

CAN ARGUMENT-DRIVEN INQUIRY MODELS HAVE IMPACT ON CRITICAL THINKING SKILLS FOR STUDENTS WITH DIFFERENT PERSONALITY TYPES?

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Abstract: Critical thinking skills are important in the context of 21st-century learning, where students are able to express reasons that support the assumptions or conclusions they obtain. A preliminary study at 25 Bandar Lampung Middle Schools found that science learning had not been maximized in training critical thinking skills. This study aims to determine the effect of applying the Argument-Driven Inquiry (ADI) learning model on students' critical thinking skills based on differences in academic abilities, gender, and personality type. This study used Nonequivalent (Pretest and Posttest) Control Group Design and One-Group Pretest-Posttest Design. The data of pretest and posttest essay questions results were analyzed using nonparametric statistical tests. The results showed that there was an effect of ADI learning on critical thinking skills in high and low academic students. Moreover, this model provided a greater influence on students' high academic abilities. The ADI model could also accommodate all male and female students with various types of personality types because the gender and personality type aspects do not show significant differences in students' critical thinking abilities, both between male and female students and students with different personality types. Overall, the ADI model is effective in improving students' critical thinking skills.

Keywords: *argument-driven inquiry, gender, academic ability, critical thinking skills, personality type*

DAPATKAH MODEL ARGUMENT-DRIVEN INQUIRY BERDAMPAK PADA KETERAMPILAN BERPIKIR KRITIS SISWA DENGAN TIPE KEPRIBADIAN YANG BERBEDA?

Abstrak: Keterampilan berpikir kritis penting untuk distimulasi melalui pembelajaran yang direncanakan dalam konteks pembelajaran abad ke-21, dimana siswa mampu mengungkapkan alasan yang mendukung asumsi atau kesimpulan yang diperolehnya. Pada penelitian pendahuluan di 25 SMP Bandar Lampung, ditemukan bahwa pembelajaran IPA belum maksimal dalam melatih keterampilan berpikir kritis. Penelitian ini bertujuan untuk mengetahui pengaruh penerapan model pembelajaran Argument-Driven Inquiry (ADI) terhadap keterampilan berpikir kritis siswa berdasarkan perbedaan kemampuan akademik, jenis kelamin dan tipe kepribadian. Penelitian ini menggunakan *Nonequivalent (Pretest and Posttest) Control Group Design* dan *One-Group Pretest-Posttest Design*. Data hasil pretest dan posttest soal esai yang mengacu pada kriteria berpikir kritis dianalisis dengan menggunakan uji statistik nonparametrik. Hasil penelitian menunjukkan terdapat pengaruh pembelajaran ADI terhadap keterampilan berpikir kritis pada siswa berakademik tinggi dan rendah, model ini memberikan pengaruh yang lebih besar terhadap siswa berakademik tinggi. Model ADI juga dapat mengakomodir seluruh siswa laki-laki dan perempuan dengan beragam jenis tipe kepribadian, karena aspek gender dan kepribadian tidak menunjukkan perbedaan yang signifikan pada kemampuan berpikir kritis siswa, baik antara siswa laki-laki dan perempuan maupun siswa dengan tipe kepribadian yang berbeda-beda. Secara keseluruhan, model ADI efektif dalam meningkatkan keterampilan berpikir kritis siswa.

Kata Kunci : *argument-driven inquiry, jenis kelamin, kemampuan akademik, keterampilan berpikir kritis, tipe kepribadian*

INTRODUCTION

Education is a continuous 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. Critical thinking skills are one of the skills that must be trained in the context of 21st

century skills where these skills train students' reasoning and argumentation in providing reasons to support assumptions or conclusions obtained (OECD, 2018). These competencies are important to be taught to students in the context of the field of study and the theme of 21st century learning. Critical thinking (along with creative thinking) in thought (Gibson, 1995) will be an important personal asset for future success. Critical thinking skills are important skills that a person needs to have for a better future.

Critical thinking is good thinking, almost opposite to thinking that is illogical and irrational (Facione, 2010). Critical thinking is one of the higher order thinking skills required. The definition of critical thinking skills in a nutshell is a mental process in perceiving the world using existing knowledge. Research conducted by Kirmizi, Saygi, & Yurdakal (2015) revealed that there was a moderate, positive and significant relationship between their disposition of critical thinking sub-scale scores and problem solving skills scores. That is, critical thinking skills have a relationship with problem solving skills, where the better the critical thinking skills will be followed by better problem solving skills. Critical thinking skills were influenced by various factors, one of which is the structure of thinking, which is the structure of thought expressed in oral and written, which is called argumentation (Hasnunidah, Susilo, Irawati, & Sutomo, 2015). Critical thinking skills also have a relationship with argumentation skills. One indicator of critical thinking developed by Ennis (2011), namely, regulating strategies and tactics, One of the sub-aspects of managing strategy and tactics is analyzing arguments. So, it can be stated that if someone has good critical thinking skills, he/she will also have good argumentation skills.

Some educational researchers have investigated various factors that can influence the level of students' skills in critical thinking. Among them are academic abilities, gender, and personality types. Academic ability is one of the keys to one's success, where a student with a good academic achievement will gain several benefits, so it needs special emphasis on academic abilities (Calaguas, 2012). Academic ability is also an important aspect that is reviewed to measure the success of school education and education in a country at large. Student academic

ability is influenced by four factors, namely: 1) the role of teachers and schools; 2) peers; 3) family; and 4) students themselves (Yahaya, 2003). From the students themselves, academic abilities can be determined by the basic process of student learning, learning goals from students, the use of strategies of thinking and thinking of the way students think. Each school usually mapped students' academic conditions in the last few years into high and low levels of academic ability (Sukmawati, Ramadani, Fauzi, & Corebima, 2015). High and low academic ability of students need to be trained to empower their thinking skills and metacognitive skills so that mastery of the concept was better so as to improve learning performance (Van der Stel & Veenman, 2008). High and low academic abilities require a special attention because students who have moderate academic skills may experience an increase or decrease caused by the factors mentioned above.

Sulistiana, Sriyono, & Nurhidayati (2013) explained about the discussion on gender and motivation focused on how differences in the ways men and women have in their beliefs and values. The confidence of female and male students related to competence varies based on the context of achievement (Ricketts & Rudd, 2004) stating the value of women is higher than the value of men in terms of critical thinking skills analysis. Women are also rated higher than men in their ability to draw conclusions, which means women are better able to identify the elements needed to draw conclusions, to form hypotheses, and to consider relevant information.

A good learning process in students is also influenced by factors that are in students which are called internal factors. One of the internal factors that influence student learning is the characteristics of students (Aunurrahman, 2012). One of the problems in the learning process is the characteristics of students related to the personality of students. Student personality has an influence in the learning process. In fact, there are still many teachers who teach without paying attention to the personality/characteristics of students (Halder, Roy, & Chakraborty, 2017). As an educator it is highly demanded to understand the personality characteristics of students so that they can provide stimulation or treatment that is in accordance with the personality types of students faced. In general, personality is divided

into 4 types. Four types of personality types: sanguinis, choleric, melancholy, and phlegmatic. Thus, there needs to be an understanding of the teacher to pay attention to and recognize the personality of students in carrying out learning.

A particular learning model is needed to practice critical thinking skills, one of which is inquiry. Sequential implementation of inquiry in science learning has the potential to improve students' thinking skills, because scientific inquiry in science learning helps students develop their ability to think, work, and become scientific and communicate it as an important aspect of life skills (BNSP, 2006). From the results of the preliminary study, 82% of the 18 respondents from Bandar Lampung science teachers have applied the inquiry model, but the implementation has not been maximized. Inquiry learning applied by the teacher influences the improvement of students' skills, both those with high and low academic abilities; students with melancholic, sanguine, choleric, and phlegmatic personality types; and male and female students. Based on the results of preliminary research, 78% of 18 teachers reviewed how to form heterogeneous study groups in their students' abilities. The application of inquiry-based learning showed the results of high critical thinking in students (Greenwald & Quitadamo, 2014). The purpose of using the inquiry inquiry strategy was to emphasize the process of thinking systematically, logically, analytically, and critically (Hadisi, 2014). One way to improve students' critical thinking skills in learning science, especially Physics, is to use inquiry.

Critical thinking ability is a reasoning ability that requires students to be able to express the reasons that support the assumptions or conclusions they obtain. Critical thinking (along with creative thinking) will be an important personal asset for a better future. Critical thinking skills are important skills that need to be stimulated through learning planned and designed in the context of the field of study with the theme of 21st century learning. One solution that can be carried out to improve student's critical thinking skills was to apply learning with the Argument-Driven Inquiry (ADI) model. Sampson & Gleim (2009) stated that ADI learning model was a model that is designed

to arrange the objectives of activities in the classroom as an effort to develop, understand, or evaluate a scientific explanation of a natural phenomenon or a solution to a problem. Then, Demircioglu & Ucar (2015) stated a harmonious opinion that ADI was an effective model for improving academic achievement and science process skills. The ADI learning model was designed to change conventional learning which makes students have the opportunity to learn in scientific inquiry in a reflective manner so they can develop skills argumentation and critical thinking (Kadayifci, Atasoy, & Akkus, 2012; Sampson, Grooms, & Walker, 2010). There were eight stages in implementing learning using the ADI model as presented in Table 1.

Table 1. Stages in the ADI learning model

Stages	Description
Stage 1	Task Identification
Stage 2	Data Collection
Stage 3	Production of Tentative Arguments
Stage 4	Argumentation Session
Stage 5	Compilation of Written Investigation Reports
Stage 6	Review the Report
Stage 7	Revision based on Review Results
Stage 8	Reflective Discussion

The implementation of ADI learning model had many advantages in classroom. Amin & Corebima (2016) stated that ADI learning model could: 1) frame the purpose of class activities; 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) give a place for students how to propose, support, evaluate, revise ideas through discussion and writing in a more productive way; 5) create a class community that values evidence and critical thinking; 6) encourage students to take control of learning from themselves.

Ginjar (2015) stated that the methods developed in the ADI model can train students' scientific argumentation skills. The results of the research conducted by Sampson, Enderle, Grooms, & Southerland (2012) showed some evidence for the effect that ADI-based learning

can improve inquiry skills and scientific understanding. The study result of Hidayat (2017) showed that the mathematical reasoning abilities of students who get learning with ADI learning model are better than students with direct learning.

Critical thinking skills need to be trained to students so that they can face the demands of 21st century learning according to the objectives of Indonesian education. ADI learning model may be the best alternative solution to developing student's critical thinking skills. Thus, this research was conducted to examine the influence of ADI learning model compared to other learning models on improving students' critical thinking skills by paying attention to differences in academic abilities, gender, and student personality types.

METHOD

This study adopted the *Non-equivalent (Pretest and Posttest) Control Group Design* that was also mixed by adopting *One-Group Pretest-Posttest Design*. Determination of the experimental and control groups was conducted using random sampling techniques. This research was conducted on eighth grade students of Public and Private Middle Schools in Bandar Lampung City. We used different samples for each data collection. So, the sample we used for the four data packages we obtained, namely 1) we involved 52 students (each experimental and control class was 26 students) to obtain pretest-posttest data on students' critical thinking skills in the experimental class (using ADI learning model) and control class (using conventional learning model), 2) we involved 26 students to obtain pretest-posttest data of students' critical thinking skills through the application of the ADI learning model by looking at student academic ability level variables, 3) we involved 30 students to obtain data students' pretest-posttest critical thinking skills through the application of the ADI learning model by looking at gender aspect, and 4) we involved 32 students to obtain pretest-posttest data on students' critical thinking skills through the application of the ADI learning model by looking at aspect of students' personality types. We used purposive sampling techniques to determine the sample. The variables in this study were the application

of the ADI model as an independent variable, critical thinking skills as the dependent variable and academic ability; gender; and personality type as a moderator variable. Samples that were reviewed based on academic ability are first grouped based on their academic abilities through science and KKM grades (minimum graduation criteria). Specifically the samples reviewed based on personality types before learning were firstly tested to classify students into appropriate personality types using a personality profile test in Florence Littauer's book *Personality Plus*.

The instruments used in this study were test instruments of critical thinking skills that refer to the indicators of critical thinking skills (Ennis, 2011). Test instruments in the form of essay questions as many as 6 questions that have been tested for validity and reliability before being used by the sample. Tests were carried out before and after learning model implementations. Furthermore, the four data packages on students' critical thinking skills were tested for normality (*using kolmogorov smirnov test*) and homogeneity (*using Levene's test*).

Overall, the data analysis techniques we used were descriptive and inferential quantitative analysis techniques. For the first data package, namely the pretest posttest data of students' creative thinking skills from the implementation of the ADI and conventional models, we used the nonparametric *Mann-Whitney U Test* to see the significance of differences in each pretest and posttest data in each experimental class and control class. Meanwhile, to see the improvement of students' critical thinking skills through pretest and posttest data, we used nonparametric *Wilcoxon Signed Rank Test* and were supported by N-gain analysis to see the effectiveness of the ADI model implementation. Meanwhile, the data analysis techniques for the second dan data packages were almost the same as the first data package analysis. For the last data package based on personality type, we used *Kruskall Wallis Test* to examine the significance of differences in each pretest and posttest data in each personality type which then be continued using *Mann-Whitney U Test*. We only use the experimental class, so the focus of data analysis was more oriented to the aspects of academic ability level (high vs. low), gender (male vs. female), and personality type (choleric vs. melancholy vs. phlegmatic vs. sanguine).

FINDINGS AND DISCUSSION

Findings

We describe the findings that we obtained in four sections because we adjust to the four data packages we analyzed. All the findings that we obtained always focused on students' critical thinking skills. The findings we obtained were outlined as follows.

ADI vs. Conventional Learning Model

The earliest data we obtained aimed to see the effect of implementing ADI and conventional learning models on students' critical thinking skills. The results of the normality and homogeneity test indicated that the data were not normally distributed with a significance value of $<.05$ but homogeneous with a significance value $>.05$. Then, the results of the Mann-Whitney U Test and descriptive analysis can be seen in Table 1 and 2.

Table 1 showed that the significance value of the pretest and posttest data between the experimental and control classes showed a value of $<.05$, which means that there were significant differences from the pretest and posttest values between the experimental and the

control classes. That is, the application of ADI and conventional learning models both have an influence on students' critical thinking skills. However, if seen in Table 2, the mean value of experimental class posttest data that applies the ADI learning model was higher than the control class that applies conventional learning models. It indicated that the ADI learning model provided a greater influence than conventional models in improving student's critical thinking skills. Meanwhile, the results of pretest-posttest data analysis to examine the improvement of students' critical thinking skills were represented in Figure 1 and Table 3.

Table 3 showed that the significance values of the pretest and posttest data between the experimental and control classes $<.05$, which means that there was a significant increase between the pretest and posttest data in both the experimental and control classes. However, N-gain analysis results in Figure 1 showed that the N-gain for experimental class was higher than the control class which means ADI learning model was more effective than conventional model in improving student's critical thinking skills.

Table 1. Analysis Result of Mann-Whitney U for Experiment and Control Classes

	Pretest Before Learning Model Implementation	Posttest After Learning Model Implementation
Mann-Whitney U	189.500	134.500
Wilcoxon W	540.500	485.500
Z	-2.747	-3.768
Asymp. Sig. (2-tailed)	.006	.000

a. Grouping Variable: Learning Model

Table 2. Descriptive Analysis Result of Pretest Posttest Data

		N	Mean	Std. Dev	Min	Max
Pretest Before Learning Model Implementation	ADI Learning Model	26	30.1281	9.15131	12.50	45.83
	Conventional Learning Model	26	23.2369	7.18513	8.33	33.33
	Total	52	26.6825	8.85799	8.33	45.83
Posttest After Learning Model Implementation	ADI Learning Model	26	71.3142	7.39088	58.33	87.50
	Conventional Learning Model	26	62.0192	7.66737	45.83	75.00
	Total	52	66.6667	8.81009	45.83	87.50

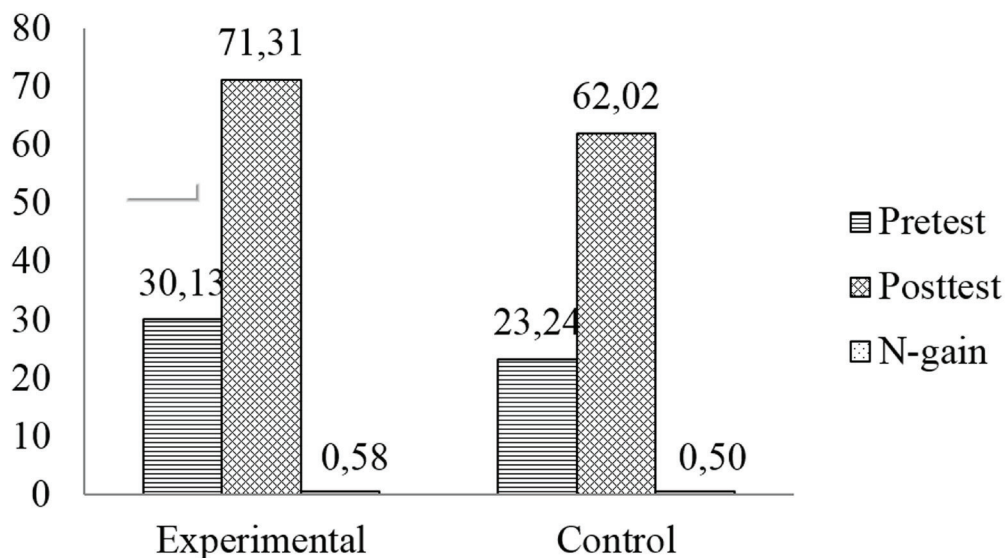


Figure 1. N-gain Analysis Results for Experimental and Control Classes

Table 3. Analysis Result of Wilcoxon Signed Rank Test for Pretest-Posttest Data

	Posttest After ADI Model Implementation - Pretest Before ADI Model Implementation	Posttest After Conventional Model Implementation - Pretest Before Conventional Model Implementation
Z	-4.467 ^b	-4.471 ^b
Asymp. Sig. (2-tailed)	.000	.000

b. Based on negative ranks.

Student's Critical Thinking Skills Based on Academic Ability Level (High vs. Low)

The results of the normality and homogeneity test of pretest-posttest in one class which implementing ADI learning model indicated that the data were not normally distributed with a significance value of $<.05$ but homogeneous with a significance value $>.05$. Then, the results of the Mann-Whitney U Test and descriptive analysis can be seen in Table 4 and 5.

Table 4 showed that the significance value of each pretest and posttest showed a value of $<.05$, which means that there were significant differences for each pretest and posttest values between high and low academic ability students after ADI learning model implementation. That is, the application of ADI gave a contribution on high and low academic ability students' critical thinking skills. However, in Table 5, the posttest mean value of high academic ability level was

higher than the low one. It indicated that the ADI learning model provided a greater influence on improving critical thinking skills of students who had high academic abilities. Furthermore, the results of pretest-posttest data analysis to examine the improvement of students' critical thinking skills based on academic ability levels were represented in Figure 2 and Table 6.

Table 6 showed that the significance values of the pretest and posttest data between high and low academic ability level <0.05 , which means that there was a significant increase between the pretest and posttest data in both the high and low academic ability level. However, N-gain analysis results in Figure 1 showed that the N-gain for high academic ability level was higher than the low one which means ADI learning model was more effective in improving critical thinking skills of high academic ability student than low academic ability student.

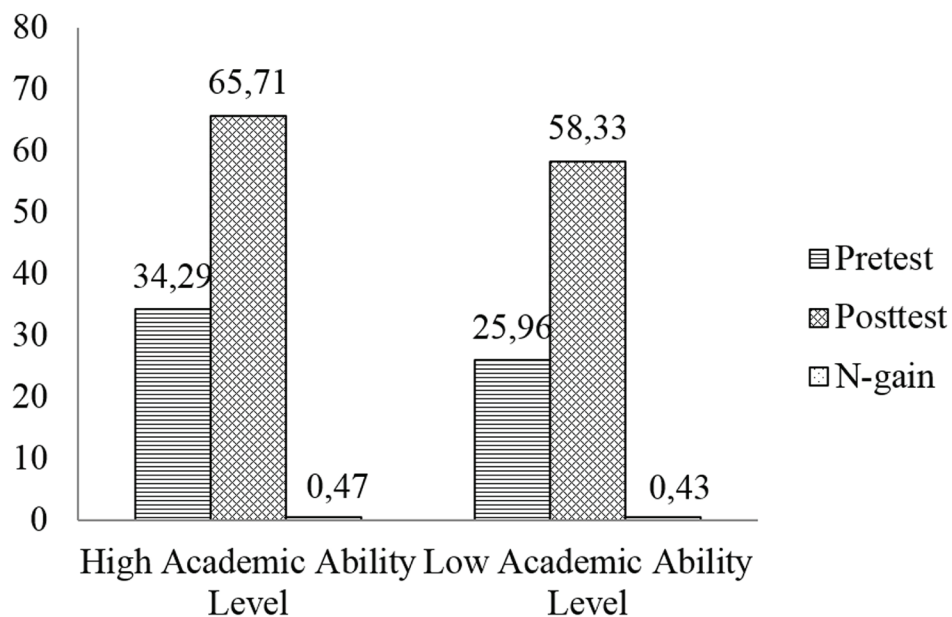
Table 4. Mann-Whitney U Test Analysis Result of Pretest and Posttest Data Based on Academic Ability Level

	Pretest Before ADI Model Implementation	Posttest After ADI Model Implementation
Mann-Whitney U	39.000	35.000
Wilcoxon W	130.000	126.000
Z	-2.358	-2.578
Asymp. Sig. (2-tailed)	.018	.010

a. Grouping Variable: Academic Ability Levels of Students

Table 5. Descriptive Analysis Result of Pretest Posttest Data Based on Academic Ability Level Aspect

	N	Min	Max	Mean	Std. Dev
Pretest using ADI Model Towards High Academic Level	13	25.00	45.83	34.2938	5.41992
Posttest using ADI Model Towards High Academic Level	13	50.00	75.00	65.7054	6.39943
Pretest using ADI Model Towards Low Academic Level	13	12.50	45.83	25.9623	10.36807
Posttest using ADI Model Towards Low Academic Level	13	45.83	70.83	58.3331	7.21688

**Figure 2. N-gain Analysis Results Based on Student's Academic Ability Level****Table 6. Wilcoxon Signed Rank Test Results Based on Student's Academic Ability Level**

	Pretest using ADI Model Towards High Academic Level - Posttest using ADI Model Towards High Academic Level	Pretest using ADI Model Towards Low Academic Level - Posttest using ADI Model Towards Low Academic Level
Z	-3.185 ^b	-3.182 ^b
Asymp. Sig. (2-tailed)	.001	.001

b. Based on positive ranks.

Student's Critical Thinking Skills Based on Gender (Male vs. Female)

The results of the normality and homogeneity test of pretest-posttest in one class which implementing ADI learning model indicated that the data were not normally distributed with a significance value of $<.05$ but homogeneous with a significance value $>.05$. Then, the results of the Mann-Whitney U Test and descriptive analysis can be seen in Table 7 and 8.

Table 7 showed that the significance value of each pretest and posttest data showed a value of $>.05$, which means that there were no significant differences for each pretest and posttest values between male and female students after ADI learning model implementation. That is, the application of ADI gave the same contribution on male and female students' critical thinking skills. Although Table 8 showed the mean value

of posttest data for female students was higher than male students, but statistically the difference was not significant. It indicated that the ADI learning model provided the same influence on improving critical thinking skills of male and female students. Furthermore, the results of pretest-posttest data analysis to examine the improvement of students' critical thinking skills based on gender levels were represented in Figure 3 and Table 9.

Table 9 showed that the significance values of each pretest and posttest data between male and female students $<.05$, which means that there was a significant increase between the pretest and posttest data in both male and female students. This result was supported by N-gain analysis results in Figure 3. It showed that the N-gain for male and female students were the same in the high category which means ADI learning model was very effective in improving critical thinking skills of male and female students.

Table 7. Mann-Whitney U Test Analysis Result of Pretest and Posttest Data Based on Gender

	Pretest Using ADI Learning Model	Posttest Using ADI Learning Model
Mann-Whitney U	71.500	84.000
Wilcoxon W	191.500	204.000
Z	-1.860	-1.254
Asymp. Sig. (2-tailed)	.063	.210

a. Grouping Variable: Gender Variable

Table 8. Descriptive Analysis Result of Pretest Posttest Data Based on Gender

		N	Mean	Std. Deviation	Min	Max
Pretest Using ADI Learning Model	Male	15	20.5513	5.33539	16.66	33.33
	Female	15	24.4420	5.86587	16.66	33.33
	Total	30	22.4967	5.85391	16.66	33.33
Posttest Using ADI Learning Model	Male	15	77.7760	8.72129	66.66	100.00
	Female	15	82.7753	11.55902	66.66	100.00
	Total	30	80.2757	10.37712	66.66	100.00

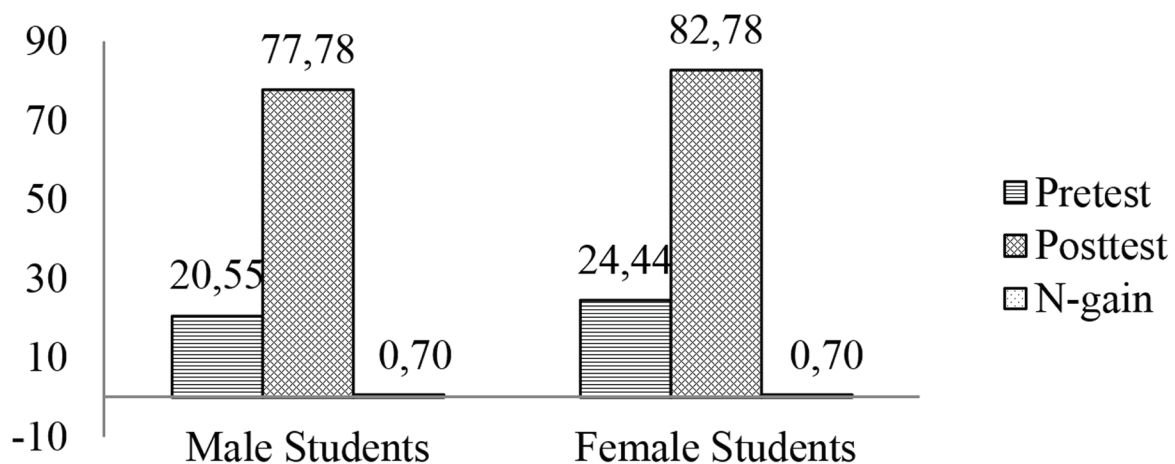


Figure 3. N-gain Analysis Results Based on Gender

Table 9. Wilcoxon Signed Rank Test Results Based on Gender

	Pretest of Male Students Using ADI Learning Model - Posttest of Male Students Using ADI Learning Model	Pretest of Female Students Using ADI Learning Model - Posttest of Female Students Using ADI Learning Model
Z	-3.461 ^b	-3.423 ^b
Asymp. Sig. (2-tailed)	.001	.001

b. Based on positive ranks.

Student's Critical Thinking Skills Based on Personality Type

The results of the normality and homogeneity test of pretest-posttest in one class which implementing ADI learning model indicated that the data were not normally distributed with a significance value of $<.05$ but homogeneous with a significance value $>.05$. Then, the results of the Kruskal Wallis Test and descriptive analysis can be seen in Table 10 and 11.

Table 10 showed that the significance value of pretest data showed a value of $<.05$, which means that there was a significant difference for pretest value between the four personality types (choleric, melancholy, phlegmatic, and sanguine). Meanwhile, posttest data showed a value of $>.05$, which means that there was no a significant difference for posttest value between the four personality types. That is, the application of ADI learning model had the same influence in improving student's critical thinking skills in four personality types observed. That is, the

ADI learning model could accommodate all students with different personality types in order to improve students' critical thinking skills. Furthermore, the results of pretest-posttest data analysis to examine the improvement of students' critical thinking skills based on student's personality type were represented in Figure 4 and Table 12.

Table 6 showed that the significance values of the pretest and posttest data of Choleric and Sanguine personality types $<.05$, which means that there were significant increase between the pretest and posttest data. However, Table 6 also showed that the significance values of the pretest and posttest data of Melancholy and Phlegmatic personality types $>.05$, which means that there were no significant increase between the pretest and posttest data. These results indicated that ADI learning model was powerful in improving critical thinking skills of choleric & sanguine students, but the learning model was less potential for the same purpose of melancholy and phlegmatic students.

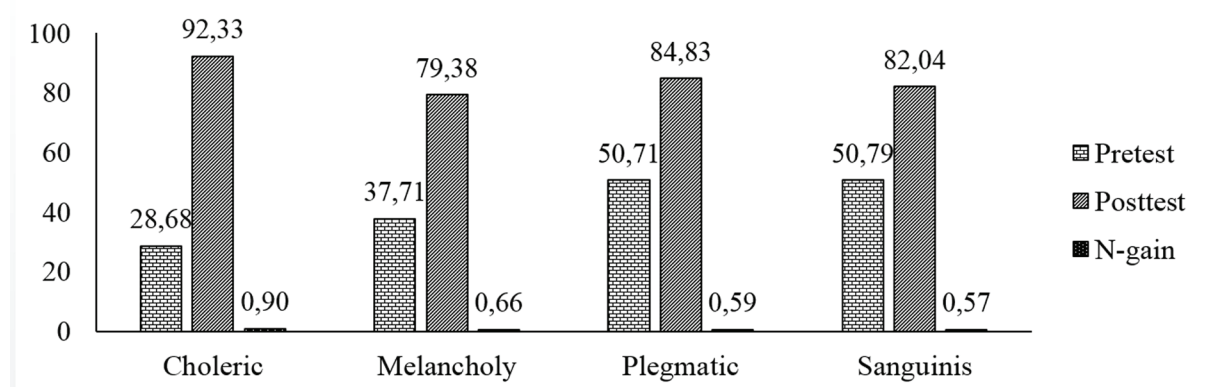
Table 10. Kruskal Wallis Test Analysis Result of Pretest and Posttest Data Based on Personality Type

	Pretest Results Using ADI Towards Personality Types	Posttest Results Using ADI Towards Personality Types
Chi-Square	10.909	5.530
Df	3	3
Asymp. Sig.	.012	.137

a. Grouping Variable: Student's Personality Type

Table 11. Descriptive Analysis Result of Pretest Posttest Data Based on Personality Type

	N	Min	Max	Mean	Std. Deviation
Pretest of Choleric Type using ADI Model	12	12.50	54.17	28.6800	13.44965
Posttest of Choleric Type using ADI Model	12	73.00	99.00	92.3333	10.92398
Pretest of Melancholy Type using ADI Model	4	30.00	50.00	37.7075	8.75056
Posttest of Melancholy Type using ADI Model	4	79.17	80.00	79.3775	.41500
Pretest of Plegmatic Type using ADI Model	4	20.83	70.00	50.7075	22.23276
Posttest of Plegmatic Type using ADI Model	4	78.00	98.00	84.8325	9.04943
Pretest of Sanguinis Type using ADI Model	12	30.00	70.00	50.7908	13.68281
Posttest of Sanguinis Type using ADI Model	12	70.00	99.00	82.0417	10.07262
Valid N (listwise)	4				

**Figure 4. N-gain Analysis Results Based on Student's Personality Type****Table 12. Wilcoxon Signed Rank Test Results Based on Student's Personality Type**

	Posttest of Choleric Type using ADI Model - Pretest of Choleric Type using ADI Model	Posttest of Melancholy Type using ADI Model - Pretest of Melancholy Type using ADI Model	Posttest of Plegmatic Type using ADI Model - Pretest of Plegmatic Type using ADI Model	Posttest of Sanguinis Type using ADI Model - Pretest of Sanguinis Type using ADI Model
Z	-3.061 ^b	-1.826 ^b	-1.826 ^b	-3.064 ^b
Asymp. Sig. (2-tailed)	.002	.068	.068	.002

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Discussion

The results of data analysis showed that the ADI learning model was more powerful in improving students' critical thinking skills than the conventional learning model. This could happen because the application of the ADI model in the classroom trained students to argue. In the third stage, namely, the tentative argument production stage, students and their groups were guided to make schemes of argumentation consisting of three parts namely claim, evidences, and warrant/backing. Claims contain statements that are answers to research questions, evidences contain facts obtained based on experiments, and warrant/backing contains rational reasons why evidences can be used to support claims. Furthermore, in the fourth stage, which is an interactive session of argument, students were given the opportunity to assess or revise their arguments after discussions with other groups. At this stage, students were trained to look at the quality of arguments based on claims, evidences and warrant/backing both from the group itself and from other groups.

The overall steps in the ADI learning model were very supportive in optimizing the achievement of students' critical thinking skills. These steps were not found in conventional learning models. Conventional learning only provided opportunities for students to practice understanding the material context through explanation and practice questions. The methods used in conventional learning are less varied, unlike the ADI model. In conventional models, the method used was discussion, but in the ADI learning model, the methods used were very varied, ranging from discussions, presentations, experiments, and demonstrations.

The reason why the ADI learning model was effective in enhancing students' critical thinking skills was because through the ADI learning model, students will be trained to analyze arguments, starting from identifying conclusions, identifying reasons, looking for similarities and differences, identifying and dealing with irrelevance, search for structural arguments, and summarize. The following whole activities were indicators of students' critical thinking skills (Ennis, 2011). In the aspect of giving further explanation, one of the sub critical thinking skills was identifying assumptions, which was further divided into

identifying stated reasons and assumptions for reconstructing arguments. These two sub critical thinking skills were in accordance with the third and fourth stages of the ADI model where students produce arguments that contain claims, evidences, and warrant/backing and then assess and revise arguments. Thus, the application of the ADI model was very appropriate to improve students' critical thinking skills. These study results were in line with the research conducted by Fatmawati, Susilowati, & Iswari (2019). They stated that the implementation of the ADI model had an effect on argumentation and critical thinking skills. Learning with the ADI model required students to develop critical thinking skills through problem solving. This was in line with research conducted by Rajagukguk & Simanjuntak (2015) who stated that problem-based learning could contribute greatly to improving students' critical thinking skills, especially if learning is integrated with ICT.

Those findings were also supported by research conducted by Sampson, et. al. (2010), the use of the ADI model improves students' ability to argue. ADI model in learning shows a close relationship between students' weaknesses in arguing with their critical and creative thinking skills (Kadayifci, et. al., 2012). The research conducted by Riandi (2015) showed that the application of the Argument Driven Inquiry learning model can significantly improve the mastery of students' concepts compared to guided inquiry learning. The research conducted by Ginanjar (2015) showed that the methods developed in the ADI model can train the ability of junior high school students' scientific argumentation on the topic of light. Demircioglu & Ucar (2015) stated that the ADI model can improve students' critical thinking skills because students are given the opportunity to design their research and find the results of their own research. Thus students will be involved in many scientific argumentation processes that will support strengthening their critical thinking skills. ADI learning model could train students' scientific argumentation skills (Dwiretno & Setyarsih, 2018; Kurniasari & Setyarsih, 2017). After participating in learning, students' scientific argumentation skills increase from level 1 to level 3. Based on the results of research by Marhamah, Nurlaelah, & Setiawati (2017), ADI model could improve students' argumentation skills, it means

that the ADI model can facilitate students in practicing scientific arguments and evaluating the quality of their arguments, one of which is at the stage of making tentative arguments and the stage of argumentation sessions. Hasnunidah, et. al. (2015) stated that ADI strategy was an effective strategy in improving students' critical thinking skills from conventional strategies and also critical thinking achievement for students with high academic abilities higher than students with low academic abilities.

These results were also strengthened by constructivist learning theory. The application of the ADI Model is based on constructivist learning theory. Constructivist learning theory is a process of forming knowledge (Sudarsana, 2018). This formation must be carried out by the students themselves. Then students must actively carry out activities, actively think, form concepts and give meaning to something they learn. Constructivist learning theory was a learning theory that conceptualizes learning as a result of building meaning based on previous experience and knowledge (Lowenthal, Muth, & Provenzo, 2009).

Based on the learning theory above, the application of the ADI Model will train students' argumentation skills in the process of making, revising and evaluating an argument. Then, the argumentation skills of students trained through this ADI Model will be saved and will be used when this argumentation skill is needed. By being active in the learning process using the ADI model, students will experience in making and evaluating arguments so that they can improve their argumentation and critical thinking skills. The ability to think critically was influenced by various factors, especially the structure of one's thinking (Hasnunidah, et. al., 2015). The structure of thought can be expressed through language, both oral and written, which is then referred to as argumentation.

The results of statistical data analysis supported by N-gain analysis showed that the application of the ADI learning model had an impact on students' critical thinking skills, both those who had high academic abilities and low ones with the effectiveness in the medium category. However, ADI learning models were provided a greater influence and more effective in improving critical thinking skills of students who have a high academic ability than they who

had a low academic ability. These results were in line and strengthen the research conducted by Zohar & Dori (2003); Saido, Siraj, Nordin, & Al_Amedy (2018), students with high academic achievements have gained higher thinking scores than their peers with low academic achievements. This happened because the high academic ability of students had capacity above and beyond their average ability of peers (Ramos & Verschueren, 2019), so they tended to have great motivation to learn, enthusiasm and curiosity (Froiland & Worrell, 2016), so they were more active and more participating in the learning process. The great motivation of students who have high academic abilities certainly had an impact on improving more optimal critical thinking skills (Howard, Tang, & Austin, 2015; Kwan & Wong, 2015).

Based on gender aspects, the results of data analysis show that the application of the ADI learning model had an impact and influence on improving students' critical thinking skills, both male and female students. That is, the ADI model was able to accommodate all students without looking at gender aspects to be able to improve the critical thinking skills that students had. This happened because male and female students were given the same roles, responsibilities, opportunities, and demands during the learning process, so that they had equal opportunities in gaining learning experience. Research conducted by Sulistyawati (2017) showed results that there were no significant differences regarding the influence of gender on students' thinking and learning outcomes. As stated in Sugihartono's (2007) study that there is actually no evidence that relates between physical differences and intellectual abilities. The results of Sulistiana, et. al. (2013) study showed that there was no gender influence on students' Physics learning achievement. Although some of the other opinions expressed by Ricketts & Rudd (2004) showed that the value of women is higher than the value of men in terms of critical thinking skills of analysts. Atamimi (2014) also stated that on the academic excellent scale aspects, there was a correlation with aspects of sex role differences. Actually the difference in the results of the learning that occurs is caused by environmental factors during the learning process. One of them comes from teacher treatment factors.

Statistical analysis to see the effect of

applying the ADI learning model showed that the role of the ADI model did not provide significant differences for the four personality types of students observed, namely choleric, melancholy, phlegmatic, and sanguine. That is, the ADI learning model could be applied to every student with a diverse personality type. This can be seen from the N-gain value which indicates that the effectiveness of the ADI learning model were at high and medium category. However, a significant increase in students' critical thinking skills was only shown by students who had a choleric and sanguine personality type. When viewed descriptively, the pretest and posttest values of the four personality types increased. However, statistically, the significant improvement in students' critical thinking skills with a type of melancholic and phlegmatic personality were not statistically proven. Research conducted by Sunarto, Budayasa, & Juniati (2017) also identified the influence of a person's personality with problem solving abilities. The results of the study were certainly in line with and support the results of the research we conducted that personality also contributes to problem-solving abilities that automatically also influence the improvement of thinking skills, especially critical thinking skills.

CONCLUSION

The process of knowledge construction in arguing with the ADI model improved student's critical thinking skills. The ADI learning model was more effective in improving students' critical thinking skills than the conventional learning model. This could happen because the application of the ADI model in the classroom trained students to argue, and it was the critical thinking skills indicator. ADI learning model implementation showed an impact on students' critical thinking skills, both those who had high academic abilities and low ones with the effectiveness in the medium category. However, ADI learning models were provided a greater influence and more effective in improving critical thinking skills of students who have a high academic ability than they who had a low academic ability. ADI model can also accommodate all male and female students with various types of personality types, because the gender and personality type aspects do not show significant differences in students' critical

thinking abilities, both between male and female students and students with different personality types –different.

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REFERENCES

- Amin, A. M., & Corebima, A. D. (2016). *Analisis persepsi dosen terhadap strategi pembelajaran Reading Questioning and Answering (RQA) dan Argument Driven Inquiry (ADI) pada Program Studi Pendidikan Biologi di Kota Makassar*. Paper presented in Seminar Nasional II (pp. 333–347).
- Atamimi, N. (2014). Perbedaan peran jenis kelamin, skala akademik, dan peran aktif berorganisasi dengan prestasi akademik. *Cakrawala Pendidikan*, 33(2), 236-244. doi:10.21831/cp.v2i2.2163.
- Aunurrahman, A. (2012). *Belajar dan pembelajaran*. Bandung: Alfabeta.
- Calaguas, G. M. (2012). Academic achievement and school ability: Implications to guidance and counseling programs. *Researchers World: Journal of Arts, Science & Commerce*, 3(2), 49-55.
- Demircioglu, T., & Ucar, S. (2015). Investigating the effect of argument-driven inquiry in laboratory instruction. *Educational Science: Theory & Practice*, 15(1), 267-283. doi:10.12738/estp.2015.1.2324.
- Dwiretno, G., & Setyarsih, W. (2018). Pembelajaran fisika menggunakan model Argument Driven Inquiry (ADI) untuk melatih kemampuan argumentasi ilmiah peserta didik. *Inovasi Pendidikan Fisika (IPF)*, 07(02), 337–340.
- Ennis, R. (2011). Critical thinking: Reflection and perspective Part II. *Inquiry: Critical*

- thinking across the Disciplines*, 26(2), 5-19. doi:10.5840/inquiryctnews201126215.
- Facione, P. A. (2010). Critical thinking: What it is and why it counts. *Insight assessment*, 1-28.
- Fatmawati, Z. A., Susilowati, S. M. E., & Iswari, R. S. (2019). Effect of Argument Driven Inquiry (ADI) with problem solving method for student's argumentation and critical thinking skills. *Journal of Innovative Science Education*, 8(1), 500-508. doi:10.15294/jise.v0i0.21668.
- Froiland, J. M., & Worrell, F. C. (2016). Intrinsic motivation, learning goals, engagement, and achievement in a diverse high school. *Psychology in the Schools*, 53(3), 321-336. doi:10.1002/pits.21901.
- Gibson, C. (1995). Critical thinking: Implications for instruction. *Reference Quarterly*, 35(1), 27-35.
- Ginanjar, W. S. (2015). Penerapan model argument-driven inquiry dalam Pembelajaran IPA untuk meningkatkan kemampuan argumentasi ilmiah siswa SMP. *Jurnal Pengajaran MIPA*, 20(1), 32-37. doi:10.18269/jpmipa.v20i1.559.
- Greenwald, R. R., & Quitadamo, I. J. (2014). A mind of their own: Using inquiry-based teaching to build critical thinking skills and intellectual engagement in an undergraduate neuroanatomy course. *Journal of Undergraduate Neuroscience Education*, 12(2), A100-A106.
- Hadisi, L. (2014). Inkuiri: Sebuah strategi menuju pembelajaran bermakna. *Al-Ta'dib*, 7(2), 85-98. doi:10.31332/atdb.v7i2.319.
- Halder, S., Roy, A., & Chakraborty, P. K. (2017). The influence of personality traits on information seeking behaviour of students. *Malaysian Journal of Library & Information Science*, 15(1), 41-53.
- Hasnunidah, N., Susilo, H., Irawati, M. H., & Sutomo, H. (2015). Argument-driven inquiry with scaffolding as the development strategies of argumentation and critical thinking skills of students in Lampung, Indonesia. *American Journal of Educational Research*, 3(9), 1185-1192. doi:10.12691/education-3-9-20.
- Hidayat, W. (2017). Adversity quotient dan penalaran kreatif matematis siswa SMA dalam pembelajaran argument driven inquiry pada materi turunan fungsi. *Jurnal Pendidikan Matematika Kalamatika*, 2(1), 15-28. doi:10.29071/kalamatika.v2i1.50.
- Howard, L. W., Tang, T. L. P., & Austin, M. J. (2015). Teaching critical thinking skills: Ability, motivation, intervention, and the Pygmalion effect. *Journal of Business Ethics*, 128(1), 133-147. doi:10.1007/s10551-014-2084-0.
- Kadayifci, H., Atasoy, B., & Akkus, H. (2012). The correlation between the flaws students define in an argument and their creative and critical thinking abilities. *Procedia - Social and Behavioral Sciences*, 47(2012), 802-806. doi:10.1016/j.sbspro.2012.06.738.
- Kirmizi, F. S., Saygi, C., & Yurdakal, I. H. (2015). Determine the relationship between the disposition of critical thinking and the perception about problem solving skills. *Procedia-Social and Behavioral Sciences*, 191(June), 657-661. doi:10.1016/j.sbspro.2015.04.719
- Kurniasari, I. S., & Setyarsih, W. (2017). Penerapan model pembelajaran Argument Driven Inquiry (ADI) untuk melatih kemampuan argumentasi ilmiah siswa pada materi usaha dan energi. *Jurnal Inovasi Pendidikan Fisika (JIPF)*, 06(03), 171-174.
- Kwan, Y. W., & Wong, A. F. (2015). Effects of the constructivist learning environment on students' critical thinking ability: Cognitive and motivational variables

- as mediators. *International Journal of Educational Research*, 70(2015), 68-79. doi:10.1016/j.ijer.2015.02.006.
- Lowenthal, P. R., Muth, R., & Provenzo, E. F. (2009). *Constructivism: Encyclopedia of the social and cultural foundations of education* (Vol. 1). Thousand Oaks, CA: Sage Publications Inc.
- Marhamah, O. S., Nurlaelah, I., & Setiawati, I. (2017). Penerapan Model Argument-Driven Inquiry (ADI) dalam meningkatkan kemampuan berargumentasi siswa pada konsep pencemaran lingkungan di kelas X SMA Negeri 1 Ciawigebang. *Quagga: Jurnal Pendidikan dan Biologi*, 9(02), 45-52. doi:10.25134/quagga.v9i02.747.
- OECD. (2018). *PISA 2015: Results in focus*. Retrieved from <https://www.oecd.org/>.
- Rajagukguk, W., & Simanjuntak, E. (2015). Problem-based mathematics teaching kits integrated with ICT to improve students' critical thinking ability in junior high schools in Medan. *Jurnal Cakrawala Pendidikan*, 36(3), 347-356. doi:10.21831/cp.v3i3.7342.
- Ramos, A., & Verschueren, K. (2019). *School careers of high ability students in Flanders*. Retrieved from <https://lirias.kuleuven.be/retrieve/538960>.
- Riandi, Y. A. (2015). Peningkatan penguasaan konsep siswa melalui pembelajaran argument driven inquiry pada pembelajaran IPA Terpadu di SMP kelas VII. *EduSains*, 7(2), 114-120. doi:10.15408/es.v7i2.1578.
- Ricketts, J. C., & Rudd, R. (2004). Critical thinking skills of FFA leaders John C. Ricketts, University of Georgia Rick Rudd, University of Florida. *Journal of Southern Agricultural Education Research*, 54(1), 7-20.
- Saido, G. M., Siraj, S., Nordin, A. B. B., & Al_Amedy, O. S. (2018). Higher order thinking skills among secondary school students in science learning. *MOJES: Malaysian Online Journal of Educational Sciences*, 3(3), 13-20.
- Sampson, V., Enderle, P., Grooms, J., & Southerland, S. A. (2012). *Using laboratory activities that emphasize argumentation and argument to help high school students learn how to engage in scientific inquiry and understand the nature of scientific inquiry*. Paper presented at The Annual International Conference of the National Association for Research in Science Teaching (NARST) Indianapolis, ID (p. 11).
- Sampson, V., & Gleim, L. (2009). Argument-driven inquiry to promote the understanding of important concepts & practices in biology. *The American biology teacher*, 71(8), 465-473. doi:10.1662/005.071.0805.
- Sampson, V., Grooms, J., & Walker, J. P. (2010). Argument-Driven Inquiry as a way to help students learn how to participate in scientific argumentation and craft written arguments: *An exploratory study*. *Science Education*, 95(2), 217-257. doi:10.1002/sce.20421.
- Sudarsana, I. K. (2018). Optimalisasi penggunaan teknologi dalam implementasi kurikulum di sekolah (Persepektif teori konstruktivisme). *Cetta: Jurnal Ilmu Pendidikan*, 1(1), 8-15.
- Sukmawati, I., Ramadani, S. D., Fauzi, A., & Corebima, A. D. (2015). *Perbedaan pemberdayaan retensi antara siswa SMA akademik rendah dan tinggi melalui pembelajaran cooperative script dalam pembelajaran biologi*. In Proceedings of the 2nd Seminar & Workshop Nasional Biologi, IPA, dan Pembelajarannya FMIPA UM (pp. 662-667).
- Sulistiana, S., Sriyono, S., & Nurhidayati. (2013). Pengaruh gender, gaya belajar, dan reinforcement guru terhadap prestasi belajar fisika siswa kelas XI SMA Negeri se-Kabupaten Purworejo tahun pelajaran 2012/2013. *Radiasi*, 3(2), 102-106.

- Sulistiyawati, S., & Andriani, C. (2017). Kemampuan berpikir kritis dan hasil belajar biologi berdasarkan perbedaan gender siswa. *WACANA AKADEMIKA: Majalah Ilmiah Kependidikan*, 1(2), 127-142. doi:10.30738/wa.v1i2.1289.
- Sugihartono, F. K., Harahap, F., Setiawati, F. A., & Nurhayati, S. (2007). *Psikologi Pendidikan*. Yogyakarta: UNY Press.
- Sunarto, M. D., Budayasa, I. K., & Juniati, D. (2017). Profil proses berpikir mahasiswa tipe kepribadian sensing dalam pemecahan masalah logika matematika. *Cakrawala Pendidikan*, 36(2), 299-308. doi:10.21831/cp.v36i2.13119.
- Van der Stel, M., & Veenman, M. V. (2008). Relation between intellectual ability and metacognitive skillfulness as predictors of learning performance of young students performing tasks in different domains. *Learning and Individual Differences*, 18(1), 128-134. doi:10.1016/j.lindif.2007.08.003.
- Yahaya, A. (2003). Factors contributing towards excellence academic performance. *Journal of Science & Mathematics Education*, 1-11. Retrieved from <https://core.ac.uk/>.
- Zohar, A., & Dori, Y. J. (2003). Higher order thinking skills and low-achieving students: Are they mutually exclusive? *The journal of the learning sciences*, 12(2), 145-181. doi:10.1207/S15327809JLS1202_1.