

Argument Driven Inquiry Supported By Argument Map to Identify The Student Argumentation Levels of Simple Harmonic Motion

Jasmi Roza^{a)}, Muslim^{b)}, Lilik Hasanah^{c)}

*Department of Physics Education, Indonesia University of Education
Jl Setiabudhi No. 229, Bandung, Indonesia*

^{a)}Corresponding author: jasmi.roza@yahoo.com

^{b)}mus_upi@yahoo.co.id

^{c)}lilikhasanah@upi.edu

Abstract. The aim of this study was to investigate the effect of argument driven inquiry (ADI) supported by argument maps (AM) on identify the student argumentation levels. The study was conducted using a quasi-experimental with counterbalanced design. The population were all of students in X IPA grades on one of the MA (islamic senior high school) in Batam city. The study was conducted two sampel that chosen at randomized sampling class with 70 students. The participants in the experimental group A (N= 35) student's, and the participant in the experimental group B (N= 35) student in second semester the 2016-2017 academic year. Data about student argumentation levels was collected using the individual reports of the participants. Qualitative and quantitative techniques were used together to analyze the data, to explore differences between ADI only and ADI supported argument maps. The results showed that there was different of student's argumentation levels in two classes. But, the student's argumentation levels in the experiment's class using argument maps was better than in experiment's class without using argument maps. Therefore, ADI supported by argument maps was an effective method for improving and identifying the argumentation levels.

INTRODUCTION

Physics is very important taught in schools in support of the development of science and technology. The education system in school an important role in developing students' thinking skills especially in the field of physics. Processes and thinking skills of learners like scientists in understanding the characteristics of scientific research, can be constructed with activity inquiry [1]. Scientific inquiry is the basis for research and study [2,3], and argumentation is one of the most important processes of scientific inquiry [4,5]. In addition, argumentation is one of the effective learning strategies that enhances 21st century skills [6]. Scientific inquiry and argumentation has a crucial place in science education [7,8].

Most of the researches reported that "cookbook" laboratory activities in which students are often passive in the laboratory [5,9]. The results of study in one of the MA (islamic high school) in Batam City, showed the physic learning activities cookbook laboratory and not including argumentation. Based on these problems, to including argumentation and inquiry process in physics learning is Argument Driven Inquiry (ADI). ADI is a new laboratory instructional model, that can serve as a guide for teachers in designing more authentic laboratory activities. its effectiveness to improving the argumentation level [5,10,11,12,13,14].

The ADI learning model will maximally if assisted by techniques that support argument ability, one of which is Argument Maps (AM). Similar result were reported [15,16], showed that theoretical support for the use of arguments has been widely presented, but students have limited knowledge to practice well. Therefore, a method capable of constructing arguments is needed, one of which is argument maps.

Based on the background of the problems mentioned above, this research problem was: how the student argumentation level who get the learning of physics through the application of ADI supported by AM compared with students who get physics learning through the application of ADI without AM on material Simple Harmonic Motion? . Thus, the purpose of this study is to identify and get a picture of the difference in the student level argumentation who get physics learning by applying ADI with AM and ADI only.

EXPERIMENTAL

A quasi experimental model was used. The design used is Counterbalanced Design. This research uses two group and each group was exposed to two treatments such as Table 1.

TABEL 1. A Two-Treatment *Counterbalanced Design*

Group	Treatment (1 st , 2 nd) Experiment	Posttest	Treatment (3 rd , 4 th) Experiment	Posttest
Experimental A	X ₁	o	X ₂	o
Exsperimental B	X ₂	o	X ₁	o

Information:

X1: The application of ADI Supported by AM

X2: The application of ADI without Supported by AM

O : Observe the argumentation level during the implementation ADI with AM and ADI without AM

The participant were X IPA student at a MA in Batam City the second semester of academic year 2016-2017. Among the non randomized sampling method, convenience sampling was used in the study. A total of 70 students who participated in the study. 35 were in the first experimental group (8 male and 27 female), and 35 were in the second experimental group (9 male and 26 female).

Qualitative and quantitative data collection tool were used in the study throught document analysis. Document analysis were the reports that were written individually by student as their result from each experiment. To analyze and identify this report whether there was any significant difference of argumentation levels (AL) between both experiment group, reports that were written were examined in two stage. First the argument written in the student reports were divided into component according to the Toulmen Model, then argumentation level for each report were determined throught the framework developed by Erduran, *et al.*[17].

The argumentation levels can be found in Table 2. Each level was scored from 1 to 4 by researchers and these score were used for *Mann Whitney U Tes*.

TABEL 2. Level Argumentasi

Analytical Framework Used for Assesing the Quality of Argumentation [17]	
Level 1	argumentation consists of arguments that are a simple claim versus a counterclaim or a claim versus claim.
Level 2	argumentation has arguments consisting of claims with either data, warrants, or backings, but do not contain any rebuttals.
Level 3	argumentation has arguments with a series of claims or counterclaims with either data, warrants, or backings with the occasional weak rebuttal.
Level 4	argumentation shows arguments with a claim with a clearly identifiable rebuttal. Such an argument may have several claims and counterclaims as well, but this is not necessary.
Level 5	argumentation displays an extended argument with more than one rebuttal.

The study was conducted with student in a simple harmonic motion laboratory. In this instruction, student followed a step by step procedure ADI supported by AM laboratory activity. Each laboratory activity in ADI includes six step has been developed [11,12,4,10] and added AM technique in some part of procedure ADI. The activities that the participant performed were as follows:

1. *Identification of the task.* In this stage, at the beginning of the lesson, participant were introduced to the research question. They were then asked to design an experiment in order to answer this question.
2. *Generation of data.* Groups in this stage developed an inquiry methods for answering the research question. They decided how to collect data and which observation and measurements to take.
3. *Production of a tentative argument.* After performing the experiment, student prepared an A3 paper size presentation sheet that consist of an explanation, claim, evidence, and reasoning by each group to share idea, defend, and present their idea. An example of presentation sheet was a given in Figure 1.
4. *Interactive argumentation session.* Participants debated over their research using round robin format.
5. *Creation of a written investigation Report.* Participants prepared individual reports whit the data they obtained and result they found and answer what they were trying to do and why, what they did and why, what their argument was.
6. *The Double-blind peer review of written report.*

The implemetation ADI supported by AM, was added AM technique in stages (1), (3), and (4). In addition, argument maps will make students easier to write components of the argumentation while production a scientific argumentation.

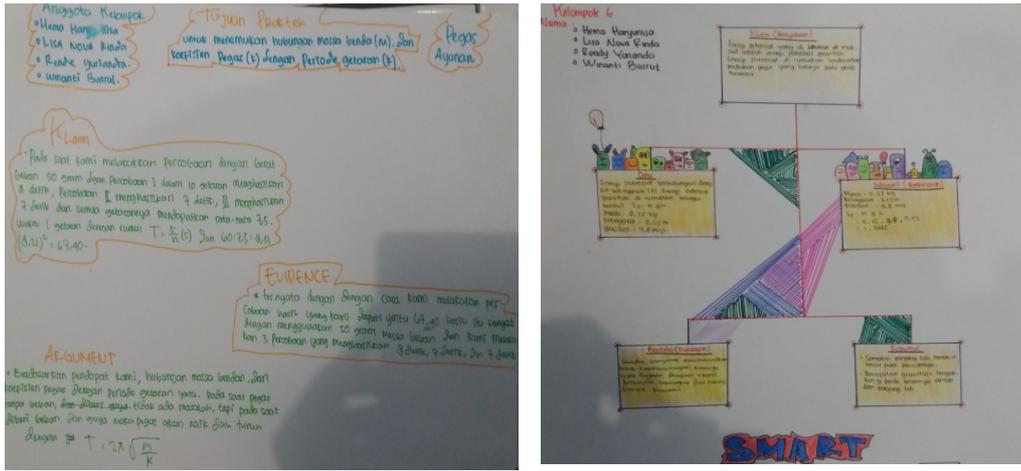
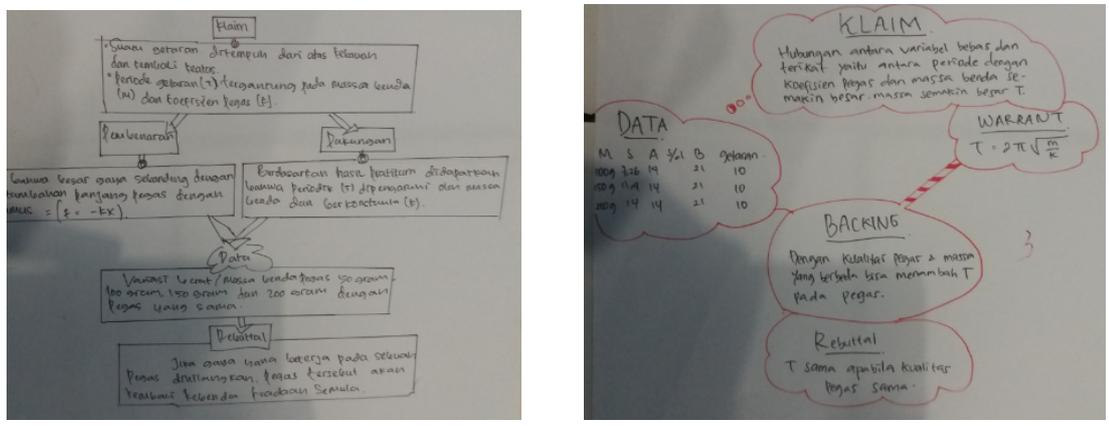


FIGURE 1. An example of a poster prepared by student

RESULTS AND DISCUSSION

The written report were categorized in four levels. These levels are respectively Level 1, Level 2, Level 3, and Level 4. An example from the argument in the students' written report for Level 3 on like Figure 2. The result of the argumentation level for *Mann Whiney U* tes from both experimental group were given.

Level 3: There were data, warrant, backing with claim and a weak rebuttal in this report. These report were scored "3" by researchers.



(a) (b)

FIGURE 2. An example the student report for Level 3.

Argumentation level of the both experimental group at the first, the second, the third and the fourth experiment after treatment are given in Table 3.

According to Table 4, it is seen that argumentation levels the highest are at Level 4, lowest are at Level 2, and no students up to Level 5 and average are at Level 3. And then, for the first experiment and the second experiment it is seen that experimental group A have argumentation levels higher of experimental group B, but for the third experiment and the fourth experiment is seen that students' argumentation levels were balanced between experimental group A and experimental group B. Although the student argumentation levels of both experimental group have similarity, but argumentation level of the both experimental group have a different percentage. Percentage distribution of both experimental group participants' argumentation levels are given in Table 4.

TABLE 3. Recapitulation of description the students argumentasi level for both experimental group at the first, second, third and fourth experiment

Experiment	Group	Deskription Argumentation Levels		
		Highest	Lowest	Average
The firts	Experimental A	Level 4	Level 1	Level 3
	Experimental B	Level 3	Level 1	Level 2
The second	Experimental A	Level 4	Level 3	Level 3
	Experimental B	Level 3	Level 2	Level 2
The Third	Experimental A	Level 3	Level 2	Level 2
	Experimental B	Level 3	Level 2	Level 3
The Fourth	Experimental A	Level 4	Level 2	Level 3
	Experimental B	Level 4	Level 2	Level 3

TABLE 4. Percentage distribution of both experimental group participants' argumentation levels at the first, second, third and fourth experiment

Argumentasi Level	Experimental A (%)				Experimental B (%)			
	1 st	2 nd	3 rd	4 th	1 st	2 nd	3 rd	4 th
Level 1	5.71	0.00	0.00	0.00	17.14	0.00	0.00	0.00
Level 2	11.43	8.57	45.71	31.43	68.57	28.57	20.00	5.71
Level 3	80.00	74.29	54.29	60.00	14.29	71.43	74.29	71.43
Level 4	2.86	17.14	0.00	8.57	0.00	0.00	5.71	22.86

Based on the Table 5, it is seen that most of the participants in the experimental group A are at level 3 in the first, second, third and fourth of experiment, and the levels of the participants appear to be evenly distributed among Levels 2, 3 and 4 at the end of the treatment. On the other hand, in the experimental group B, almost all participants are at Level 2 in the first, second, third and fourth of experiment, there are no participants at Level 4. The all meetings for the two group, when compared to their presentation when applying the argument maps and argument map assisted ADI learning, can be seen that the acquisition of the quality of argumentation of students applying ADI supported by AM was better than from ADI only. The learning of ADI is supported by AM, was implementation in the first, the second experiment of group A and the third and the fourth experiment of group B, showed the students' argumentation level was getting higher and fewer students at Level 1 and the every experiment heve Level 4. This In line with the opinion [18], who conducted research on argument maps, states that there is a significant influence between argument mapping skills on physics learning outcomes.

To show whether there were any significant differences between the argumentation level mean scores of the participants' with ADI supported by AM and ADI only in the first, the second, the third and the fourth of experiment, the *Mann Whitney U* test was conducted in Table 5, because all the data not normal after used test of normality.

TABLE 5. Mann Whitney U Tes Results by Group for Argumentation Level Mean Scores of the Both Experimental Group at the First, The Second, the Third, and the Fourth of the Experiment

	Test Statistics ^a			
	1 st Experiment	2 nd Experiment	3 rd Experiment	4 th Experiment
Mann-Whitney U	253.000	197.500	436.000	408.500
Wilcoxon W	883.000	827.50	1.066E3	1.038E3
Z	-4.686	-5.452	-2.480	-2.852
Asymp. Sig. (2-tailed)	.000	.000	.013	.004

a. Grouping Variable: Group

According to Table 5, it was found a Asymp. Sig. (2-tailed) was < 0.05 , that the argumentation-level scores of the experimental group using ADI supported by AM were found to be significantly higher than in all the experiment. So, according the analysize the Table 5, there were any significant differences between the argumentation level mean scores of the participants' using ADI supported by AM and ADI only.

According to the findings regarding changes in argumentation levels, most participants of the experimental groups using ADI supported by AM were at Level 3, but it was found that throughout the study

the number of the participants in Level 3 and Level 4 increased and not found in Level 5. While 5.71 % of the participants in the experimental group using ADI supported AM were in Level 1 at the first experiment, there were no Level 1 students in at the second, third and fourth of the experiment. Additionally, in the second of experiment, the number of the Level 4 participants increased when compared to the first of the experiment. It can be stated that one reason for this result might be related to the fact that participants who were using only claims in their reports in Level 1 started using constituents that would support and prove their claims in the second of the experiment. Rebuttals are the indicators of high-quality argumentation, and discussions using rebuttals have a higher level of argumentation [17,19]. An increase in the number Level 3 and 4 participants using rebuttals indicates the increase of argumentation levels of the experimental group participants using ADI supported AM.

The experimental group using ADI only, most participants were at Level 2, but it was found that throughout the study the number of the participants in Level 3 and Level 4 increased. This was a similar result is noted [11,12,17], the majority of student arguments were Level 2 both at the beginning and at the end of the study. The result a research observed [20] also found that students produced high quality written arguments after the treatment they carried out with the university students. Similar result were reported [8], who showed that after argumentation training, students' argumentation skills had statistically changed. A similar results, has been finded [5], after the study applied the ADI method, there was a significant difference between students using the ADI method and those using the traditional laboratory method regarding their use of evidence and reasoning skills.

According results, it can be claimed that laboratory training using the argument-driven inquiry supported by argument maps is more effective than argument-driven inquiry laboratory model in increasing argumentation levels, in other words the argumentation quality of students. Laboratory training that uses the argument-driven inquiry supported by argument maps model also needs to be performed longer term in order to observe those changes. These findings prove the involvement of students when the production of argumentation and argumentation sessions in learning ADI supported by AM the student argumentation levels. In line with the results researcher has been reported [21], the students responded positively to the application of argument-oriented learning. Student involvement is seen from the results of individual argumentation sheets. Although no level of argument reaches Level 5, the level of argumentation of students who have learned ADI is better argument maps. The addition of the argument maps technique to the production stage of the argument and argument sessions further strengthens and facilitates the student in constructing the components of the argument to become a scientific argument. Through argument maps cultivate a deep sense of interest that creates confidence during the learning process. This is in line with the questionnaire results of the attitude scale filled out by the students after applying the ADI-assisted instruction argument maps, which states: (1) 93% of students agree with the application of ADI learning assisted argument maps capable of developing the ability to make claims and argument maps. (2) 87% of students stated that this learning is able to develop my ability to make backing to verify warrant and support claim. (3) 92% of students stated that learning ADI assisted argument maps to train the ability to argue to answer the problem both orally and in writing.

CONCLUSION

Application Argument Driven Inquiry supported by Argument Maps can identify the students' argumentation level through document analysis of student report in simple harmonic motion laboratory. Based on the results obtained, the student argumentation level is higher when applying argument driven inquiry supported by argument maps learning model than when applying argument driven inquiry without argument maps learning model. The argumentation level obtained by the average student is still at Level 3 and few are able to reach Level 4, while no student has a level of argument at Level 5. Therefore, to overcome this deficiency it is suggested that the application of argument driven inquiry supported by argument maps was an effective method for improving and identifying the argumentation levels.

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