learning outcome is 82.33 for 30 students used as the study sample. The value of the standard deviation in the pre-test is 25.728 and post-test is 10.317. The result also revealed there is a significant change in student's average value of learning outcomes on the post-test higher than pre-test (60.33 < 82.33).

TABLE 3. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Posttest & Pretest	30	.510	.004

The table above shows the correlation or relationship between the two data or the relationship between the pre-test variable and the post-test variable. Based on the above output it is known that the value of the Correlation coefficient is 0.510 with significant value (Sig.) of 0.004. Because the value of Sig. 0.004 <probability 0.05, it can be said that there is a relationship between the variable of pre-test and post-test.

TABLE 4. Paired Samples t-Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Posttest – Pretest	22.000	22.307	4.073	13.671	30.329	5.402	29	.000

Overall, the result explains the two hypotheses in this study. The first hypothesis of Ho is that the value of the post-test and pre-test is the same, and the second hypothesis Ha is the post-test and pre-test value is not the same. The paired sample t-test produces a P-value of 0,000. Based on the "Paired Samples Test" output in the table above, the "Mean Paired Differences" value is 22,000. This value shows the difference between the average pre-test learning outcomes with the average post-test learning outcomes or 82.33-60.33 = 22.00 and the difference is the difference between 13,671 to 30,329 (95% Confidence Interval of the Difference Lower and Upper). Sig. (2-tailed) is 0,000 <0,05, then Ho is rejected, and Ha is accepted. So that it can be concluded that there are differences in the average between pretest learning outcomes and post-test which means that there are an influence on the use of Science Process Skills (SPS) learning strategies in improving learning outcomes in Senior High School (SMA) 1 student in Banda Aceh academic year 2018/2019.

Content Analysis

The 2013 curriculum has a strong emphasis on scientific approaches rather than merely mastering the content of a subject (Sukemi and Andriono, 2014) than can be conducted through the learning process and using the relevant methods. Four competencies, namely the competence of (1) spiritual attitudes, (2) social attitudes, (3) knowledge, and (4) skills should be achieved at the end of the learning process for all subject including physic. In this paper, we are suggesting that the Science Process Skills can be one of methods that can be used to achieve all the competencies.

The description of the four competencies in the first grade in the Senior High School (Class X) as below. First, the formulation of spiritual attitude as first competence (Kompetensi Inti-1/KI-1) is referred to as the meaning "to live and practice the teachings of each own religion." Second, the formulation of social attitude (KI-2) as the second competence aims "to demonstrate honest behavior, discipline, responsibility, caring (mutual assistance, cooperation, tolerance, peace), polite, responsive and pro-active as part of the solution to various problems in interacting effectively with the social and natural environment as well as putting ourselves as a reflection of the nation in the world interaction." Both of these competencies can be achieved by learning indirectly (indirect teaching), through exemplary, habituation, and school culture by observing the characteristics of the subjects, as well as the needs and the circumstances of the learners (Ministry of Education, 2013). Third, the knowledge (KI-3) and skill of attitude (KI-4) competencies aim to build students understanding on the specific topic which can be achieved throughout the ongoing learning process as shown below (Table 5).

TABLE 5. Competence of Knowledge and Skills class X (Ministry of Education, 2013)

CORE COMPETENCE 3 (KNOWLEDGE)	COMPETENCE CORE 4 (SKILL)
3. Understanding, applying, analyzing factual, conceptual, and procedural knowledge based on curiosity in science, technology, art, culture with humanity, national, and civilization insight related to causes of phenomena and events, as well as applying procedural knowledge in a specific field of study according to each talent and interest to solve problems	4. Processing, reasoning, and presenting development learned independently in the concrete and abstract realm, and capable of using the method according to the rules of science
3.1 Explaining the nature of Physics and its role in life, scientific method, and work safety in the laboratory	4.1 Preparing scientific work procedures and work safety, such as the measurement of heat
3.2 Applying the measurement principles of physical quantities, accuracy, thoroughness and important figures, as well as the scientific notation	4.2 Presenting the results of measurements of physical quantities and its thoroughness in using proper equipment and techniques and following the rules of important figures for a scientific investigation
3.3 Applying the principle of plot vector (e.g. Displacement)	4.3 Designing an experiment to determine the plot resultant vector (e.g. Displacement) and presenting the results and the physical meaning

3.4	Analyzing physical magnitudes in rectilinear motion with constant velocity (fixed) and rectilinear motion with constant acceleration (fixed) following its application in everyday life, e.g. Traffic safety	4.4.	Presenting data and graphs resulted from experiments of motion to investigate the characteristics of rectilinear motion with constant velocity (fixed) and a straight motion with constant acceleration (fixed) and its physic meanings
3.5	Analyzing parabolic motion using vectors, and its physical meaning and application in everyday life	4.5	Presenting the experimental results of parabolic motion and its physical meaning
3.6	Analyzing the physical quantities in a circular motion at a constant rate (fixed) and its application in everyday life.	4.6	Conducting experiments and presenting the result about circular motion, physical meaning, and utilization
3.7	Analyzing the interaction of force and the relationship between force, mass and rectilinear motion objects as well as their application in daily life	4.7	Conducting experiment, presenting the result about the force and the relationship between force, mass, and acceleration in a straight motion object by applying the scientific method
3.8	Analyzing regularity of planets and satellites motion in the solar system based on Newton's laws	4.8	Presenting works about the motion of artificial satellites orbiting in the earth, the utilization and resulted impact from the study on various sources of information
3.9	Analyzing the concept of energy, work, relations between work and changes in energy, the law of energy conservation, as well as its application in everyday events	4.9	Applying the scientific method, propose the idea of solving the motion problems in everyday life, which is related to the concept of energy, work and the law of energy conservation
3.10	Applying the concept of momentum and impulse, and the law of momentum conservation in everyday life	4.10	Presenting the results of testing on the application of the law of momentum conservation, for example, the ball free fall to the floor and a simple rocket
3.11	Analyzing the relationship between force and vibration in daily life	4.11	Conducting an experiment about harmonious vibration on simple swing and/or spring vibration, and presenting results of the experiment and its physical meaning.

The curriculum emphasizes that the process of learning should be intended to engage the student with different aspects of scientific skills. The table showed that the Physics curriculum has included all aspects of inquiry learning: observe, interpreting, hypothesized, classifying, experimenting, inferring, predicting, communicating and applying (Maradona, 2013).

These aspects are relevant to the skills that form the foundation in learning sciences. Acquisition of these skills is known as the science process skill can be achieved through a process, and it should be introduced from the beginning of the teaching. The development of this skill can help students to improve their understanding of the topic in physic can help students to understand the physics subject most easily.

The content analysis showed that there is a positive correlation between the content of the physics syllabus and the science process skills. This condition has contributed positively to the learning achievements of students. It can be seen from the result of pre- and post-test where the result of post-test has improved after applying this approach.

However, this study is one of the examples of how Science Process Skills can increase students' understanding of the topic. Nevertheless, another on the physic subject, such as momentum and pulse, motion, physical magnitude solar systems are considered to develop science process skills where student need to develop the scientific concepts can also apply this concept during the teaching-learning process.

CONCLUSIONS

The aims of the physic subject as stated in the 2013 curriculum are to build a balance between spiritual, social, knowledge and skills to prepare students for the global competition and the higher level of education. From this study, it found that Science Process Skills can be one of the methods to achieve competency standards of the Indonesian curriculum through the learning process in the laboratory to improve students' understanding of Physics. Also, it is hoped that this SPS can be utilized in teaching other science subjects in high school in Indonesia.

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