The application of guided-inquiry-learning to enhance science process skills and student learning outcomes

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Abstract. This study aims to identify the increase achieved in science process skills (SPS) and student learning outcomes after the implementation of guided-inquiry learning compared with the lecturing method. The SPS correlation to learning outcomes, along with the responses, was also determined. This study employed the experimental method with pretest posttest design with a control group. The sample of 61 students was selected by purposive sampling technique. The results obtained of the SPS hypothesis test data analysis and learning outcomes were t<sub>count</sub> of 2.838 and 4.863>2.001 t<sub>table</sub>, which means there are differences in SPS and learning outcomes of students between the group treated with guided-inquiry learning and that treated with lecturing method. There is a correlation between SPS and learning outcomes, as evidenced by t<sub>count</sub> 3.12˃2.04 t<sub>table</sub> at the value of r² 0.509 in the medium category. Then, the students’ and teachers’ response with “yes” answers obtained a percentage of 87.22 (interested) and 100 (highly interested). It can be concluded that SPS and learning outcomes using guided-inquiry strategies are better than lecturing method; besides, SPS method has a positive impact on student learning outcomes, and the students responded positively to the implementation of guided-inquiry learning.

1. Introduction
Learning outcomes are students’ abilities that have been achieved after carrying out an activity or a test [1]. One way to improve learning outcomes is by improving the learning process, so a supporting skill is needed to enhance these outcomes. The skill that can be developed in developing new concepts, especially learning science, is the science process skill or known as SPS for short [2]. Characteristics of SPS skills are the ability to observe, classify, formulate hypotheses, design and conduct experiments, communicate, apply concepts, predict, and interpret data [3].

From the initial observation done at SMPN 1 Darul Imarah, Aceh Besar, it was learned that the student’s SPS were still not trained well enough science practices were rarely implemented. The fact leads the students to be less active and not skillfully trained in retrieving the facts and concepts they had learned. Then, the learning outcomes of students as indicated by the average test scores of one of the 2016/2017 academic year subjects in concern to Human Respiratory System material are still low which is only 41.32; whereas the minimum passing grade requires the score of 78. Presumably, this
occurs since the learning process carried out at the school generally emphasised the final results and only used lecturing method.

*Human Respiratory System* materials can train student’s SPS because the content requires observing respiratory organs and these materials can provide direct experience through experiments to find facts and concepts when it comes to the activity of measuring the frequency and volume of breathing. It is clear that it directly involves several SPS in it.

One effort that could be done to develop SPS and improve student learning outcomes is by implementing a guided-inquiry-learning strategy. Inquiry learning requires students to plan and conduct experiments, collect, and analyse data so that students will be active in solving problems [4]. Guided-inquiry learning can improve concept understanding, critical thinking skills [5], and scientific literacy [6].

Guided-inquiry-learning strategy was chosen in this study to train and improve student’s SPS because as supported by previous research that the components and objectives of SPS have the similarity of learning syntax with inquiry [7]. The syntax of inquiry learning has potential that is beneficial in increasing SPS [8]. The implementation of guided inquiry can improve learning outcomes and SPS indicators for students [9].

2. Methods

This study employed the experimental method with pretest-post test design with a control group. The population in this study were all eighth-grade students in the even semester at SMPN 1 DarulImarah Aceh Besar, and there were 153 classes in total. The sample taken was 61 students only. The sampling technique used was purposive sampling. The criterion taken for the purposed sample is the result of the initial ability test throughout all the classes. Shortly, two classes were taken as each the experimental and control class.

The study was conducted on March 17th to April 20th, 2018. The instruments used in this study were 10 SPS questions and 24 learning outcomes which consisted of 24 multiple-choice items and the SPS questionnaire assessment sheets using a questionnaire with a Guttman scale.

3. Results and Discussion

3.1. SPS data analysis

In the following is provided with the analysis result for the pretest, posttest, and N-gain SPS questions of the students in *Human Respiratory System* material which is presented in Figure 1.

![Figure 1. Average pretest, posttest and N-gain scores about SPS](image)

Figure 1 above shows the average pretest and posttest scores of the experimental and control group, which is 33 and 35, respectively. Both groups’ pretest score is slightly different. Meanwhile, the posttest score average was 64 for the experimental group and 55 for the control group. The result shows that the average score of the experiment can be seen from N-gain value for experimental class which is 46 criteria, while control only has low-value criteria which are 26.

The normality test of the two classes was carried out using the *Shapiro-Wilk’s* test, and the homogeneity test used the *Levene’s* test. And for hypothesis testing, the t-test with the independent
sample t-test using SPS software version 19 at a significant level of 0.05 was utilised. The results obtained are some tests on the SPS problem which were carried out before and after learning from both groups, namely experiment and control groups. The normality test of the experimental class SPS questions is 0.485 and control group is 0.762, while the homogeneity test is 0.446. The results obtained from both tests with a significant level of $\alpha > 0.05$, it can be concluded that the data are normally distributed and homogeneous.

The pretest hypothesis test was $0.484 > 0.05$, and it can be concluded that there were no significant differences in the results of the experimental group SPS and control group in regard to the questions so that it was known that the class had almost the same initial ability. Later, from the results of the hypothesis test, it is obtained the sig. $0.006 < 0.05$ or $t_{\text{count}}$ equal to $2.838 > 2.001$ $t_{\text{table}}$. Conclusively, there were significant differences in the two classes that appear as the results of the application of guided-inquiry learning. It is in line with is search that the learning process using guided inquiry can improve student’s SPS, so it can be concluded that the score of SPS questions obtained by students treated using guided-inquiry learning is higher than the group which used lecturing method [10]. An inquiry is more effective in encouraging students’SPS compared to lecturing methods since inquiry leads to solving problems and improving performance. Inquiry involves retrieving, searching, defining the problem, formulating a hypothesis, collecting and interpreting data, and drawing a conclusion [11]. An inquiry is effective in increasing SPS [12].

The observations of SPS was later carried out when the learning process took place, and an observation sheet was used to note the occurring situation as the data. The results of the percentage of SPS indicators of SMPN 1 Darul Imarah in the experimental and control group in Human Respiratory System material based on nine indicators can be seen in Figure 2 below.

![Figure 2](image.png)

**Figure 2.** Percentage of the average score of SPS indicators for experimental and control class students

Based on Figure 2, it can be seen that different average scores obtain the percentage of each SPS indicator. The SPS with the highest score of 86 is the skill to apply the concept with a ‘very good’ category followed by communicating skills which are 85 in the ‘good’ category. This result shows that students already know practising and learning are carried out procedurally so that students can show a causal relationship, the compatibility between the experiments carried out, and the conclusions taken. Later, in communicating, students correctly presented each practical step that they implemented during the practice. The knowledge possessed by the experimental group who had been exposed to the application of inquiry-learning is better because they were trained to perform, while the control groups were not as they were treated only with lecturing method.
On the contrary, the lowest score gained by the student is the skill to formulate a hypothesis that is 71 (enough). It happened because students do not have background knowledge about the material of the Human Respiratory System, so it is rather difficult to give a short answer and associate it within the everyday life context. It can be overcome by frequently instructing a reminder or task to read before the learning begins, for example by reminding reading about the material as learning material before the content is studied so that students have fundamental knowledge about learning that will be implemented later. Inquiry guides and trains students to generate hypotheses on the presented problem formulation. It is contrary to lecturing methods that do not present problems, so the hypothesis cannot be formulated.

Then, skills to plan experiments obtained 82 (good). This aspect is very important because it is a part of the discovery/investigation activities, and in this aspect, it is seen that students are very enthusiastic about finding out the practice procedures. According to previous research, the experimental planning indicators implemented for students are directed to seek and learn the steps ahead of conducting experiments [13]. Skills for conducting experiments in the experimental class gained 76 (good) while the control class in category 68 (enough). When the learners do the experiments with guided-instructions and guided-questions from their teacher, it can improve the skills of conducting experiments which leads to the expansion of the scientific knowledge through investigation [14].

Next, the skill of interpreting data is obtained within a “good” category which is 80. Occasionally, students seemed not to get accustomed to processing the data obtained after practising. But with guidance from the teacher, it is easier for students to practice this aspect of SPS. Later, predicting skills gained 81 (good) as students can predict the results of the data according to the purpose and results of the experiment with the knowledge and information that has been searched earlier.

Later, observation skills obtained the score of 76 (good) in the experimental group and 71 in the control group (sufficient). Observing ability is important because it is a skill that must be possessed by students to begin investigations in finding a problem. And finally, the classification skills obtained 76 results (good) in the experimental class, and the control class gained 66 (enough). In accordance with the learning materials, the students were expected to be able to classify various types of breathing volumes based on the number.

Inquiry learning is designed to encourage students to ask questions, develop critical thinking, improve skills, and implement their knowledge. The inquiry-learning process can improve SPS and learning outcomes as students can observe, classify, measure, predict, summarise, and communicate [15]. Inquiry learning provides students with a wealth of experience from the scientific search process to provide meaningful knowledge and manifest in the growth of the students’ SPS. To emphasise, processing skills the basic ability for students to utilise in applying scientific methods as the skill is needed when searching for knowledge and posing a role in the process of generating scientific knowledge and promoting knowledge development [16].

3.2. Analysis of Learning Outcomes Data
In the following is provided with the analysis for the pretest, posttest, and N-gain learning outcomes of students in Human Respiratory System material.

![Figure 3](image-url)  
**Figure 3.** Average pretest, posttest and N-gain score in learning outcomes
Figure 3 shows the average pretest and posttest scores of the experimental and control classes, which are 47 and 49, respectively. Both classes have a nearly similar average score. However, the scores appear to be different in the posttest, which is 79 and 63, respectively for each group. The results show that the average score of the experimental group is higher than the control group, this can be seen from the N-gain experimental class has 59 criteria while the control class is only with 24 criteria—which is considered low.

The analysis of several tests on learning outcomes was carried out before and after the learning process from both classes, namely experimental and control class. The normality test of the experimental and control class learning outcomes was 0.553 and 0.802, respectively, and homogeneity test was 0.443. The results obtained from the two tests Sig > 0.05 and it can be concluded that the data from both groups are normally distributed and homogeneous.

Last, the pretest hypothesis test was 0.441 > 0.05 which brought to the conclusion that there were no significant differences in the learning outcomes of the experimental and control classes before the treatment. In other words, the initial abilities of both classes were somewhat similar. The results of the hypothesis test obtained a sig value of 0.000 < 0.05 or t_{count} of 4.863 > 2.001 _{table}. Hence it was concluded that there were significant differences in the two classes. The difference in the average score of the pretest and posttest was due to the application of guided inquiry learning during the treatment. These results are in line with previous research stating that the implementation of guided inquiry by training SPS can improve learning outcomes [17]. Inquiry increases student’s understanding because there are more opportunities to be active in the learning process, and the results obtained are higher than those taught by the lecturing method because, in lecturing method, the students are not directed by teachers [18]. Additionally, another research also supports that participants in the experimental class understand faster with guided inquiry and they were more successful than the control class who were treated with the lecturing method. It could be concluded that the scores of learning outcomes obtained by students taught by guided-inquiry were higher than those taught by lecturing method [19].

3.3. Correlation and regression test
The correlation between SPS and student learning outcomes in the experimental class can be seen in Figure 4 below.

![Figure 4](image)

Figure 4. Equation of the regression lines between SPS and learning outcomes.

Figure 4 shows the regression direction between SPS and student learning outcomes, and it forms a straight line with the equation y = 1.1906x - 15.46, after which, the correlation is calculated as 0.509. The relationship between the correlation test between SPS and learning outcomes is seen in (t_{count} 3.12 > 2.04 _{table}) and significant value (2-tailed) 0.004 < 0.05. It shows that between SPS and learning outcomes, there is a moderate correlation. The magnitude of the relationship is determined by the results of the analysis of the coefficient of determination (r^2) is (0.509)^2 which shows that factors of high or low SPS determine 0.25 or 25% of learning outcomes. Shortly, it can be concluded that SPS poses a positive impact on student learning outcomes.

Further, the relationship between SPS and learning outcomes is influenced by the application of guided-inquiry learning. In accordance with previous research revealing that there is a positive correlation between SPS and student learning outcomes after the implementation of guided-inquiry
learning. In other words, the guided-inquiry strategies can improve SPS and learning outcomes and provide a good influence between SPS and learning outcomes [20]. Inquiry-based learning increases SPS and is proven to be more effective in improving learning outcomes compared to the lecturing method [21].

3.4. Analysis of student and teacher responses questionnaire

In the following is provided with the questionnaires distributed to students to find out their responses toward the application of guided-inquiry-learning strategies. The results of responses can be seen in Table 1 below.

Table 1. Recapitulation of questionnaires responses of students.

| No | Questionnaire Item                                                                 | Percentage Alternative Answers |
|----|-----------------------------------------------------------------------------------|--------------------------------|
| 1  | Does the application of guided-inquiry learning increase your learning interest in the material of the human respiratory system? | Yes: 90 No: 10                |
| 2  | Does the application of guided-inquiry learning help you to make science lessons more likeable? | Yes: 83 No: 17               |
| 3  | Does the application of guided-inquiry learning make it easy for you to study the material of the *Human Respiratory System*? | Yes: 93 No: 7                |
| 4  | Does the application of guided-inquiry learning improve your science process skills? | Yes: 93 No: 7                |
| 5  | Does the application of guided-inquiry learning make you more active in the group? | Yes: 80 No: 20               |
| 6  | Does the application of guided-inquiry learning add new information for you?       | Yes: 83 No: 17               |
|    | Total                                                                             | 523                            |
|    | Percentage                                                                        | 87.22 12.78                  |

Based on Table 1 shown above, it can be seen that the responses of students to guided-inquiry learning obtained an average score of 87.22 with the ‘interested’ category. Besides, in its implementation, inquiry can make students become more active, creative and can cooperate during the learning process [22].

The questionnaires were also distributed to the teacher to find out the responses toward the implementation of guided inquiry-learning strategies. These questionnaires were given to one of the eighth-grade teachers, and the results show the percentage of 100 with an alternative answer ‘yes’ for each of the six items. It can be said that the application of guided-inquiry strategies can facilitate learning and increase students' interest in learning about the material of the *Human Respiratory System*. Furthermore, besides it expands information for students, the guided-inquiry strategies can make the students more active in groups.

4. Conclusions

Based on the findings, it can be concluded that there are differences in SPS and learning outcomes of students between the group treated using guided-inquiry-learning strategies and the group treated with lecturing method in concern of *Human Respiratory System* material. SPS and learning outcomes with guided inquiry are better than the lecturing method. Therefore guided inquiry is suggested to be effectively used in learning because there is a correlation between SPS and student learning outcomes; the higher the SPS score, the better the student learning outcomes would become.

Later, concerning to students’ response, the comparison between ‘yes’ and ‘no’ toward the six questions offered in the questionnaire obtained an average percentage of 87.22 and 12.78 with categories of ‘interest’ and ‘little interest’; while for the teachers, the percentage is 100 and 0 in the
category ‘very interested’ and ‘not interested’, respectively. In brief, the implementation of guided-inquiry-learning strategies made it easier for the students to study Human Respiratory System material and could increase SPS and interest in learning, help them to be fond of science lessons, be more active in groups, and expand information.

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