The Process of Developing Students’ Scientific Argumentation Skill Using Argument-Driven Inquiry (ADI) Model in Senior High School on The Topic of Elasticity

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Abstract. The Argument-Driven Inquiry (ADI) learning model is a laboratory-based learning model. ADI requires students to be able to work as a group and make argumentation that shows their understanding of concepts. It is important to practice scientific argumentation in learning so that the students can explain scientific phenomena based on evidence and concepts learned. The purpose of the research is to train the student’s argumentation with the ADI model. This research used a qualitative descriptive with the subject of research is 37 senior high school students. Students’ scientific arguments skill is measured by verbal arguments supported by written arguments and analyzed using Toulmin’s Argumentation Pattern. The results show that there is an influence of the ADI model on students spoken scientific argumentation with a mean at level 3 and supported by written argumentation which increased with a mean value of 2.72 on the topic of Elasticity. It can be concluded that the most student’s ability in providing scientific argument is at the level of giving claim with the weak support warrant.

1. Introduction
Arguments are one of the important purposes in the modern era of learning because it is the basic step to promote student’s critical thinking process and science literature [1]. Some important reasons argue capabilities applied to the study of physics [2-3]. For example, scientists use arguments in developing and enhancing the scientific knowledge acquired [4]. Some people use the argument in the scientific debate. The students in the learning require abiding argument to reinforce the concepts learned [5]. The argument was processed, which used by someone to analyze information on a topic and then the results of the analysis was communicated to others [1]. Thus the using of argumentation in science learning was part of the development of higher-order thinking skills [6].

The ability of a scientific argument is very important to apply the physics learning so that the students have a logical reason and critical thinking [7]. Physics is the knowledge acquired and developed through the scientific method. Through this method, the discovery and development of knowledge obtained through systematic measures to be accompanied by strong evidence, so this method is closely related to the argument. From the argumentation, the students can to explain and evaluate the scientific phenomenon based on scientific evidence.

Based on the results of observations in SMAN 1 Magetan that physics learning activities are still focused on the delivery of content and problem-solving. Laboratory activities have been implemented, but the students were completing a lab report. The students usually are not communicating about the
results and exchanging opinions with other students. From the observation, there was no activity in arguing about the findings or the results that they get from the lab activities. Additionally, learners have difficulty in understanding the concepts of physics because they only focus on memorizing formulas to resolve the problems. Based on these facts, the learning activity is focused on the physical aspects of knowledge, so scientific argumentation skill has not been applied. Students avoid making objections considering their risks in discussion activities, especially argumentation. They worry that their arguments can have a negative impact on their social lives [8].

From research conducted by Ofi, Demibarg et al., and Demircioglu et al. [9-11], the application of the ADI model helps understand the concepts of learning being taught. For example, Ofi stated that the ADI model was well implemented, as shown by the increased ability to argue [9]. Also, Demircioglu said that the ADI model was effective in improving the quality of arguments [11]. However, in this research is verbal argumentation skills were not studied, while this research is studied in oral and written argumentation skills. Based on the description that background, it should be applied to the learning model-Driven Argument Inquiry (ADI) so that students can improve the ability of scientific argumentation in physics learning, and create the competent students are expected in the 21st-century learning.

2. Method
The research used the qualitative descriptive method. Subjects are student grade XI MIPA in SMAN 1 Magetan total of 32 students. This research was carried out on August 2019. The oral argumentation obtained when the students presenting the results of the experiment/observation, in phase 4 (session argument) in the learning ADI model. The written argumentation obtained from the written report of the investigation/trial each group and the results of each group answer questions related tasks at a given concept. To determine the increase in oral arguments and written arguments learners measured by using Toulmin's Argumentation Pattern [6] written argument learners measured by looking at the development of the points/levels obtained [12].

3. Results and Discussion
3.1. Improved Oral Arguments
The results showed an increase in the number of arguments at every level of learning activities ADI. Arguments level 1 is an argument that consists of simple claims. Simple claims often arise when learners discuss employment-related measures or trial preparation in conducting data collection, such as the following conversation excerpt.

Teacher  : “How to make a constant spring value?”
Student : “The comparison with the length spring style, Mrs..”
Teacher  : “What is the manipulation of the load used? And how hypothesis while?”
Student : “5 Load manipulation. Spring constant value for each experiment should be the same. Because only use one spring”.

The response is a simple reply. Arguments like this happened when the teacher gave a briefing on each group and when students discuss the preparation and investigation work steps that will be used. The number of units of learners identified arguments when students discuss in early learning of ADI have almost the same quality.

At level 2, arguments have increased arguments. Ability students argument for including the data, theories, or concepts of physics relevant to justify and support an increase. Either during the discussion groups as well as during a session of the argument. Students can make a claim based on the justification based on his knowledge related to the theory of elasticity. The ability of students in problems related to the better argument on each learning activity ADI. Students are getting better at stating more claims are based on data/evidence obtained from the results of the investigation.

At level 3 an argument is getting increased arguments when the students presented the results of the investigation group on the session argument put forward a claim that sparked a rebuttal while answering
questions on LKPD (Worksheet Students) regarding the value of the resulting spring constant is different.

   Student A: "According to the investigation results that you get, why the results of the spring constant value can be different?"
   Student B: "No, the spring constant value results obtained are relatively the same."
   Student C: "From the 5 experimental groups. The results of the spring constant value that you produce is very far away, where 4 groups mean getting results with a value of tens. But you get the value of hundreds of groups, why it has happened buffer?"

In excerpts questions / disclaimer students "................. But you get the value of hundreds of groups, why it has a buffer to happen?". Learners’ understanding that should the value of the spring constant of each group is not too far away. So the question arises as proposed.

   Student B: "Yes. Because each group could not be concluded that the value of the spring constant should be the same in each group. Therefore, it could only spring type group A, B, C and D are not the same as the spring group E. Similarly, the level of elasticity of each spring, including the length of spring is produced."

In the quote "................ Therefore, it could only spring type group A, B, C and D are not the same as the spring group E ..............." a refutation of the spring constant rate differences generated. The refutation is a strong rebuttal. Because it could be a spring used has a limit of elasticity which is weaker than the other spring, so the spring constant value in the group is very much different from other groups. In the physics lab in the school has a spring which is very minimal and can not generalize the type of spring used in each group were used.

   Student A: "Based on the results of the investigation that you do. Is it in accordance with the theory?"
   Student B: "Yes, it is. Based on data obtained and graph the relationship between the force and the length in accordance with the theory."

At level 4, the argument tends to decrease, because of the knowledge and conceptual understanding of learners are becoming increasingly well in implementing the learning activities so that the appearance of a rebuttal weakened ADI is reduced.

Based on the results of research on an oral argument for each level of argumentation identified in each learning activity ADI, the ability of oral argument learners at every level showed a different trend pattern. Improving the ability of oral argument indicated by the learners can use the components of a scientific argument is better.

   Based on other research [13-15], the results showed that the students' verbal argumentation process was found to only claim to be supported by weak warrants. However, in this study, it was found that the students' oral arguments were able to provide claims supported by a well warrant, with a level 3 average. That means the research subjects have understood the concepts of physics that have been studied. So students can provide arguments by making claims supported by a warrant, it's just that they need to be re-trained in the next physics learning.

3.2. Improved Writing Arguments

Valuation techniques used for this argument skill that is written assessment technique performed with a written test with a test to supply answers (Description) by scoring every point because given a score based on Table 1.

The increasing of argument students writing is measured from the written report of the investigation/trial each group and the results of the assignment answer questions related to the concepts learned. The results measure using Toulmin's Argumentation Pattern. It is generally known that the ability of scientific argumentation has increased every learning activity based on Table 2.

The mean increase in written scientific arguments, students have an increased scientific argument with a mean score increase of 2.72. Data show that the ability of learners to make claims, include data and provides justification for the claims that have been made it better all the time in learning activities. Also, students can write the theory/concepts that are relevant in answering the question of investigation.
Table 1. Matrix Scoring Arguments Adapted from Toulmin’s Argumentation Pattern [12]

| Level | Criteria |
|-------|----------|
| 1     | a) The argument is very weak  
        b) The claim is invalid and the data is not reliable  
        c) The relationship between the claims, data, warrant very weak  
        d) The relationship between the components no argument |
| 2     | a) The argument is quite good  
        b) Claims inadequate and insufficient data good  
        c) The relationship between claims and evidence good enough  
        d) The relationship between the components is sufficient argument |
| 3     | a) strong argument  
        b) The claim is valid, the data is strong and well warrant  
        c) The relationship between claims and evidence  
        d) Relationships between components are strong arguments |
| 4     | a) The argument is very strong  
        b) Very valid claim, the data to clarify the claims, include a strong evidence  
        c) The relationship between the claim and the evidence is very strong  
        d) The relationship between the components very strong argument |

Table 2. Score of Argumentation

| Analysis of Data Argumentation | Question 1 | Question 2 | Question 3 | Mean |
|--------------------------------|------------|------------|------------|------|
| Group A                        | Level 3    | Level 3    | Level 3    | 3    |
| Group B                        | Level 3    | Level 3    | Level 3    | 3    |
| Group C                        | Level 3    | Level 2    | Level 2    | 2.3  |
| Group D                        | Level 3    | Level 3    | Level 3    | 3    |
| Group E                        | Level 2    | Level 3    | Level 3    | 2.7  |
| Group F                        | Level 3    | Level 1    | Level 3    | 2.3  |

Score Mean of Argumentation 2.7

Based on the results obtained, it can be seen that the syntax based on ADI at stage 3, which is conceptual in inquiry in the group. This stage learners are given issues related to sample images of elastic objects, plastic objects and objects fault. This stage, students were asked to categorize the types of objects and asked to give another example. This stage is designed so that students have the space to practice in presenting arguments, and the question is structured so that students can bring up the argument to make hypothesize up with data processing. Phase 4 provides more opportunities to come up with a more critical analysis when the analysis capabilities associate the data with the concept. Criticality students will move back to the data quality checks, and this ability will be raised at the next learning. Therefore, practising arguments is proven to improve students’ critical thinking skills. Critical thinking is due to one of the elements of critical thinking is recognizing arguments [7].
Rismatul et al (2015) stated that students still have difficulty learning physics in solving problems and difficulty understanding concepts [16]. Therefore it is necessary to do scientific argumentation to find out the understanding of student concepts that have been learned, to get competent students as expected.

4. Conclusion
From the research, the result shows that the most student’s ability in providing scientific argument is at the level of giving claim with the weak support warrant. It caused the students are still not confident in expressing opinions/arguing. Therefore, it can be recommended that the first step to trained the process of argumentation to know the student’s understanding of concepts.

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