Improving high school students’ physic performance using science process skills

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Abstract. This study is aimed to investigate the application of Science Process Skills (SPS) as the scientific skills that could use to develop and increase science process skills and understanding of physics subject through laboratory activity. This study utilized experimental design by involving students grade ten-3 from Senior High School Banda Aceh academic year 2018/2019 as a sample. It followed the competence standard of 2013 Indonesian Curriculum. This study found that there was a positive correlation between the content of physics syllabus and the science process skills. This condition had contributed positively to students’ learning achievements. It could be seen from the result of pre and post-test where the result of post-test had improved after applying this approach. The research method used was the quasi-experimental with pretest-posttest one group design and observation sheets to observe the implementation of the learning method. Data processing was done by test obtained by the percentage of the average value of the initial test 60.33%. Then the final percentage average score was 82.33%. The result there was a significant change in student’s average value of learning outcomes on the post-test higher than the pre-test.

1. Introduction
Learning is a process or activity that aims to provide experience and knowledge to students, so there is a change of way of thinking (cognitive), attitude (affective), and acting (psychomotor). Physics is one branch of science that examines the interaction between energy and the basis of natural science. In the learning process of physics in the secondary school in Indonesia, students are expected to master not only theoretical concepts 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 science process skills [1]. Science Process Skills (SPS) is a skill used by scientists to study or investigate a problem, an issue, a question or a scientific phenomenon that happened during the process of learning [2]. SPS aims to develop the sensitivity of students toward learning experience by using scientific methods [3]. The methods have been widely known as part of the science curriculum in school. The process skills are 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 [4]. The process skills approach leads to the development of physical and mental abilities.
It is essentially possessed by students in the form of potential that has not been disclosed. By developing physical and mental abilities, students will be able to discover and develop their 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 [5].

In the learning process many components that influence learning outcomes, among others: the objectives, learning materials, learning strategies, students and teachers as the object of learning, learning media and support the learning process [6]. 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 creative sciences, such as finding answers to the questions asked [7].

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 an 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 an effective method that can be used in learning physics, it can be used to stimulate the three aspects of learning (cognitive, psychomotor, and affective) simultaneously [8].

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 fully obtained when students conduct practicum activities focus on the improvement of science process skills and scientific attitudes [9]. Practicum is one of the approaches that enable students to learn a concept directly through observations and experiments while improving student skills [10]. The primary aim of science process skills is to support student s work, to discover, to verify, to investigate and to prove the scientific approach. The science process skills concepts are useful to understand of all science subjects [11]. A diversity of studies has proved that learning by using inquiry in the laboratory has been known effective in developing students' science process skills during the learning process [12]. 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 [13]. 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 [14]. Using inquiry learning in the laboratory can provide a way student intellectual skill (thinking skills) that related to reflective thinking processes, known as SPS [15].

This research was experimental research focused on inquiry learning on the concepts of work and energy to improve students’ science process skills and improve student learning outcomes towards Physics subjects at one of senior high school in Banda Aceh. This study has 2 (two) variables, first is the independent variable and the second is dependent variables. The independent variable in this study was inquiry learning, while the dependent variable was the science process skills and student learning outcomes.

2. Method
The method used in this methodology included an experiment by using the 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 was by using the inquiry approach used as a method to improve students’ understanding of topic work and energy in physics. While the content analysis means understanding 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.
This study utilizes classroom research in education field under the frame of 2013 curriculum. The study was conducted in one of senior high schools in Banda Aceh in April 2019. The sample of this study included 30 students in grade ten-3 in the academic year of 2018/2019.

Student’s performance instruments measured in this study used pretest-posttest one group design. This design used pretest to know the initial state of the subject before being treated so the researchers can find out the condition of the subject that studied before and after the inquiry learning was given whose results could be compared or seen the changing [16]. The procedure and implementation in this study consisted of three stages, as follows: (1) Research preparation stage. In the preparatory phase carried out as follows: a) determining the school that will be used as a place of research, b) making observations at school, c) consulting with physics subject teachers in places used as research, d) literature study, e) compiling chapter I, II, and III, f) compiling the syllabus and the full learning plan presented in the appendix, g) compiling the research instrument, h) consulting the instrument with expert experts (lecturers and teachers), i) testing the research instrument, and j) conducting the analysis trials and determining the instruments used in research. (2) Research implementation stage.: a) determining the time of research implementation, b) providing an initial test of learning outcomes and science process skills (pretest), c) carrying out inquiry learning in class, d) making observations during the learning process takes place, e) providing a final test (posttest) to measure student’s cognitive abilities and science process skills after being treated. (3) The final stage of the study was the analysis of research data consisting of test data on learning outcomes and science process skills, which are scoring, calculating the average score of the test, calculating the normalized gain, testing the prerequisites of the analysis (normality test and homogeneity of the initial and final tests) and testing hypothesis.

3. Results and discussion
The pre and posttest items in topic matter on work and energy that had been validated by expert were distributed to the 30 students. The analysis of the data was analyzed by using SPSS.

| Table 1. The result of pre-test post-test |
|-----------------------------------------|
| Minimum Score | Pretest | 15 | Posttest | 60 |
| Maximum Score | 95      | 95  |

Table 1 showed a significant different from the minimum score in pretest and posttest, while posttest had similar maximum score.

| Table 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 was 60.33. While for the value of post-test obtained of the average learning outcome was 82.33 for 30 students used as the study sample. The value of standard deviation in the pre-test was 25.728 and post-test was 10.317. The result also revealed there was a significant change in student’s average value of learning outcomes on the post-test higher than pre-test (60.33 < 82.33).
Figure 1. Comparison of the average score of the pretest and posttest

Table 3. Paired samples correlation

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

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

Table 4. Paired samples t-test

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

Overall, the result explained about the two hypotheses in this study. First hypothesis of Ho was that the value of the post-test and pre-test was the same, and the second hypothesis Ha was the post-test and pre-test value was not the same. The paired sample t-test produced a P-value of 0.000. Based on the “Paired Samples Test” output in the table above, the “Mean Paired Differences” value was 22.000. This value showed 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 in the difference between 13.671 to 30.329 (95% Confidence Interval of the Difference Lower and Upper). Sig. (2-tailed) was 0.000 < 0.005, then the conclusion is Ho rejected and Ha is accepted. So that it can be concluded that there were differences in the average between pretest learning outcomes and post-test which meant that there was influence on the use of Science Process Skills (SPS) learning strategies in improving learning outcomes in Senior High School students in Banda Aceh academic year 2018/2019.
4. Content analysis

The average values were shown that all aspects of the process skills that emerge through inquiry-based learning appeared according to the criteria value. The data showed that all aspects of student science skills indicators had good criteria, the average score of students’ process skills was based on the highest to the lowest order, namely, (1) communicating, (2) formulating a hypothesis, (3) planning an experiment, (4) conducting experiments, (5) interpreting data, (6) making observations, (7) predicting, and (8) applying concepts. The result of students’ attitudes was in line with inquiry strategies that require the curious aspects of students in the learning process.

The 2013 curriculum has a strong emphasis on scientific approaches rather than merely mastering the content of a subject [17], than can be conducted through the learning process and using the relevant methods. Four competencies, such as 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 subjects including physics. In this paper, we suggest that Science Process Skills can be one of the 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) which are: first, the formulation of spiritual attitude as first competence (Core Competence-1/KI-1) is referred to 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, responsible, caring (mutual assistance, cooperation, tolerant, 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 circumstances of the learners [18]. Third, the knowledge (KI-3) and skill of attitude (KI-4) competencies aim to build students’ understanding of a certain topic that can be achieved throughout the ongoing learning.

The curriculum has emphasized 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 had included all aspect of inquiry learning for instance observing, interpreting, hypothesized, classifying, experimenting, inferring, predicting, communicating and applying [19].

These aspects are relevant to the skills that form the foundation in learning sciences. Acquisition of these skills or 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 and help students to understand physics subject more quickly.

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

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

5. Conclusion
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, we 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 physic. Also, it is hoped that this SPS can be utilized in teaching other science subjects at senior high school in Indonesia.

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