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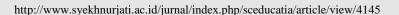- Bibliographic material
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The Effect of Applying Argument Driven Inquiry Models to the Critical Thinking Skills of Students Based on Gender Differences

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abstract

This study aims to determine the effect of the application of the Argument-Driven Inquiry (ADI) learning model on students' critical thinking abilities and to determine the differences in critical thinking skills between female and male students in the class using the learning model Argument-Driven Inquiry (ADI). The subjects of this study were students of class VIII.1 and VIII.5 JHS 8 Bandarlampung, consisting of 30 students of class VIII.1 and 30 students of class VIII.5. The sample was taken using a purposive technique by looking at the class with the same number of female and male students. The research design used was quasi-experimental design with Pretest-posttest Control Group Design and data collection techniques of critical thinking skills using pretest-posttest, which refers to the five criteria of critical thinking according to Ennis. The results showed that (1) there is an effect of applying the Argument-Driven Inquiry learning model on female students' critical thinking skills as indicated by the sig value. equal to 0,0001 (2) there is an effect of the application of the Argument-Driven Inquiry learning model on male students' critical thinking skills as indicated by the sig value. for 0,000 (3) there is no difference in critical thinking skills between female and male students using the ADI model indicated by the sig value and amounting to 0.725. That is, the application of the Argument-Driven Inquiry model affects the critical thinking skills of both female and male students, but there is no difference in critical thinking skills between female and male students. This means, the implementation of Argument-Driven Inquiry model effective on students' critical thinking skill, but there is no difference in critical thinking skills between female and male students.

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1. Introduction

Education is a continuing process of learning in social activities to gain knowledge, skills, attitudes, and thinking abilities that are carried out by someone to develop individual skills that can later be useful in community life. One form of thinking skills obtained through the educational process is critical thinking skills which are abilities that train reasoning skills and require students to have reasons to support assumptions or conclusions obtained, which are then used to solve problems.

Critical thinking is not innate since birth and is an essential ability in all aspects of life (Sarjono, 2017). Fisher (2008) revealed that critical thinking is an academic competency similar to reading and writing. Then Facione (2010) says that critical thinking means thinking well, which is briefly a mental process in perceiving the world using science. Whereas

according to Asmawati (2015), critical thinking is a persistent effort to test something that can be trusted truthfully with supporting evidence so that conclusions can be drawn.

Critical thinking skills have a relationship with problem-solving skills and influence the learning process and outcomes (Zhang, 2003). Based on the research conducted by (Kirmizi, Saygi, & Yurdakal, 2015), they revealed that there was a decent, positive, and significant relationship between critical thinking and problem-solving skills. Kulsum and Nugroho (2014) said that a good learning process is learning that can develop needed abilities such as the ability to think critically, solve problems, collaborate, and communicate.

According to Ennis (2011), the important thing concerning critical thinking is that critical thinking is focused on the understanding of something that is done with full awareness and leads to a goal. Where one of the main objectives that are very important is to help someone make the right decision and be able to solve the problem. Also, Ennis revealed that there are five major indicators of critical thinking activities, namely providing simple explanations, building basic skills, concluding, providing further explanations, and strategies and tactics.

Critical thinking skills in schools, especially at the level of junior high school can be developed through the learning process of Science Physics that studies phenomena that are directly related to everyday life that learn something concrete that can be proven through experimental methods. The experimental method, according to Djamarah and Zain (2013), is a way of presenting lessons where students experience and prove themselves a concept learned by conducting an experiment. Based on research conducted by Akinoglu, O (2008) physics learning that uses project-based guided inquiry and experimentation can increase students' interest in technology and science. In line with this, Sadeh and Zion (2012) revealed that there were differences in the learning outcomes of students who used guided inquiry based on experiments with those who did not. So, learning science in physics that uses experimental methods and proofing systematically becomes a means for students to develop the ability to think critically, logically, and consistently, which will help students understand a concept. Therefore, a teacher must pay attention to the learning strategies used in particular, the use of appropriate learning models so that the science learning objectives contained in the 2013 curriculum can be achieved.

Based on the results of the 2015 PISA test and evaluation (OECD, 2018), the ability of Indonesian students is still relatively low. The achievement of Indonesian children in science is still below the average of international score. The average score of achievement of

Indonesian students in sequence for science, reading, and mathematics is ranked 62, 61, and 63 of the 69 countries evaluated. This shows that learning for these three fields, including science in Indonesia is still below average and needs to be improved. One way is to use the inquiry model in the learning process. Learning science, especially physics in schools, can train students' critical thinking skills through learning that prioritizes direct experiences such as experiments or investigations. Osborne, Erduran, and Simon (2004) say that science learning can develop students' ability to understand and practice ways of arguing and thinking critically in a scientific context.

The results of interviews with science subject teachers in 23 public and private junior high schools in Bandarlampung regarding critical thinking skills also resulted in 73% of teachers answering knowing what critical thinking skills are and have encouraged the emergence of critical thinking skills in the science learning process especially Science Physics. But the teacher assessed that in the learning process only 19% of students were able to provide a simple explanation, 7% of students were able to build basic skills, 20% of students were able to conclude, 8% of students were able to provide further explanation, and 8% of students were able to set strategies and tactics. Observations made on grade VIII students in 23 junior high schools regarding their knowledge of critical thinking skills also resulted, 54% of students observed answered that they did not know what critical thinking skills were. This is consistent with the research conducted by Rahmawati, Hidayat, and Rahayu (2016) which states that the average percentage of students' critical thinking skills for the five aspects of critical thinking skills is still very low below 50%, which is 45.09%. Also, another reason is that there are still many teachers who have not carried out the learning process without regard to the learning model used. There are still many teachers who do not yet know that the use of the right learning model will influence the improvement of students' critical thinking skills.

Lack of teachers' knowledge regarding the use of appropriate learning models causes various problems that arise. One of them is a relative lack of critical thinking skills, which will have an impact on students' low ability to solve problems. Finally, the learning objectives that have been designed at the beginning are not achieved optimally because students only succeed in getting a value that is by the standards of achievement or KKM that have been determined without building their understanding to face a problem and how to solve it. Another problem is that the use of learning models that do not pay attention to differences in

characteristics between male students who tend to be better in verbal abilities and better female students in completing reading and writing tasks has an impact on the different levels of critical thinking skills among male students, and women.

Judging from the existing problems, it is considered necessary to conduct a study of the appropriate learning model to foster critical thinking skills. A particular learning model is needed to practice students' critical thinking skills. One of them is an inquiry. BNSP (2006) states that science learning should be carried out in scientific inquiry (scientific inquiry) to foster the ability to think, work, and be scientific. The inquiry learning model based on the results of the study (Wulanningsih, Prayitno, & Probosari, 2012), was able to equalize the science process skills of students with the students' gender, namely women and men.

There are several learning models that can develop students' critical thinking skills by paying attention to differences in student sex, one of which will be used in this study is the ADI learning model. According to (Sampson & Gleim, 2009) ADI is a model created to set the objectives of activities in the classroom as an effort to develop, understand, or evaluate a scientific explanation of a solution to a problem. According to the ADI learning model (Kadayifci, Atasoy, & Akkus, 2012) is a learning model that makes students have the opportunity to learn in scientific inquiry reflectively so they can develop argumentation and critical thinking skills. The research conducted by (Riandi, 2015) shows that the application of the Argument-Driven Inquiry (ADI) learning model is significant in improving the mastery of students' concepts compared to learning with other models. The results of the research conducted by (Sampson, Grooms, & Walker, 2010) have some evidence of the influence of ADI-based learning in improving critical thinking skills and scientific understanding. According to (Hidayat, 2017), the mathematical reasoning abilities of students who obtain learning with Argument-Driven Inquiry (ADI) are better than students with direct learning.

Demircioglu and Ucar (2015) state that ADI is different from other models that give students the opportunity to design their research and find the results of their research. Students will also be heavily involved in the argumentation process, where they can share and support their ideas. This model consists of reviews that improve students' critical thinking skills. This model is also considered as an effective model for improving communication and writing skills of students, building students' knowledge, and inviting students to experience the process of forming their knowledge firsthand.

The advantages of the ADI learning model, according to Amin and Corebima (2016), namely: 1). Frame the purpose of class activities as an effort to develop, understand, or evaluate scientific explanations for natural phenomena or solutions to problems; 2). Involve students in investigations; 3). Encourage individuals to learn how to produce arguments that articulate and justify explanations for research questions as part of the investigation process; 4). Provide opportunities for students to learn how to propose, support, evaluate, revise ideas through discussion and writing in a more productive way; 5). Creating a class community that values evidence and critical thinking; 6). Encourage students to take control of learning from themselves.

Based on the things mentioned above, this research is carried out which aims to see the extent of the influence of the ADI learning model compared to other learning models on improving students' critical thinking skills by paying attention to the different sexes of students gender.

2. Method

This study applies a quantitative approach that aims to differentiate or compare the results of research from two or more groups of research groups and more towards things or events of a practical nature. This research was conducted at Junior Hight School 13 Bandarlampung, which was addressed at Marga Street No. 57, Beringin Raya, Kemiling in July 2018. The population in this study were all eighth grade students in the second semester of JHS 13 Bandar Lampung in the academic year 2018/2019. From all existing VIII classes, the sample was selected using a purposive sampling technique, which is a technique that uses researchers' assessment of groups to select samples that researchers believe based on previous information. Based on the purposive sampling technique, the class was chosen by looking at the class where the number of female and male students was equal or almost balanced. This study took two classes as research samples. The first class was used as a control class using conventional learning models and the second class was used as an experimental class using the ADI learning model. The first class used as a control class is class VIII.5 which contains 30 students with 15 male students and 15 female students. While the second class used as the experimental class is class VIII.1 which also contains 30 students with 15 male students and 15 female students.

The procedure of the study was to determine the sample based on differences in gender, female and male. Pre-test of the research sample was about to determine students' initial abilities. Carrying out the learning process using the ADI learning model on light and optical material. Post-test of the research sample was about to determine the ability of students' critical thinking skills after carrying out the learning process using the ADI learning model. Then, Analysis of the results of the pre-test and post-test regarding the effect of using the ADI learning model on the critical thinking skills of students of a different gender was conducted. The last was making a research conclusion. The research design can be seen in the picture below:

O_1	X	O_2

Figure 1. Experimental Design of Non-Equivalent Control Group Design

Description:
O_1: pre-test Experimental Class
O_2: posttest Experimental Class
X: using the ADI learning model

The data collected in this study is data on students' critical thinking skills obtained through the provision of pretest-posttest by using instruments of critical thinking questions that refer to the critics thinking critically according to Ennis.

Data from the results of this study, namely the value of the pretest-posttest critical thinking skills analyzed using covariance analysis (ANCOVA). The difference between pretest and posttest was analyzed by single variance analysis. The analysis was aided by SPSS 21 software for the Windows operating system. To test the research hypothesis, the research data were analyzed by conducting normality, homogeneity, and Independent Sample T-test.

3. Results and Discussion

The results obtained from this study are quantitative data, namely data on students' critical thinking skills, which are then processed using SPSS 21. Before the pretest and posttest instruments are used during the research stage, the instruments are tested first to determine whether or not the instruments are used. The instrument, which numbered 20 questions, was tested on 30 respondents and 13 items were declared valid and reliable with the Pearson Correlation value> 0.361 and Cronbach's Alpha value of 0.806. Data from the pretest posttest held at the beginning and end of learning can be seen in Table 1.

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Table 1. Average posttest pretest value

Class	Gender	Pretest	Postest
Experiment	Female	24,99	75,55
	Male	20,55	73,33
Control	Female	23,33	58,88
	Male	19,99	56,66

Based on Table 1., it can be seen that an increase in the average value with posttest results is greater than the results of the pretest. After the pretest posttest was carried out, the N-gain value was sought to see the improvement in learning outcomes after research. The results of obtaining an N-gain value are shown in Table 2.

Table 2. N-gain value

Class	Gender	n-gain	Category
Experiment	Female	0,68	Medium
	Male	0,67	Medium
Control	Female	0,46	Medium
	Male	0,46	Medium

From Table 2., the experimental class using the ADI model obtained a greater n-gain value than the control class. So based on Table. 1 and Table. 2, we can know that there is an increase in students' critical thinking skills after using the ADI model in the learning process. This is consistent with what Riandi (2015) said in his research that the use of the Argument-Driven Inquiry learning model could improve students' mastery of concepts compared to other learning models. Also, findings in other studies by (Kurniasari & Setyarsih, 2017); and (Dwiretno & Setyarsih, 2018) states that the ADI model can train students 'scientific argumentation skills which will refer to improving students' critical thinking skills. And than based on Table. 1 it can be seen that the average posttest results obtained by female students are greater than male students. This is in line with the research carried out by Hardy (2015). It can be seen from the test results that the average test scores of male students were 2.571 lower compared to female students. Then the normality test for the research results data is shown in Table 3.

Table 3. Normality value test

Class	Gender	Shapiro-Wilk		
		Statistic	df	Sig.
experiment	Female	0,920	15	0,194
	Male	0,953	15	0,578
control	Female	0,930	15	0,194
	Male	0,945	15	0,455

Based on Table 3. It is known that the data is normally distributed, because of the sig value data on critical thinking skills in students in both classes female and male all exceed the level of sig. 0.05. The Homogeneity test is then shown in Table 4.

Table 4. Homogeinity Value Test

Data	Gender	Lavene Statistic			
		Statistic	df1	df2	Sig.
critical thinking skills	Female	0,816	1	28	0,374
	Male	0,332	1	28	0,569

The homogeneity test results are shown in Table. 4 shows that the research data is homogeneous with the value of sig. Data on critical thinking skills of female students and male sex exceeds the sig level. 0.05. After the data is normally distributed and homogeneous, a different test is carried out to test the research hypothesis, which aims to determine whether the hypothesis is accepted or not. This different test for hypothesis testing is done by the Independent Sample T-Test method. Hypothesis test results of critical thinking skills using SPSS 21 software with the Independent Sample T-Test method. Based on the paired sample T-Test test presented in Table. 5 can be seen that the first and second hypotheses are accepted, and the third hypothesis is rejected.

Table 5. independent sample t-test value.

Hypothesis	Sig.	There is a difference	No difference
First	0,001	√	
Second	0,000	√	
Third	0,722		√

This study was conducted at JHS 13 Bandar Lampung by using two classes as the research sample, namely classes VIII.1 and VIII.5 with the number of students in both classes

the same and the distribution of students male and female balanced. Both classes were given the subject matter of light with a sub chapter of the properties of light and the formation of shadows in a mirror. Class VIII.1 as the experimental class, was given treatment using the Argument-Driven Inquiry (ADI) and class VIII.5 as the control class using conventional models. The study was conducted using a quasi-experimental design with the study design was a pretest-posttest non-equivalent control group design. This means that the collection of research data is to do the pretest-posttest. Before conducting the pretest-posttest, the research instrument that contained questions to measure students' critical thinking skills that referred to critical thinking skills according to Ennis (2011) tested their validity and reliability first. The result, of the 20 questions tested for validity and reliability, obtained 13 valid questions with Cronbach's Alpha reliability value 0.806> 0.80, which means a high degree of reliability. After a valid and reliable instrument, the instrument can be used to measure students' critical thinking skills.

The ADI model with the learning steps its able to improve students' argumentative abilities, which will later refer to improving critical thinking skills. This can be seen from the ADI model which has the third and fourth steps in the form of the production of tentative arguments and interactive arguments by the critical thinking indicators used for the research developed by Ennis (2011). Where in the third step ADI, namely the production of student arguments guided by the teacher to write their arguments based on the research that has been done and then the written arguments will be submitted to fellow friends in the interactive stage of the argument that will further train students' argumentative skills.

Also, teaching and learning activities that use ADI that invites students to think critically in solving problems are supported by Cognitive Information Processing (CIP) learning theory or information processing theory. Where in the steps of ADI that begins with the identification of tasks, data collection, production of arguments, interactive arguments, preparation of reports, review of reports to the process of revision of the report, all are learning processes to find, receive and process information to become a knowledge gained through the process learning.

The ADI step that corresponds to information processing theory in improving critical thinking skills is in data collection, production arguments, and interactive arguments, where at the data collection step students are asked to conduct investigations to collect data then the data is processed by connecting with various other sources of information including linking it

with information that students previously had then conveyed it at the interactive stage of the argument. This is consistent with what is said by Sa'dijah and Sudirman (2016) regarding the theory of information processing is cognitive learning theory related to the way a person obtains and processes information, stores information, and calls back knowledge from the brain or mind.

After doing the research, data obtained from the research results were then processed and tested. Based on the results of hypothesis testing using the Independent Sample T-test that has been carried out, the first hypothesis to see the effect of applying the ADI model on female students' critical thinking skills is obtained sig. Male students obtained the sig value of 0,000. Both hypotheses show the results of a sig value that is less than 0.05, which means that H_0 in both of these hypotheses is rejected, and H_1 is accepted so that it can be said that there is an influence of the application of the Argument-Driven Inquiry (ADI) model to students' critical thinking skills in both female and male gender.

This is consistent with the research conducted by Demircioglu and Ucar (2015) which states that the ADI model can improve students' critical thinking skills because students are allowed to design their research and find the results of their research. Thus students will be involved in many scientific argumentation processes that will support strengthening their critical thinking skills. Khusnayain (2017) also in his research stated that argumentative inquiry-based learning is appropriate learning to provide learning experiences to students in practicing their scientific argumentation skills because students will be required to develop their explanations and express their ideas.

The research conducted by Ginanjar and Utari (2015) shows that the methods developed in the ADI model can train the ability of junior high school students 'scientific argumentation on the topic of light and in the research of Marhamah, Nurlaelah, and Setiawati (2017) the application of the learning model Argument-Driven Inquiry (ADI) can improve students' argumentation skills so that it refers to skills improvement critical thinking.

Hypothesis testing using the Independent Sample T-test was also conducted on the third hypothesis in the study to see differences in critical thinking skills between female students and male students using the ADI learning model. The results of testing this hypothesis show the value of sig. obtained is 0.722 more than 0.05. This means that H_0 in the third hypothesis is accepted and H_1 is rejected. So that it can be said that there is no difference in critical thinking skills between male students and female students using the ADI learning model.

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Research conducted by Sulistiyawati and Andriani (2017) states that there are no significant differences regarding the influence of gender on students' thinking and learning outcomes as stated in Sugihartono's et al., (2007) study that there is no evidence that relates between physical differences and intellectual abilities. The results of Sulistiana's and Nurhidayati's (2013) study showed that there was no gender influence on students' physics learning achievement. Although some of the other opinions expressed by Ricketts and Rudd (2004) state that the value of women is higher than the value of men in terms of critical thinking skills of analysts. But research data shows that male students are better able to write answers in more detail than female students. This is consistent with what Wilder and Powel (1989) said that starting from junior high school boys look better in tasks that involve reasoning, meaning they excel in the fields of mathematics and science, and girls are superior in terms of memory.

There is also gender interaction and student creativity towards students' speaking and socializing abilities. Some researchers argue that there is a possibility of differences in skills argued due to differences in cognitive abilities, attitudes, creativity, and thinking of students. As stated by Karnadi (2009), that differences inthe cognitive potential of students and the tendency of traits possessed between boys and girls occur because of differences in physical and psychological development that occur between the two. This difference will affect the ability of boys and girls to express their opinions. The ability to express the opinions of boys is higher than that of girls. The ability to express boys is higher than the ability to express the opinions of girls who share high creativity and the ability to express opinions of girls who have low creativity is not different from the ability to express the opinions of boys who also have low creativity.

In fact, the difference in learning outcomes that occur is caused by environmental factors during the learning process. One of these environmental factors is derived from the teacher's treatment factor. Williams (2014) states that teachers have a large influence on student learning processes, both directly and indirectly. For example, how to give instructions in class, appreciation of students, and grouping students in the class. Yuniarti (2014) also states that differences in treatment by teachers to male and female students result in differences in their learning achievement. Students who get more attention will have greater learning achievement.

The results of this study indicate that based on the discussions carried out above the Argument-Driven Inquiry model applied to students in the learning process can improve critical thinking skills, both for female and male students. This increase is indicated by the N-Gain of female and male students in the experimental class greater than the control class. Then based on the results of the Independent Sample T-Test it can be concluded that the application of the Argument-Driven Inquiry Model can improve students' critical thinking skills both female and male, but there is no difference in critical thinking skills between female and male students.

4. Conclusion

Based on the results and discussion, the conclusions are as it follows: (1) There is a significant effect of learning carried out using the Argument-Driven Inquiry (ADI) model on female students' critical thinking skills with sig. amounting to 0.001. (2) There is a significant effect of learning carried out using the Argument-Driven Inquiry (ADI) model on males students' the critical thinking skills with sig. amounting to 0,000. (3) There is no difference in critical thinking skills between male and female students who use the Argument-Driven Inquiry (ADI) model, as indicated by the sig value. amounting to 0.722> 0.05.

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