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The Effect of e-Worksheets in Eco-Friendly Technology Oriented with Argument-Driven Inquiry Model to Improve Students Argumentation Skills

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Abstract: This study aims to describe the effect of implementing e-worksheets on environmentally friendly technology materials with the Argument-Driven Inquiry (ADI) model in improving students' argumentation skills. This study involved 60 grade IX students in a junior high school in South Lampung, Lampung province. The research design used was a non-equivalent pretest-posttest control group design with an experimental class of 30 students and a control class of 30 students. Students in the experimental class get learning assisted by e-worksheet with the ADI model, while students in the control class are taught using the Problem Based Learning (PBL) model. The results showed that students who were taught using the e-worksheets with the ADI model had a higher N-gain (g=0.61 with medium criteria) than students taught using the PBL model (g=0.17 with low criteria). Furthermore, the effectiveness of learning environmentally friendly technology using the ADI model shows a high category (ES=0.84). This shows that the e-worksheet material on environmentally friendly technology using the ADI model was effective in improving students' argumentation skills.

Keywords: e-worksheet, argumentation skills, argument-driven inquiry.

Abstrak: *Penelitian ini bertujuan untuk mendeskripsikan pengaruh penerapan e-LKPD materi teknologi ramah lingkungan dengan model Argument-Driven Inquiry (ADI) dalam meningkatkan keterampilan argumentasi siswa. Penelitian ini melibatkan 60 siswa kelas IX disebuah SMP Negeri di Lampung Selatan, provinsi Lampung. Desain penelitian yang digunakan adalah non-equivalent pretest-posttest control group design dengan kelas eksperimen sebanyak 30 siswa dan kelas kontrol sebanyak 30 siswa. Siswa pada kelas eksperimen mendapatkan pembelajaran dengan berbantuan e-LKPD dengan model ADI, sedangkan siswa pada kelas kontrol diajar menggunakan model Problem Based Learning (PBL). Hasil penelitian menunjukkan bahwa siswa yang diajar menggunakan e-LKPD dengan model ADI memiliki N-gain (g=0,61 kriteria sedang) yang lebih tinggi dibandingkan dengan siswa yang diajarkan dengan model PBL (g=0,17 kriteria rendah). Selanjutnya, efektivitas pembelajaran teknologi ramah lingkungan dengan menggunakan model ADI menunjukkan kategori tinggi (ES=0,84). Hal ini menunjukkan bahwa e-LKPD materi teknologi ramah lingkungan dengan menggunakan model ADI efektif untuk meningkatkan keterampilan argumentasi siswa.*

Kata kunci: *e-LKPD, keterampilan argumentasi, argument-driven inquiry.*

▪ INTRODUCTION

Argumentation is the process of strengthening a claim through critical thinking analysis based on the support of evidence or logical reasons (Inch et al., 2006). Argumentation skills are very important to be empowered in science learning. The importance of argumentation skills in learning is expressed by several experts. According to Ginanjar & Utari (2015) it is important to develop argumentation skills in science learning to improve students' reasoning and understanding of the material being studied. In addition, according to Deane & Song (2014) argumentation skills have an

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important role in improving students' critical thinking patterns so that they can add in-depth understanding of an idea or idea. Therefore, it is very important to train argumentation skills so that students have logical and rational reasoning with the things being studied. During scientific argumentation, students reflect on their own ideas and learn about the ideas of others. Thus, helping students to correct misunderstandings and ensure a meaningful learning experience (Aufschnaiter et al., 2008). Although argumentation has an important role in science education, it is rarely used in science learning (Driver et al., 2000; Kim & Song, 2005). This can be seen from several research results regarding argumentation. Research conducted by Okumus & Unal (2012) shows that students have difficulty in forming arguments because they have never participated in argumentation activities. In addition, the results of other studies on argumentation concluded that the discussion was weak and some students were not involved in argumentation in science learning (Zohar & Nemet, 2002; Watson et al., 2007).

Science learning that involves scientific argumentation will not occur naturally, but must be carefully planned. Therefore, the learning model used by the teacher should be able to direct students in building their knowledge through argumentation, assessing and responding to arguments (Probosari et al., 2016). The success of developing students' argumentation skills in a more productive way depends on the creativity of the teacher in designing the perfect strategy (Hasnunidah et al., 2015). Given this, in this case the teacher needs to apply the right learning model to grow students' argumentation skills. The learning model that can develop students' argumentation skills is the Argument-Driven Inquiry (ADI) model. This is supported by several studies including Ginanjar & Utari (2015) which apply the ADI model in science learning, the results state that there is an increasing trend of argumentation. In addition, the results of research by Demircioglu & Ucar (2012) state that the ADI learning model is more effective in improving the quality of students' argumentation skills than conventional methods. This is because the ADI learning model is integrated with argumentation activities that can help students know how to create scientific explanations, how to generalize scientific facts, using data to answer research questions and being able to reflect on the results of investigations that have been carried out. (Sampson et al., 2010).

The ADI learning model is appropriate to use in learning the subject matter of Environmentally Friendly Technology. This is because this material is related to technologies that protect the environment, reduce pollutant power, use resources in a sustainable manner, recycle products and their waste and handle waste in the right way (Santa et al., 2017). The material content also contains knowledge, procedures, goods and services, organizational and management tools and procedures to promote environmental sustainability (Kardono, 2009). In addition, the concepts of daily lifestyles that divert sustainable energy, switch to environmentally friendly consumption patterns, save natural resources and use environmentally friendly products with the aim of overcoming problems caused by environmental damage that have an impact on environmental balance (Retno & Yuhanna, 2018). So, through the ADI learning model, it is hoped that students can answer environmental problems by submitting their ideas, ideas or opinions about eco-friendly technologies that are effective for the sustainability of human life. The existence of a problem will encourage students to be trained in

solving problems by conducting investigations and then using data to answer research questions, and communicating them so as to improve their argumentation skills.

The application of the ADI model in learning the subject matter of Eco-Friendly Technology requires good teaching materials. Various studies on the application of the ADI model assisted by worksheets have been carried out, one of which is research conducted by Lismawati et al. (2021) that learning using worksheets with ADI model can improve students' argumentation skills. However, currently there are still few who implement it with the help of electronic worksheets, especially during the Covid-19 pandemic. Therefore, this study focuses on efforts to improve the argumentation skills of junior high school students using electronic worksheets with the ADI model on eco-friendly technology materials

▪ METHOD

Participants

The population in this study were all grade IX students of SMP Negeri 1 Candipuro, South Lampung, Lampung province. The sample of this study was students of class IX B and IX D, each of which amounted to 30 people.

Research Design and Procedures

The type of data in this study is quantitative data. The research design used in the study was a non-equivalent pretest-posttest control group design.

Class of IX D students as the experimental class were treated using e-worksheets with the ADI model and class of IX B students were taught using worksheets with the PBL model. Diagrammatically the treatment of the two classes is presented in Figure 1 as follows.

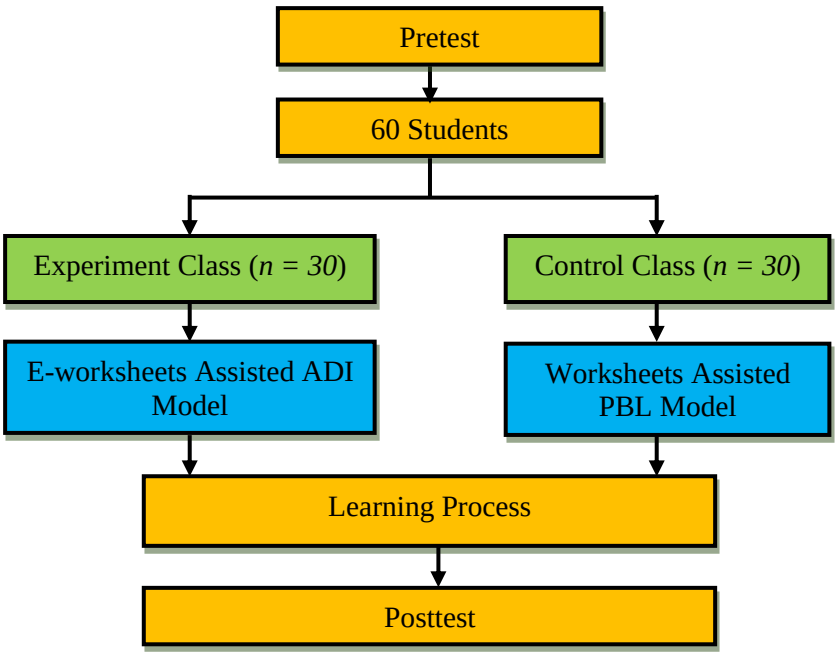

Figure 1. Procedure for conducting experiments

Instrument

The data collection technique used in this research is by giving questions to students. In this study, the test used was an argumentation skill test. The test instrument used in the study was in the form of a pretest-posttest in the form of a description test which was adjusted to the learning indicators in KD 3.10 regarding environmentally friendly technology. This instrument refers to Toulmin's argumentation analysis framework (Toulmin's Argument Pattern/TAP). The scientific argumentation analysis framework used by students is a kind of argumentation assessment rubric based on the completeness of the argumentation components. The question instrument used to collect data on argumentation skills was first tested for validity and reliability. Based on the results of the validity test, only 4 questions are valid. Cronbach's Alpha value in the reliability test is 0.67, which means that the instrument used is reliable. The rubric for assessing the quality of students' argumentation uses an assessment adapted from Hazeltine (2017) which is presented in Table 1

Table 1. Argumentation quality assessment rubric.

	4	**3**	**2**	**1**
Claim	The claim is easily distinguishable and is well written	The claim is well written, but could use some clarifying.	The claim is not quite clear, and needs developing.	The claim is indistinguishable or doesn't exist.
Grounds	The grounds to your argument are clear, concise, and easy to identify.	The grounds to your argument are easily identified, but need some clarifying.	The grounds to your argument are murky and need some development.	The grounds to your argument aren't displayed or aren't relevant.
Warrant	The warrant is well written, easily identifiable, and connects the claim and grounds of your argument efficiently	The warrant is clearly identifiable, but could use some clarifying.	The warrant is unclear, but there is something connecting your claims and grounds.	The warrant doesn't connect your claim to your grounds or it isn't easily identifiable.
Backing	Evidence supports the warrant.	Evidence that supports the warrant, but could use some clarifying to show connection as evidence.	Evidence that supports the warrant but the connections need to be clearer.	Evidence that supports the warrant is not identifiable or does not support the warrant.

Data analysis

The data to be analyzed is transformed into N-gain (g) which is obtained from the posttest score minus the pretest score divided by the maximum score minus the pretest score. The N-gain scores were then interpreted according to Table 2.

Table 2. N-gain interpretation

Gain	Interpretation
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Moderate
$g < 0.3$	Low

The argumentation skill data were analyzed by statistical tests which included normality test and homogeneity test as a prerequisite test and independent sample t-test as a comparative test or difference between two groups of data. Then the effect size test was carried out to determine the strength and weakness of increasing students' argumentation skills.

▪ RESULT AND DISSCUSSION

The results of this study focused on the implementation of e-worksheets using the ADI model to improve the argumentation skills of class IX students at the junior high school level. The improvement of students' argumentation skills can be seen from the pretest and posttest scores. The results of the average pretest and posttest scores of students in the control class and experimental class are presented in Figure 2.

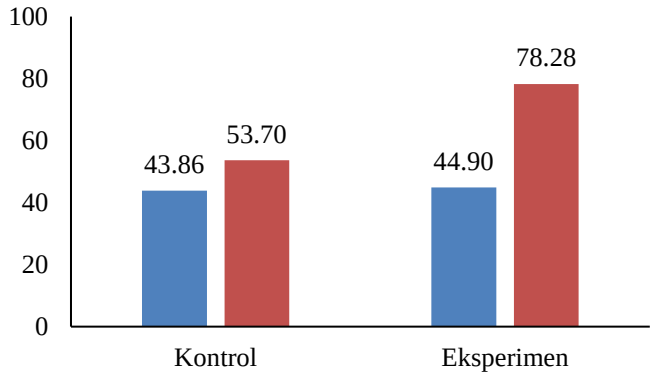

Figure 2. The average value of pretest (blue) and posttest (red)

The pretest and posttest value data were then analyzed using statistical tests including the N-gain test, normality test, homogeneity test and independent sample t-test. The results of the statistical test of the pretest and posttest score in the experimental class and control class are presented in Table 3.

Table 3. The results of the students' pretest-posttest statistical test

Score	Group	N-gain	Normality Test	Homogeneity Test	Independent Sample T-Test
Pretest	E	0.61 (E)	Sig. 0.192 > 0.05	Sig. 0.970 > 0.05	
	C		Sig. 0.170 > 0.05		Sig. (2-tailed)
Posttest	E	0.17	Sig. 0.926 > 0.05	Sig. 0.114 > 0.05	0.00 < 0.05
	C	(C)	Sig. 0.226 > 0.05		

Description: E = Experiment; C= Control

The results (Table 3) show that the posttest score in the experimental class is greater than the average posttest score in the control class and the n-gain score in the experimental class is higher than the control class, meaning that the application of environmentally friendly technology e-worksheets with the ADI model can improve students' argumentation skills. The results obtained can occur because the stages in the e-worksheets with the ADI model are designed to provide space for students to practice in arguing because they are arranged systematically and questions on the e-worksheets are arranged so that students can come up with arguments from hypothesizing to data processing. This is supported by Hadiwidodo et al. (2017) that all stages of the ADI learning model are effective for training students' scientific argumentation skills.

The increase in students' argumentation skills can also be seen from the increase in the level of argumentation. The increase in the level of argumentation skills of students in the control class can be seen in Figure 3 and in the experimental class can be seen in Figure 4.

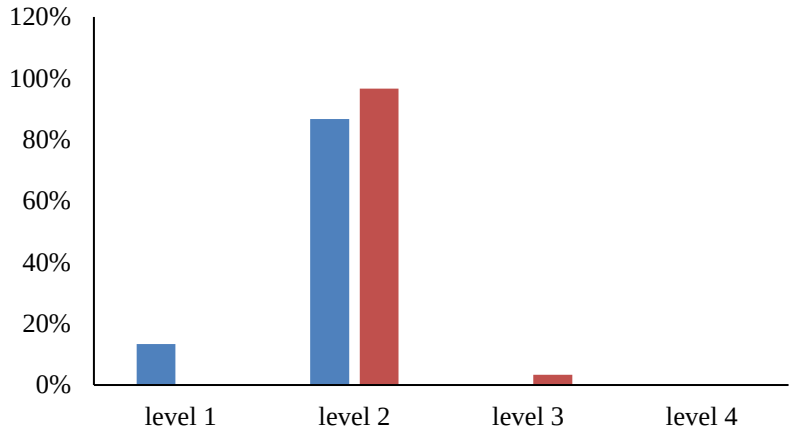

Figure 3. Percentage of argumentation skills each level of control class

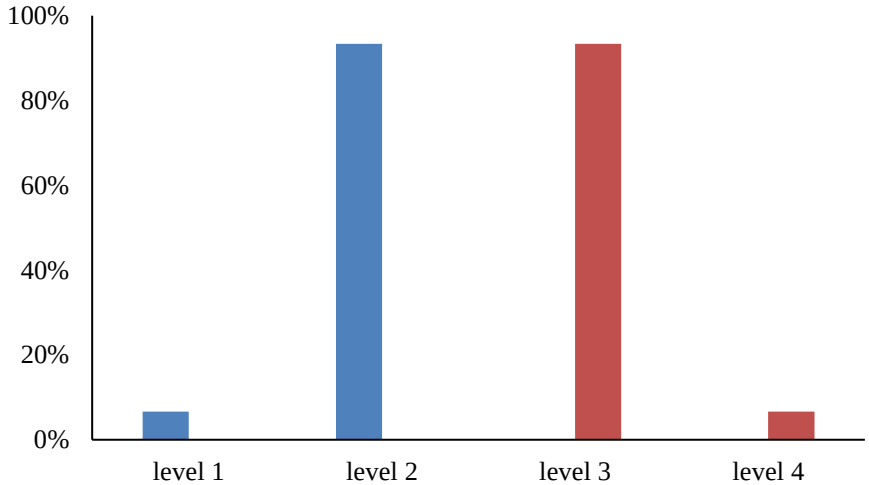

Figure 4. Percentage of argumentation skills each level of experiment class

Based on Figure 2 and Figure 3 the increase in the level of argumentation in the control class is lower than the level of argumentation in the experimental class. Figure 2 shows that in the control class there was an increase in the level of argumentation from level 2 to level 3. In the control class students were able to give their opinions (claims) well, write down evidence (ground/data) and provide justification (warrants) and provide support (backing).), but still needs to use some clarification. While Figure 2 shows that there is an increase in the level of argumentation skills of students in the experimental class, from level 2 to level 4. The results obtained can occur because before the application of interactive e-worksheets with the ADI model, the claims given by students are not very good and need to be developed. , the data written is not clear and needs development, the warrant is not clear but there is something that connects the claim with the data and the backing that supports the warrant is not clear. After applying the e-worksheets with the ADI model, there was an increase in the level of argumentation skills of students in the experimental class, reaching level 4. This increase could occur because after the e-worksheets with the ADI model was implemented students were able to write claims well, write evidence (ground/data).) clearly, concisely and easily identified, provides a good justification (warrant) that is easy to identify and link claims and warrants efficiently and provide support (backing) that supports warrants.

One of the factors that causes an increase in the level of argumentation skills is the application of the ADI model in learning activities. Activities in the ADI model provide opportunities for students to make an argument through investigation activities. Investigation activities in the ADI model aim to provide students with concepts that are used as a basis for arguing. This finding is supported by the research results of Andriani & Riandi (2015) which states that the ADI learning model is seen as being able to facilitate students to understand science concepts well, because the ADI model learning activities emphasize the construction and validation of knowledge through investigation activities. According to Squire & Jan (2007) that argumentation skills can develop well in students if students are able to interpret concepts well. In addition, the ADI model can facilitate students to practice students' argumentation skills, one of which is at the stage of making tentative arguments and the stage of argumentation sessions (Marhamah et al., 2017).

The results of the calculation of the effect size obtained a value of 0.84 with a large category, this shows that the argumentation skills of students are influenced by learning using e-worksheets with the ADI model. This is supported by the results of Ginanjar's (2014) research that there is a significant increase in students' scientific argumentation skills after using the ADI learning model. In addition, Hasnunidah et al. (2015) stated that the use of scaffolding in the Argument-Driven Inquiry strategy succeeded in improving students' argumentation skills.

▪ CONCLUSION

The main finding of this study shows that the e-worksheets with the ADI model has encouraged students to be actively involved in thinking and experimenting with science so that it has a positive impact on improving students' argumentation skills. E-worksheets with the ADI model succeeded in stimulating all stages of students' argumentation and providing effective scaffolding in building students' argumentation

skills. The next argumentation skill will be useful for students in making decisions from any problems faced by students in everyday life. In addition, science learning innovations that are oriented to the development of argumentation skills, in addition to contributing to the active involvement of students in learning, will also encourage a high-level thinking culture needed in the era of the Industrial Revolution 4.0 and Society 5.0.

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