Application of guided inquiry learning model to improve students’ scientific attitudes and learning outcomes

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Abstract. This study aimed to determine the improvement of scientific attitudes and student learning outcomes through a guided inquiry model on work and energy. The sample used was Senior High School 1 Montasik (SMAN 1 Montasik) and Senior High School 1 Darul Imarah (SMAN 1 Darul Imarah) Aceh Besar consisted of two classes, specifically student of class one of 10th year as experiment class and class four as the class of control. This research was conducted with a quasi-experimental design method through the nonequivalent control group pretest-posttest design. Data was collected using pretest and posttest to find out the improvement of learning outcomes and observation sheets to determine the scientific attitude of students. Based on the analysis the average value of the experimental class experienced an increase of 0.73 and 0.76, while the control class was 0.60 and 0.64. Descriptively the scientific attitude of the students also showed a difference, specifically the experimental class showed a better scientific attitude than the control class. It can be concluded that the guided inquiry model can improve scientific attitudes and student learning outcomes.

1. Introduction
Physics learning is learning that provides learning experiences by looking at students' physical and mental states. Students are expected to have the scientific ability to develop the ability to think and be scientific. However, the implementation of Physics science learning is still based on teacher-centered learning. The teacher's role is more as a source of information that transforms the knowledge possessed to students [1]. Based on observations and information at SMAN 1 Montasik and SMAN 1 Darul Imarah, teaching and learning activities in physics are still conducted conventionally so that it causes a lack of interest in learning. It gives difficulties for teachers in directing students to be able to learn actively. Student learning outcomes are still below the minimum score criteria which are 75 with ± 50 percent of completeness, the data is obtained from the midterm exam. Another indicator that serves as a benchmark is the pure value of the National Examination (UN) which is still far from what is expected.

Efforts are being made to improve the learning process by choosing the right learning model. The teacher must be able to choose suitable methods to be able to make students more active in learning. So, students can improve their scientific attitude in using measurement tools, because physics is a science that studies natural phenomenon.
The scientific attitude of students in learning can affect student learning outcomes. People who are scientific are those who have seven kinds of scientific attitudes. The seven types of scientific attitudes are (1) curiosity, (2) a critical attitude, (3) open minded, (4) objective, (5) willingness to respect the work of others, (6) responsibility, and (7) forward reaching attitude [2].

Attitude is a condition of readiness for a certain type of activity. Attitudes held by the individuals may be simple or complex, stable or unstable, temporary or permanent and superficial or fundamental, judgments based upon insufficient facts are likely to yield wrong results and there by develop based attitude [3]. Scientific attitudes are normally associated with the mental process of scientists. These habits are important in the everyday life and thinking not only for the scientist but also for everyone [4].

Efforts to improve students’ scientific attitudes are the need for a teaching strategy that actively involves students in the learning process. One strategy to improve students' scientific attitudes is to use guided inquiry models. Inquiry learning is an approach in learning and understanding the environment through a series of activities including formulating questions, conducting investigations, observing, and explaining the results [5]. National Science Education Standard (NSES) explains that inquiry in education can facilitate students to learn through various aspects of activities that include observation activities; making questions; examining books and other sources of information to see what has been known beforehand; planning an investigation; double-checking what is already known from the standpoint of experimental activities; using tools to collect data; analyzing and interpreting data, submitting answers, explaining and predicting, and communicating results [6].

With the inquiry learning model, students are actively involved in obtaining concepts and principles and the teacher encourages students to gain experience by carrying out activities that enable them to discover concepts and principles for themselves [7]. Thus, understandings of Scientific Inquiry are believed to be critical and essential components of the modern-day battle cry of “scientific literacy” [8]. Then, the learning model gives emphasis on students to learn through stages to gain knowledge through scientific method processes, which are formulating problems, proposing hypotheses, collecting data, verifying result, and generalizing by drawing conclusion. In guided inquiry process, the role of teacher is as a mentor in decision making process [9].

In the process, students and teachers work together to formulate problems and develop answers [10]. There are significant differences in scientific attitudes and student learning outcomes between groups of inquiry learning models and conventional learning model groups [11]. Furthermore, there is an effect of the inquiry model on the ability to think logically, where the ability of students to use the inquiry model is higher than that to use conventional methods [12]. Based on the description above, researchers are interested in applying the guided inquiry model to improve scientific attitudes and student learning outcomes.

2. Research Method

2.1. Experiment design
This research is a quantitative research. The research approach used was quasi-experimental (quasi-experimental). The design used in this study was "nonequivalent control group pretest-posttest design" taken from random sampling. There were two groups of objects specifically as the class of experiment and the class of control.

2.2. Population and sample
The population in this study was grade ten students of SMAN 1 Montasik and SMAN 1 Darul Imarah Aceh Besar District in the academic year 2017/2018. The samples taken were two classes per school, which are grade ten-one and grade ten-two with a total of 24 students. One class was applied the guided inquiry learning model and the other class was applied the model directly.
2.3. Data analysis
Analysis of the data used in this study was a prerequisite test consisting of a normality test and a homogeneity test. Hypothesis was tested using the t test and for the test to increase learning outcomes using N-gain. The data in this study are scientific attitude and student learning outcomes. Data about students' scientific attitudes were collected using observation sheets, and student learning outcomes were collected using multiple choice objective tests with five choices.

3. Results and Discussion

3.1. Learning outcomes
The assessment of learning outcomes for business materials and energy at SMAN 1 Montasik and SMAN 1 Darul Imamah in the experimental class and the control class were carried out in different ways. In this study, the acquisition of pretest and posttest values that have been given can be seen in Figure 1.

![Figure 1. Comparison of experiment and control class](image)

Based on Figure 1, the percentage of SMAN 1 Montasik and 1 Darul Imamah SMAN 1 with the average value of the experimental class has increased by 73% and 77%, while the control class is 60% and 64%. Based on these data, the N-gain of the experimental class learning outcomes is higher than the N-gain of the control class.

3.2. Observation Results on Scientific Attitudes
Data on the results of improving scientific attitudes using the guided inquiry learning model and direct learning were obtained from the average scores of each individual at each meeting. This research was conducted in two meetings. In each meeting students were observed by observers by using observation sheets to find out the increase in students' scientific attitudes during the learning process.

The aspects of scientific attitude measured in this study were seven aspects. The aspects used are a curiosity, respect for data/facts, critical thinking, discovery and creativity, open minded and cooperation, perseverance and sensitivity towards the surrounding environment. Data on scientific attitudes of students based on indicators can be seen in Table 1.

| Indicator of Scientific Attitude | SMAN 1 Montasik (%) | SMAN 1 Darul Imamah (%) |
|----------------------------------|---------------------|-------------------------|
| | Experiment | Control | Experiment | Control |
| Curiosity | 69 | 92 | 56 | 65 | 69 | 89 | 57 | 65 |
| Respect for data / facts | 77 | 92 | 59 | 68 | 75 | 88 | 63 | 66 |
| Critical thinking | 67 | 92 | 61 | 64 | 67 | 89 | 66 | 71 |
AN overview and creativity guided inquiry learning had a percentage of 61% and an increase of 23% of the experimental class at SMAN 1 Darul Imarah at the first meeting had a percentage of 68% and at the second meeting was 88% so that it had an increase of 21% after given guided inquiry learning, while the control class at the first meeting had a percentage of 58% and the second meeting of 65% had an increase of 8% with direct learning. An increase in curiosity is seen in the habits of students to ask questions about various matters relating to the material being studied.

| Indicator of Scientific Attitude | SMAN 1 Montasik (%) | SMAN 1 Darul Imarah (%) |
|----------------------------------|----------------------|-------------------------|
|                                  | Experiment | Control | Experiment | Control |
| Discovery and creativity         |           |         |           |         |
|                                  | I   II     | I   II  | I   II     | I   II  |
| Open minded and team player      |           |         |           |         |
|                                  | 70  92    | 62  69  | 68  89     | 66  68  |
| Perseverance                     |           |         |           |         |
|                                  | 76  93    | 66  71  | 73  89     | 58  66  |
| Sensitivity to surrounding       |           |         |           |         |
| environment                      | 80  92    | 66  69  | 79  90     | 56  66  |

3.2.1. Indicator of Curiosity “The attitude of curiosity of the experimental class in SMAN 1 Montasik at the first meeting had a percentage of 69% and at the second meeting amounted to 92% so that it had an increase of 23% after given guided inquiry learning, whereas the control class at the first meeting had a percentage of 56% and at the second meeting of 65% it had an increase of 8.4% with direct learning. While the experimental class at SMAN 1 Darul Imarah at the first meeting had a percentage of 69% and the second meeting amounted to 89% so that it had an increase of 21% after given guided inquiry learning, while the control class at the first meeting had a percentage of 58% and the second meeting of 65% had an increase of 8% with direct learning. An increase in curiosity is seen in the habits of students to ask questions about various matters relating to the material being studied.

3.2.2. Indicators of Respect for Data/Facts ‘The attitude of respect for data/facts of the experimental class in SMAN 1 Montasik at the first meeting had a percentage of 77% and at the second meeting amounted to 92% so that it had an increase of 15% after given guided inquiry learning, whereas the control class at the first meeting had percentage of 59% and at the second meeting of 68% had an increase of 8.8% with direct learning. At the same time, the experimental class at SMAN 1 Darul Imarah at the first meeting had a percentage of 75% and the second meeting was 88% so that it had an increase of 13.2% after given guided inquiry learning, while the control class at the first meeting had a percentage of 63% and the second meeting of 66% had an increase of 3.0% with direct learning. The increase in attitude has an impact on openness to the facts and findings in the field or development even if it contradicts or is not in accordance with existing theories.

3.2.3. Indicators of Critical Thinking Attitude Critical thinking attitude of the experimental class at SMAN 1 Montasik at the first meeting had a percentage of 67% and at the second meeting was 92% so that it had an increase of 23% after given guided inquiry learning, while the control class at the first meeting had a percentage of 61% and at the second meeting of 64% had an increase of 3% with direct learning. While the experimental class at SMAN 1 Darul Imarah at the first meeting had a percentage of 67% and the second meeting amounted to 89% so that it had an increase of 22% after being given guided inquiry learning, while the control class the first meeting had a percentage of 66% and the second meeting of 71% had an increase of 5.6% with direct learning. This improvement in critical thinking shows that the students' habit of finding as much information as possible is related to their field of study to find truth or so on.

3.2.4. Indicators of Attitudes to Discovery and Creativity The attitude of discovery and creativity of the experimental class in SMAN 1 Montasik at the first meeting had a percentage of 70% and at the second meeting amounted to 92% so that it had an increase of 22% after being given guided inquiry learning, whereas in the control class at the first meeting it had a percentage of 62% and at the second meeting 69% the increase was 7% with direct learning. Meanwhile at SMAN 1 Darul Imarah, the first meeting of the experimental class had a percentage of 68% and the second meeting amounted to 89% so that it had an increase of 21% after given guided inquiry learning, while in the control class the first meeting had a percentage of 66% and the second meeting of 68% had an increase of 1.5%
with direct learning. The attitude of discovery and creativity was improved because students showed the results of their reports, even though they were different from their classmates and the students suggested new experiments.

3.2.5. *Indicators of Open Thinking and Cooperation* The attitude of open thinking and cooperation of the experimental class in SMAN 1 Montasik at the first meeting had a percentage of 77% and at the second meeting it amounted to 91% so that it had an increase of 14% after given guided inquiry learning, whereas the control class at the first meeting had a percentage of 61% and at the second meeting 66% had an increase of 5% with direct learning, whilst in SMAN 1 Darul Imarah, the first meeting at the experimental class had a percentage of 75% and the second meeting was 89% so that it had an increase of 13% after given guided inquiry learning, while in the control class the first meeting had a percentage of 60% and the second meeting of 70% had an increase of 9% with direct learning. This increased attitude of open minded and cooperation can be seen in the habit of listening to opinions, arguments, criticisms, and other people's information. Although in the end opinions, arguments, criticisms, and statements of others were not accepted because they were not in agreement or not in accordance. Students are also able to work together with their groups in completing experiments.

3.2.6. *Indicator of Perseverance* The attitude of persistence of the experimental class at SMAN 1 Montasik at the first meeting had a percentage of 76% and at the second meeting of 93% so that it had an increase of 18% after being given guided inquiry learning, while the control class at the first meeting had a percentage of 67% and in the second meeting 71% it had an increase of 4.5% with direct learning. At the same time, the experimental class in SMAN 1 Darul Imarah at the first meeting had a percentage of 73% and in the second meeting it was 89% so that it had an increase of 16% after given guided inquiry learning, while in the control class the first meeting had a percentage of 59% and the second meeting of 66% had an increase of 7.5% with direct learning. The improvement of attitude’s perseverance was due to students wanting to repeat the experiment has been done if the results obtained fail.

3.2.7. *Indicators of Sensitive Attitudes to the Surrounding Environment* Sensitivity toward the environment of the experimental class at SMAN 1 Montasik at the first meeting had a percentage of 80% and at the second meeting amounted to 92% so that it had an increase of 11% after being given guided inquiry learning, whereas the control class at the first meeting had a percentage amounted to 66% and at the second meeting amounted to 69% so that it had an increase of 3.3% with direct learning. Whilst the experimental class at SMAN 1 Darul Imarah at the first meeting had a percentage of 79% and the second meeting amounted to 90% so that it had an increase amounted to 11% after given guided inquiry learning, while the control class at the first meeting had a percentage of 56% and the second meeting of 66% had an increase of 10% with direct learning. The enhancement of attitudes of caring for the surrounding environment occurred because students were invited to care about maintaining environmental cleanliness after carrying out the practicum and they also participated in activities carried out at school.

In this study, the class of experiment was treated using the inquiry model and the class of control was managed using direct (conventional) learning. From the two classes, the development of scientific attitude was measured using observation sheets conducted by the observer. Scientific attitude was measured during the learning process.

From the percentage of scientific attitudes, the experimental class taught with the inquiry model is better at developing its scientific attitude than the control class taught by direct learning [13]. The difference in scientific attitudes is that the control class is teacher-centered, while the experimental class students learn actively. Another difference is that experimental class student can understand new concepts of a problem in which its truth needs to be proven. This is what can help students learn scientifically [14].


The results obtained in this research showed that there were differences of conceptual knowledge in experimental group using Scientific Inquiry model and control group using conventional learning. The findings of this study were in line with the research conducted by [15] who states that there was a difference between scientific inquiry and conventional learning on students’ learning outcomes. Students’ learning outcomes taught by scientific inquiry were better than those of conventional learning. It showed that the findings of this research were in line with Hussain’s study, but this research concerned specifically on measurement of learning outcome or conceptual knowledge.

The enhancement of students’ procedural knowledge on Scientific Inquiry learning model was caused by students’ better creativity in learning process and high curiosity in presenting authentic problems. While in the control group, as they had freedom to ask teacher directly, the students preferred to ask teacher directly and did not have an effective discussion with friends in group.

4. Conclusions
Based on research results obtained from data analysis and hypothesis testing, it can be concluded that “Learning physics with inquiry learning model increased students’ scientific attitudes and learning outcomes on business material and energy at SMAN 1 Montasik and SMAN 1 Darul Imarah Aceh Besar”.

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