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Effect of Argument Driven Inquiry (ADI) with Problem Solving Method for Student's Argumentation and Critical Thinking Skills

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Article Info	Abstract
	Problem solving skill is needed by the students on the daily basis; therefore, the innovation is demanded in the learning process. ADI model with problem solving method is the learning innovation which is expected to improve the students' thinking skills and giving the argument. This research aims to describe the effect of ADI model with problem solving method on the argumentation and critical thinking skills. This research was the experimental study employing cluster random sampling technique. The data analysis technique used independent sample t-test. The result of the students' pretest shows that the students' argumentation and critical thinking skills are in the poor category. Meanwhile, the result of the posttest shows that the there is the improvement on the students' skills after being given the treatment in the form of ADI model with Problem Solving method. Based on the result of the analysis, it can be concluded that the implementation of ADI model with Problem Solving method has the effect on the argumentation and critical thinking skills. Viewed from the result of t-test from n-gain result, experimental class is higher than the control class. The learning activity that applies this method will be developed if the teachers can design the contextual activities and provide the questions related to the students' real life in which they are not merely stated in the textbook.

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INTRODUCTION

The students' ability to solve the problems in Indonesia is categorized as poor if it is compared to other countries. It can be seen from the result of PISA in 2012 which shows that Indonesia is ranked 64th out of 65 countries participating in this program. PISA is the international study focusing on the literacy of reading, Mathematics, science, and problem solving of the students aged 15 years (OECD, 2014).

Scientific literacy is the understanding of the scientific concept and process. This understanding is applied by someone to make decision using scientific way of thinking and conclusion drawing based on the evidence. Scientific literacy is needed to answer the questions in the real life experienced by the students which is done by applying the acquired knowledge. This drives the scientific literacy to be essential for the students. Scientific literacy can be developed through well-structured learning activity (Afifah et al., 2016).

Considering the importance of science for the students, the supporting skill are needed. The skill that need to be acquired by the students are creativity, critical thinking, problem solving, communication, and collaboration. These skill lead the students to solve the problems that might exist in the future.

Scientific literacy focuses not only on the procedural concept, but also the way to communicate the obtained concept to society. This leads the argumentation ability to be important to be applied in a learning. Argumentation is the form of thinking actualization through communication underlain by the data in supporting the claim. Argumentation is demanded to build the powerful foundation to comprehend the scientific concept through critical thinking and collaboration. The students' collaboration will be generated after doing the discussion in solving the problems.

Argument Driven Inquiry (ADI) is the learning model that can be the alternative for the teachers to improve the students' argumentation and critical thinking skills, particularly in the material of digestive system. ADI is the learning model that gives the chance for the students to give the argument which is still underlain by the data. It is based on the research carried out by Demircioglu & Sedat (2015), Grooms (2011), and Sampson et al. (2009) who states that the use of ADI learning model can improve the scientific process and argumentation skills. This skills will be improved if ADI model is combined with *Problem Solving* method that arranges the material using a problem.

Based on the description above, the purpose of this study is to describe the effect of ADI model with Problem solving method to the argumentation and critical thinking skills of students.

METHODS

This research is an experimental quasi research with Non-equivalent control groups pretest-posttest design. The population in this study is class VIII SMP Muhammadiyah 3 Semarang which amounts to 7 classes. The number of students in this population is 204 students. Sampling using probability sampling technique with cluster random sampling type as much as 2 classes. Class VIII G as an experimental class gets an Argument Driven Inquiry (ADI) modeling problem solving problem and class VIII F as control class which gets treatment of Information Discussion method.

The independent variable in this research is Argument Driven Inquiry (ADI) model with problem solving and information discussion. The dependent variable is students' argumentation and critical thinking.

Data collection techniques used questionnaires, tests and observations. Questionnaires are used to obtain validation of learning device data. The test technique is used to measure the ability of written argumentation and critical thinking. Observation technique is used to know the ability of oral argumentation and critical thinking at the time of activity.

Initial data analysis techniques that do the validation of learning devices, test the validity, level of difficulty, distinguishing power and reliability. Then the final data analysis technique

is done by conducting hypothesis test with n-gain test and t test. Calculating Gain normalized score based on the formula by Sudarmin (2007), namely:

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Results Gain normalized scores are divided into three categories (Table1):

Table 1. Criteria normalized Gain

<g>	Classification
g>0,7	High
0,3≤g≤0,7	Moderate
g<0,3	Low

Observation data of students' verbal argumentation and critical thinking skills were analyzed quantitatively, using the formula:

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Criteria for percentage of critical thinking and student argumentation skills are presented in the Table 2.

Table 2. Criteria for Critical Thinking and Student Argumentation Skills

Score (%)	Criteria
85 ≤ X ≤ 100	Very High
78 ≤ X < 84,99	High
64 ≤ X < 77,99	Moderate
55 ≤ X < 63,99	Low
0 ≤ X < 54,99	Very Low

RESULTS AND DISCUSSION

The Verbal and Written Argumentation Skills

The Verbal Argumentation skills is obtained from the observation when the learning activity takes place, that is during four times meeting. While the written argumentation ability is obtained from the student's pretest-postest result. Verbal Argumentation skills between the control and experiment classes increased in four meetings, but the experimental class showed a better improvement than the control class. The observation result of the verbal argument skills of control and experiment class is presented in Figure 1.
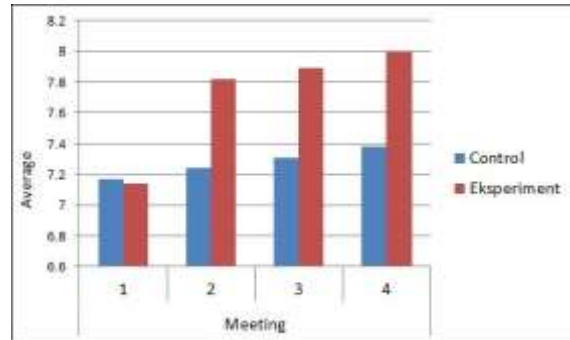

Figure 1. Average Student Verbal Argumentation Skills of Experiment and Control Class

Figure 1 shows that the average verbal argumentation skills at first encounter is very low, even lower than the control class. The average of this skills then increases at the second, third and fourth meeting. In the experimental class, the increment is very high compared to the few control classes.

The difference in the average rise in oral argumentation is due to the experimental class being treated with ADI model with problem solving problems in which there is argumentation production and argumentation sessions. In the argument production syntax and argument sessions, students are asked to provide opinions or solutions in solving problems in student LKS. While in the control class only the usual discussion which is textbook, so in answer it does not bring up the debate or argumentation.

Based on the recapitulation of the students' verbal argumentation indicator, it can be concluded that the average indicator achieved by the experiment class students is higher than the control class, although there are some lower indicators of the control class. One of the indicators that supports the argumentation of experimental class students is superior to the control class ie indicators 1b, and 1c. This indicator explains that the students in the experimental class are better at claiming and warrant, which are both good arguments.

In indicators 2b, 4a and 4c, students in the experimental class get a lower average than the control class. This is because students are in a hurry when they want to express opinions, so often cut off the conversation without raising their hands first. In addition, students are still not fluent in expressing their opinions, they still seem to think in speaking. This is because the material

presented in the experimental class requires the students to compose their own sentences, while in the control class, the material presented is already in the textbook and the sentence is well constructed in the textbook.

Learning using ADI model problem solving has a positive effect on students' argumentation skills because in their activities, students are given chance to argue. ADI is one of the models that put forward the inquiry process in its activities so that the teaching and learning activities become more active and meaningful. In the implementation, Students are given LKS (Student Works Sheet) in the form of problems and must be resolved by way of discussion. Through this discussion activity, students can develop their argument skills. According to Wulandari & Nurhayati (2018) students' verbal skills are related to the ability to think critically in solving problems.

Discussion activities in the experimental class are more developed than the control class, because the material presented in the experimental class LKS is a daily problem. The presentation of material in the form of problems in the experimental class makes the students more interested and actively argue in seeking answers or solve the problem. This is confirmed by Usman *et al.* (2017), that contextual learning causes students to feel challenged to want to know and express arguments based on their knowledge and experience. In addition, according to Noor & Insih (2015), contextual learning can spur student motivation. In the control class also occurs the process of discussion, but not as active in the experimental class, because the material presented is textbook.

The influence of ADI model with problem solving is evidenced from the result of the students' pretest-posttest improvement and observation result. Result of t test of N-gain of experiment class student in medium category (0.441), while control class in low category (0.170). Based on these results, it can be concluded that the increase of students' written argument result on the experiment class is higher than the control class. In addition, the number of students who received high and moderate categories in the experimental class was more than in the control class, while the more moderate

categories were in the control class. This suggests that students' written argumentation skills are better than control classes.

The written argument indicator used in both classes is the same, that is at least student answers include claims, warrants and data. Claims are opinions or opinions from students related to answers. Warrant is an explanation that supports a claim. While the data is a theory, law, evidence and others that support claims and warrant.

The experimental class treated with ADI model with problem solving problem is superior to control class. Students in the experimental class are accustomed to providing claims and further explanations (warrant) of claims that have been given, that is more precisely on the discussion activities by using the article in the form of problems. While in the control class, students are only required to answer about the textbook that does not bring any claim or warrant. This is why the argument of experimental class students is superior to the control class.

This is supported by research by Andriani & Riandi (2015), that learning using Argument Driven Inquiry adds the skills to understand problems and relate to existing theories, so as to provide warrant of a claim.

The argumentation skills is very necessary for students to support their daily activities, especially in communicating in school as well as in the community. This skills needs to be trained from an early age, so that they have a basic ability to argue. This is confirmed by Roekel (2012), that in facing challenges in the 21st century, students must be prepared with four C competencies, namely critical thinking, communication, collaboration, creativity and innovation.

Learning using ADI model has problem solving problem, at least contributed to the cultivation of some of C competence. In this lesson, emphasizing the process of discussion and collaboration in solving a problem, which later can develop students' argumentation skills. Learning that leads students to find their own answers to a given problem can improve students' argumentation skills (Yanti *et al.*, 2015). It is also shown in the Grooms (2011) study, that using

Argument Driven Inquiry can develop scientific argumentability.

Critical Thinking Skills

Based on the result of t-n-gain test, it can be seen that t count> t table (at 5% significance level), so it can be concluded that Argument Driven Inquiry model with Problem Solving has positive effect on students' critical thinking skills. The result of t-test of n-gain ability of students critical thinking is presented in Table 3

Table 3. Results of t test n-gain of Critical Thinking Skills of Experiment and Control Class Students

	Class		t_{hitung}	t_{tabel}
	Eksperiment	Control		
Total students	28	29		
Average	0.493	0.363	2.381	2.004
Standard deviation	0.238	0.173		

Learning using ADI model solving problem solving give positive influence to students' critical thinking skills. because in the activity the students are given LKS (Student Worksheet) in the form of problem. In completing this LKS. students will pass the inquiry process which becomes the main point of ADI model problem solving problem. According to Elisanti *et al.* (2018). inquiry learning can empower students' critical skills.

Learning using ADI model solving problem solving requires students to discuss problem solving. so that students are trained to express opinions. The process through which students solve problems and express their opinions will elicit students' critical thinking skills. The skills to think critically trains students to make decisions from various perspectives carefully. and thoroughly (Haryadi *et al.*. 2015). This skills will continue to develop if it is repeatedly trained on the students. This is in accordance with the opinion of Firmansyah *et al.* (2016). that critical thinking skills are not only aimed at smart and

critical students. but must be trained to all students because it is a gradual process that begins with the process of adjusting and forming the mindset of students.

This is evidenced from the results of observations at the time of learning activities that indicate that the average skills of critical thinking students have increased from previous meetings. The data of critical thinking observation is presented in Figure 2.
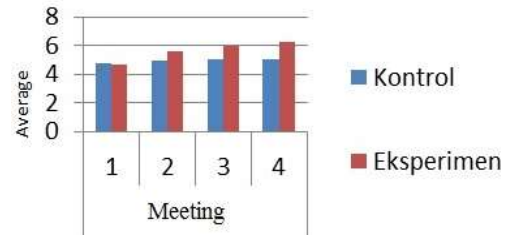

Figure 2. Observation result of students' critical thinking skills

The increase of students' critical thinking skills in the experimental class is much higher than the control class because in the experimental class each meeting is given different problems. Learning using ADI model problem solving resolved collaboration to solve the problem. It is through this problem solving that students are able to develop critical thinking skills.

Learning using problems is very good used in learning activities. because students get experience how to solve problems that arise later in the real world. This is confirmed Arends (2008). that with learning to use problems allow students bring up various solutions to solve problems that arise. In addition. according to Minarti *et al.* (2012). the experience that students gain in learning activities will improve understanding of the subject matter.

Based on these observations. the critical thinking indicators that emerged in the experimental class were higher than the control class. This proves that students' critical thinking skills is better than control class. The recapitulation of the critical thinking indicator seen at the time of learning from the first to fourth meeting is presented in Figure 3
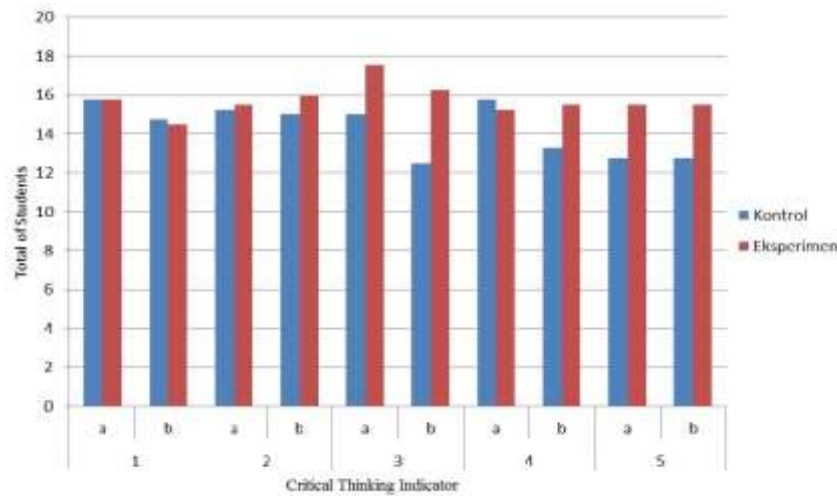
Figure 3. Recapitulation of Critical Thinking Indicators on Learning Activities

The most critical indicator indicator of the experimental class is 3a (Students are able to estimate / make a temporary answer). while the lowest one is 1b (Students are able to make questions according to the material). However. the lowest average in the experimental class is still much higher than the lowest average control class. Indicators 1b and 4a in the experimental class are lower than the control class because at the first meeting. the students who can achieve this indicator are few. so if the average result is also low. However. the next meeting has increased from the previous meeting. At this first meeting. students still do not understand how to make the right questions and read the data. Moreover. the text of the article used in learning in the form of problems. where previously had never received learning activities like this. While in the control class. the achievement of indicators at the second meeting actually decreased compared to the first meeting.

The students' pretest-posttest results show that the difference in pretest-posttest increase in critical thinking ability of the experimental class is slightly higher than that of the control class. In the experimental class. the pretest-posttest difference is 20.62. while in the control class is 18.86. The experimental and control class N-gain results were both in moderate category. but the experimental class was higher than the control class ie 0.493 in the experimental class and 0.363 in the control class. The average increase is indeed only slightly.

because to improve students' critical thinking skills takes a relatively long time. Meanwhile. in this study only done in a short time. so the increase is not too high. However. when viewed from the number of students who received medium and high criteria on the N-gain results. the experimental class was superior to the control class. According to Prihartiningsih *et al.* (2016). that critical thinking skills will be more developed if it continues to be trained on students.

This also occurs in students' problem-solving skills. where there is an increase in pretest-posttest results. but only slightly. Learning with ADI model encoded Problem Solving uses daily problems as a discussion in learning activities. According to Lestari *et al.* (2016). learning that links the student's living environment can help to think of ideas about problem solving that arise in everyday life.

Problem solving skills is one of the important components to support and develop students' thinking skills (Rahmazatullaili *et al.*. 2017). If students 'problem-solving skills improve. students' critical thinking skills also increase.

Student troubleshooting ability is assessed from pretest-posttest results. Assessment of this test refers to the assessment of critical thinking. because one of the characteristics of critical thinking is solving problems. This is confirmed by Cahyono (2015). that there is a correlation between critical thinking and problem solving.

The problem-solving indicators associated with critical thinking are presented in Table 4.

Table 4. Problem solving indicator associated with critical thinking

Problem Solving indicators	Critical thinking indicator
Understand the problem	Students can understand the problem by formulating the problem
Plan for completion	Students carry out the settlement by asking questions first
Implement the plan	Students implement the plan by analyzing the data and writing down the answers
Check again	Students re-check the answers then make a conclusion

The problem solving skills of the experimental class is higher than the control class. because in the experimental class. the student is given a Student Worksheet in the form of a problem. Students are asked to solve the problem by discussing and finding their own resources. At the time students solve problems in the given LKS. students are required to think critically by analyzing existing problems. If students solve problems. students' critical thinking skills also increase.

The pretest-posttest result of the problem-solving skills of the experimental class students has a higher average than the control class. with the recapitulation of the student problem-solving indicator in Figure 4
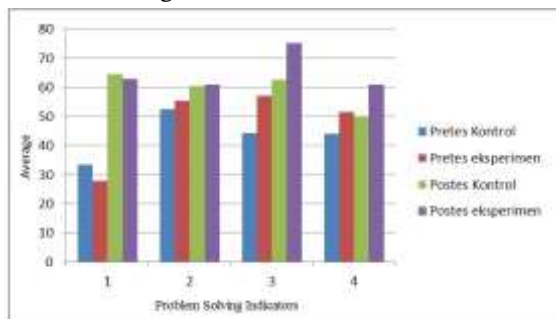

Figure 4. Recapitulation of Problem Solving Indicators

The least problem solving capability indicator shown in the student's pretest values in both the control class and the experimental class is understanding the problem. This is shown from the ability of students in formulating the problem is still relatively low. There are still many students who do not understand how to formulate a good problem in accordance with the existing problems. If a student can not formulate a problem. this means that the student has not fully understood the problem.

At the posttest value. the least problem solving indicator is checking again. Students can meet this indicator if the student can make a correct conclusion. At the time the student makes a conclusion. then he must first look back at the problems presented and re-check the answers given. Although the posttest of this indicator is the least. but the student score on this fourth indicator has increased from the pretest result. Even in the experimental class the average score of each indicator increased much higher than the control class. This is because the experimental class is treated with ADI model problem solving problem.

Research from Komariah (2011). entitled "The application of problem solving method model of Polya to improve problem solving ability for grade IX J students at SMPN 3 Cimahi" also provide support in this research that learning by using problem give positive influence to problem solving skills students. In addition. a study from Demircioglu & Sedat (2015). also supports that the use of ADI models in learning activities can improve the skills of science processes. critical thinking and student arguments.

This study contributes to the world of education and complements previous research that learning using ADI model problem solving can develop students' knowledge especially developing the skills of argumentation and critical thinking. In the learning process. teachers do not use lecture techniques. but simply observe. encourage and guide students so as to provide opportunities for students to build their own knowledge. Students who learn to solve a problem then they will apply the knowledge they have (Sulistiyoningsih et al.. 2015).

According to Karsidi et al. (2013). constructivism learning provides a great opportunity to form students' knowledge

independently and make learning meaningful. This constructivism learning will have a positive impact on student problem solving (Siswanto *et al.*. 2013). In addition. learning involving students actively contributes greatly to the success of learning activities (Wasiso & Hartono. 2013).

CONCLUSION

Based on the analysis that has been done can be concluded that students who get the learning model Argument Driven Inquiry (ADI) bermetodekan Problem Solving got higher argumentation and critical thinking score compared to students who received learning information discussion. This is because the learning with ADI model problem solving Problem Solving using problems in learning materials. and there is a session of argumentation in its activities.

Learning with Argument Driven Inquiry (ADI) modeling problem solving can be used as an alternative in learning activities by using problems that arise in the life of the students. Teachers are expected to be able to provide problems that contain contextual problems. not just a matter of textbook. Through this way students are expected to be able to develop their mindset.

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