Analysis skill of critical thinking on Newton Law Topics using Argument Based Science Inquiry (ABSI) model

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Abstract. Analysis of students' critical thinking skills is the focus of this study. The material used in this research is Newton's law. This research was conducted in one of the senior high schools in Malang City. The research was carried out using the critical thinking test method to measure students' critical thinking skills, with the collection taken was class X IPA with a sample of sixty-four students who were divided into experimental and control classes. The experimental class was applied the ABSI model while the control class was applied to the conventional model. The learning process in the classroom, especially in physics lessons, has not used a learning model that can improve students' critical thinking skills, namely still using discussion, question and answer and lecture models, this also causes less open opportunities for students to participate in learning and low student curiosity so that impact on students' critical thinking skills. By using the ABSI model and tests of critical thinking skills in seeing students' critical thinking skills in Newton's law material, the result is that in the class with ABSI model learning, students' critical thinking abilities are higher than those with conventional models.

1. Introduction

Learning physics is one of educating process about surrounding natural phenomena which is implemented using scientific approach so that students are demanded to be able to carry out and to communicate the result gained during learning process [1,2]. The objective of learning physics is not only to master the scientific concept, but also to learn to involve in scientific discourse [3,4].

The fact that learning process in class uses method of discussion, speech and question answer, it does not use learning model which can improve the student’s critically thinking skill; thus, there are only some students who pay attention during learning process. Students’ low curiosity affects their critically thinking skill [5]. The biggest issue in today’s learning is the lack of opportunity for students to participate in learning, little studying experience, and little effort to develop the arguing skill which leads students to think critically. This issue causes the lack of forming student’s critically thinking skill. Besides, learning process has not maximized either physically or mentally to absorb more information and to observe students’ thinking skill yet. It is not really suitable to 21st century’s demand, which
demands students to understand not only concept, but also critically thinking skill, solving problem skill, effectively thinking skill, and collaborating skill [6,7].

Critically thinking skill can be created by communicating and uttering understood lesson [8]. Critically thinking is thinking by connecting, evaluating, collecting, organizing, recollecting, and analyzing information of all situation or problems. The indicators of student’s critically thinking are: (1) able to understand and to formulate main problem; (2) able to utter reasons based on facts or evidences; (3) make or choose logical, relevant, and accurate arguments; (4) explain aim of arguments which is made of different point of view; and (5) able to determine effect of arguments collected as a decision. It is important for students to understand physics lesson, one of them is Newton Law. Newton Law Lesson is considered to have objects which are easily found in real life so it facilitates students to understand the phenomena and to design scientific activity [9,10].

Some of the phenomena that occur can be solved using Newton's law. Intuitively the force experienced is a form of push or pull on the object, if pushing a broken down car or shopping trolley in the supermarket, the subject will direct the force at the object. When the machine lifts the elevator, or the hammer hits the nail, or the wind blows the foliage then force is being deployed. This is referred to as contact style because the force is directed when an object is in contact with another object. if an object is in a state of silence, to make it begin to move it requires force, this means a force is needed to accelerate an object from zero to acceleration instead of zero [11].

Learning model which helps students develop their critically thinking skills and become active in arguing is Argument Based Science Inquiry (ABSI) Learning Model. ABSI learning Model is able to improve students’ cognitive skill, arguing skill, writing skill, and critically thinking skill [12]. It helps students face 21st century’s demand as creatively and critically thinking skill, which is created by communicating and uttering understood lesson. The result of the research is expected to be a base in improving critically thinking and arguing skills. The aim of the research is to analyze student’s critically thinking skill on Newton Law using ABSI Model based on the result test of critically thinking skill.

2. Research methods
The research used quantitative research method of quasi-experimental type, with only post-test group design. The population was all students of X IPA 3 and X IPA 4 who still actively study in Senior High School in Malang and were divided into two classes, they were Class A and Class B. Class A with 32 students was used as experimental class and Class B with 32 students was used as control class. The researcher’s foundation in determining control class and experimental class was the researcher’s opinion that both classes had equal skill that they had the same right to become control class or experimental class.

The variables in the research were: Independent Variable (X) which was argument based science inquiry (ABSI) learning model in the research. Dependent variable (Y) which was student’s critically thinking skill, and student’s arguing skill was moderate variable (Z). Data collecting method of the research was test documentation. It was used to collect student’s physics scores on previous lesson which was used to find out student’s initial scores before implementation. The data was used to adjust between control class and experimental class. Test method was used to collect data of student’s critically thinking using suitable instrument. Test given to both classes to collect data of final scores was ten problems in form of essay or subjective test to think critically. Having given trial test method instrument and analyzed the result to find out the validity, reliability, distinguish capacity, and difficulty rate; the researcher collected suitable problems to use in test of critically thinking skill. Test method scoring was based on critically thinking indicators. It was arranged based on the aim of learning physics in lesson plan and implemented in scoring instrument. Final data of research result was collected from the test of student’s critically thinking skill in experimental class and control class after implementing Argument Based Science Inquiry (ABSI) model to experimental class and conventional model to control class. It was then analyzed using normality test, homogeneity test, and two-ways anova hypothesis test.
3. Results and discussion

Data of research result is the score of cognitive (quantitative) test for students of experimental class and control class. Critically thinking is way of thinking with arguments which emphasizes on decision making towards what to do. Critically thinking has indicators, they are: (1) able to understand and to formulate main problem, (2) able to utter reasons based on facts or evidences; (3) make or choose logical, relevant, and accurate arguments; (4) explain aim of arguments which is made of different point of view; and (5) able to determine effect of arguments collected as a decision [13]. The percentage indicator of critically thinking skill between experimental and control class and example problem of critical thinking skill in Table 1.

| Indicator                        | Aspect                                      | Class I | Class II | Example Problem                                                                 |
|----------------------------------|---------------------------------------------|---------|----------|---------------------------------------------------------------------------------|
| Formulate main problem           | Find distinct statement from each question  | 87%     | 78%      | Burnay and Rose were reading their physics notebook about Physics Laws. They were reading it thoroughly, then they found a statement: “Motionless object equals to moving object with zero acceleration”. There was no other explanation on the book. Which law does the statement refer to? Is the statement correct? Give reason! True, because it meets the sound of Newton’s first law where the silent object will remain still (zero acceleration) and the moving object at constant speed is just as silent because there is no force working on the object. |
| Utter facts needed to solve problem | Try to know the information well            | 86%     | 80%      | Suanta was pushing a table with \( m \) mass. He gave \( F \) force which caused \( a \) acceleration to the table. If Suanta gave 2 times initial force and the table became 4 times more mass, then the acceleration became . . . Give reason: compared to straight with \( F \) and a versus upside down with \( m \), so that the \( a = \frac{\Sigma F}{m} \). \( F = 2 \, m \), \( m = 4m \) So, \( F = m \cdot a, 2 \, F = 4m \cdot a \) \( a = \frac{2F}{4m} = \frac{1F}{2m} = \frac{1a}{2} \) |
| Choose logical, relevant, and accurate argument | Find reason                                  | 98%     | 88%      | Statement: If the resultant works on object equals to zero, then the object will move in fluctuating velocity. Reason: If the resultant works on object equals to zero, then the object will remain still! The correct answer is . . . Is the statement correct/wrong and is the reason correct/wrong? If it is wrong, give the correct reason! |
| Explain aim of arguments based on different point of view | Find alternative                             | 92%     | 75%      | Maylan was crying at the corner of the street asking her mother to take pedicab home from the market, because she wanted to experience riding on it. Maylan and her mother saw a pedicab driver from afar going towards them in constant \( V_1 \) velocity then he accelerated to be \( V_2 \) velocity and became faster to be \( V_3 \) velocity. If the velocity was constant, then the resultant when the velocity was \( V_1, V_2, V_3 \) is . Give reason: Newton’s first law applies \( a = \frac{\Sigma F}{m} \) because the object is moving straight in order (fixed speed because there is no acceleration) then the resultant force at the speed of the object \( v_1, v_2, v_3 \) is \( \Sigma F_1 = \Sigma F_2 = \Sigma F_3 \) |
### Table 1. Cont.

| Determine the effect of arguments as a decision | Pay attention to the situation and condition thoroughly | 84% | 78% |
|-----------------------------------------------|--------------------------------------------------------|-----|-----|
|                                               | Act and think openly                                    |     |     |

Rika and Bima were studying to prepare their physics test the next day. Few minutes later Bima felt dizzy with the physics formulas and felt sleepy, eventually he stood up and put his physics book away on the desk. According to Rika, the correct statement to describe the condition of the book which Bima put away was. Give reason!

Resultant force that works on objects of zero value (Newton first law). The silent object on the table has two forces that work: the gravitational force and the normal force are each worth zero in the opposite direction.

Based on Table 1 shows that there are five critically thinking indicators in each problem. Analysis result of statistic test data two-ways anova shows 0.014 significance. Since the significance is less than 0.05; thus, $H_{01}$ is rejected. It can be concluded that student’s critically thinking skill in Argument Based Science Inquiry (ABSI) model is higher than student’s critically thinking skill in conventional method.

The result of the research is accordance to the research conducted by Sari et al., [14] which concluded that implementing Argument Based Science Inquiry (ABSI) model really affects to the improvement of student’s critically thinking skill. Other research conducted by Budiyono [15] shows that Argument Based Science Inquiry (ABSI) learning model affects to the improvement of arguing skill which later refers to the improvement of student’s critically thinking skill.

Experimental class, which used Argument Based Science Inquiry (ABSI) model, the teacher acted as facilitator who did her job well in guiding students to understand the lesson, without dominating the learning process, but helping students to be creative in understanding physics. The success of Argument Based Science Inquiry (ABSI) learning model in improving student’s critically thinking skill occurs because students are given opportunity during learning to find solution by doing inquiry based lab work in group, giving arguments in group based on result data of lab work, and having class discussion to compare their ideas with books or other sources. Thus, students will involve more in scientific arguing process which will support their critically thinking skill improvement.

Besides, ABSI model has learning steps to improve arguing skill which refers to student’s critically thinking skill. It can be seen in each step of ABSI learning which is able to make students be active in learning. Which states that steps in Argument Based Science Inquiry (ABSI) learning act better to improve student’s critically thinking skill and arguing skill [8]. Argument based learning can give good effect towards student’s critically thinking skill. Each learning has many varieties, by totally involving students to argue, it encourages them to think critically and they are challenged to state their own opinions on phenomena by setting previous ideas aside. They are allowed to hesitate and to express their hesitation in order to think critically. This is suitable to an opinion which states that arguing skill gives good effect towards student’s critically thinking skill [16,17].

### 4. Conclusion

Based on the analysis result of the research conducted, it can be concluded that: (1) The students’ critically thinking who study using ABSI model is higher than they who study using konvensional model, (2) The students’ critically thinking who have skill of high and low argument who study using ABSI model is higher than they who are in konvensional class.
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