THE EFFECT OF ARGUMENT-DRIVEN INQUIRY (ADI) LEARNING MODEL ON STUDENTS' MATHEMATICAL CRITICAL THINKING SKILLS

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Abstract
This research was carried out with the aim of finding out the effect of the Argument-Driven Inquiry Learning Model on students' mathematical thinking abilities at TUNAS KARYA Batang Kuis Middle School for the 2023/2024 academic year. This research method is quantitative and the type of research is Quasi Experimental with the research design being Pretest-Posttest-Only Control Design. The data analysis technique in this research uses analysis prerequisite tests, namely: 1) Normality test, the results of the normality test produce a sig value. from the Pretest and Posttest data for the experimental and control classes is greater than 0.05, so the data is normally distributed, 2) Homogeneity test, the results of the homogeneity test for the Posttest data for the experimental class and control class are 0.479 and the sig. is greater than 0.05, then the variance of the two groups is homogeneous. 3) Hypothesis testing using the t test, the results of the t test show that the significant value (2 tailed) = 0.001 < 0.05. The significant value of the data is smaller than 0.05, so H0 is rejected. So it can be concluded that there is an influence of the Argument-Driven Inquiry learning model on students' mathematical critical thinking abilities.

Keywords: Argument –Driven Inquiry, Critical thinking skills, Learning Model.

INTRODUCTION
Mathematics is an exact science that is influential in everyday life and is a science whose truth is undoubted (Habibie, Rochmad, & Isnarto, 2022). In its essence, mathematics is abstract so that some students consider mathematics to be a difficult, boring, and especially frightening subject (Shopi, Mujib, Pratiwi, & Mardiyah, 2023). From the perceptions of these students, it causes students' learning outcomes in mathematics subjects to be low. Therefore, efforts must be made by educators to make students have the ability not to have such perceptions anymore towards learning mathematics. One of the abilities to get students to solve problems in learning mathematics is with their mathematical critical thinking.

According to Ennis, critical thinking is a reflective thinking process that focuses on deciding what to believe or do (Susanto, 2016, hal. 3). In other definitions such as Emily's critical thinking includes components of skills to analyze arguments, make conclusions using inductive or deductive reasoning, assessment or evaluation, and make decisions or solve problems (Zakiah & Lestari, 2019, hal. 3). Critical thinking is high-level thinking in the process of making a decision to be able to solve problems by thinking seriously, actively, and thoroughly in analyzing all information received by including rational reasons.

Critical thinking in mathematics is defined by Glazer as the ability to use knowledge, reasoning, and cognitive strategies to conclude, prove, and evaluate unfamiliar mathematical situations reflectively. From this statement, it is known that problem situations that can trigger the emergence of critical
thinking skills are unfamiliar or non-routine situations. Critical thinking skills are one of the goals of learning mathematics.

There are several studies that we can see to see the level of critical thinking skills of students and learning outcomes of Indonesian students, namely through the Trends International Mathematic and Science Study (TIMSS) research and several other studies. Indonesian students are considered unable to make judgments and make decisions based on reasoning (OECD, 2019). Students' ability to make judgments and make decisions based on reasoning are some of the indicators of critical thinking skills.

As in the research conducted by (Sumantri D., 2017) The results of preliminary research show that students' mathematical critical thinking skills are still low. The average mathematical critical thinking ability of students is only 25.12 with indicators of formulating alternative solutions, formulating questions, identifying possible answer criteria, making problem solving steps, organizing strategies and tactics, and making conclusions.

Based on the results of observations made by researchers to the school to be studied, namely at SMP TUNAS KARYA Batang Kuis, it shows that the learning process carried out in learning mathematics at the school is less effective in improving students' mathematical critical thinking skills there. The learning process carried out by mathematics teachers there is still using conventional models such as material explanation, assignment, discussion and question and answer. This causes students' critical thinking skills at the school to be low.

Efforts that can be made in optimizing mathematical critical thinking skills are through the application of learning models that increase student activeness (Rosyidah, Susilo, & Suwono, 2023). The learning model is the entire series of teaching material presentations that include all aspects before and after learning by the teacher as well as all related facilities used directly or indirectly in the teaching and learning process (Akhiruddin, Sujarwo, Atmowardoyo, & Nurhikmah, 2019, hal. 104). According to Kemp 1998 (Sumantri, 2015, hal. 40), defined that a learning model is a learning activity that teachers and students must do so that learning objectives can be achieved effectively and efficiently.

One of the learning models that can be applied is the Argument-Driven Inquiry (ADI) learning model. (Shopi, Mujib, Pratiwi, & Mardiyah, 2023). ADI learning facilitates learners to actively engage in argumentative activities (Afgani, Hasunidah, & Subakti, 2020). The steps in ADI learning are identifying problems, collecting data, making tentative arguments, and argumentation sessions (Arfiany, Ramlawati, & Yunus, 2021). With the production of tentative arguments and argumentation sessions, students are required to find their ideas and express them clearly and in detail so that students will be better at understanding the concepts in the material being taught and can then improve mathematical critical thinking skills.

Argument-Driven Inquiry (ADI) is a learning model that combines or combines argumentation skills with an inquiry learning model. Argument-Driven Inquiry is made so that students have an opportunity to conduct scientific investigation or identification that can train students in improving critical thinking skills and argumentation. The syntax in the ADI learning model is: (1) problem identification; (2) collecting data; (3) making tentative arguments; (4) argumentation session; (5) explicit reflective discussion; (6) making an investigation report; (7) double blind review; and (8) report review based on the results of the review (Fakhriyah & et al, 2021).

The ADI learning model can make learners claim something either an opinion or theory put forward by someone, with strong evidence. The ADI learning model can train learners to argue with an emphasis on proof and a strong basis. The ADI learning model has its components, namely data, claims, justification, support, and refutation. (fadly, 2022, hal. 1). Argument-Driven Inquiry originates from constructivist theory and is expected to improve reasoning skills through practical activity-based inquiry through group work. Argument-Driven Inquiry provides opportunities for students to develop a scientific approach aimed at collecting data, designing and conducting investigations, using the data obtained to answer research questions and peer review. (Walker & Sampson, 2021).
Efforts to optimize the effectiveness of Mathematics learning can be done by learning that integrates an activity related to investigation with the delivery of theory in the classroom that emphasizes critical thinking skills, so that students are expected to be able to develop their critical thinking skills. This effort can be done by applying the ADI learning model, where the ADI learning model is a learning model oriented to emphasize students to be actively involved in argumentation activities and will emphasize students’ critical thinking skills. (Tajudin, Hasnunidah, & Subakti, 2020). Based on this description, it is necessary to conduct research with the aim of knowing the effect of critical thinking skills on students through the Argument-Driven Inquiry (ADI) model on the school to be studied because no one has ever applied the Argument-Driven Inquiry (ADI) learning model at the school. The hypothesis in this study is: There is an effect of the Argument-Driven Inquiry learning model on students' mathematical critical thinking skills.

Based on this, the researcher is interested in conducting a study entitled “The Effect of Argument Driven Inquiry (ADI) Learning Model on Students’ Mathematical Critical Thinking Ability”.

**METHOD**

This study uses quantitative research methods that are very strong to measure cause and effect (Prasetyo, 2008, hal. 158). Quantitative research is a study that produces data in the form of numbers from test results(Sugiyono, 2019). The type of research used in this study is Quasi Experiment. The type of Quasi Experiment research is a research method that in its implementation does not use random assignment (random assignment) but by using groups that already exist. (Hastjarjo, 2019). Researchers used this Quasi Experiment method because the samples used were ordinary classes without changing the existing structure. The use of this quasi-experimental method is based on the consideration that in the implementation of this research learning takes place naturally, and students do not feel experimented on, so that this situation is expected to contribute to the level of validity of the research.

The research design used in this study was Pretest-Posttest-Only Control Design (Marfani, Fatmawati, & Primawati, 2017). The two classes selected for the research were given pretest questions before learning to see how the students' initial abilities were and gave a posttest after learning to measure students' mathematical critical thinking skills after learning. The results of the pretest and posttest were then processed and analyzed for hypothesis testing. The following is a table of research design on the effect of ADI learning strategy on students' mathematical critical thinking skills.

<table>
<thead>
<tr>
<th>Class</th>
<th>Treatment</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>A</td>
<td>H1</td>
<td>H2</td>
</tr>
<tr>
<td>Control</td>
<td>B</td>
<td>H3</td>
<td>H4</td>
</tr>
</tbody>
</table>

Keterangan:
A : Experimental class treatment taught with the ADI model.
B : Treatment of control classes taught with conventional models.
H1 : Pretest (experiment class)
H2 : Posttest (experiment class)
H3 : Pretest (class control)
H4 : Posttest (class control)
This research was conducted at SMP TUNAS KARYA Batang Kuis, in class VII even semester 2023/2024 which is located at Jl. Batang Kuis, Tj. Sari, Kec. Batang Kuis, Deli Serdang Regency, North Sumatra. This research was conducted in April 2024.

The population in this study were all seventh grade students of SMP TUNAS KARYA Batang Kuis who were registered in the even semester of 2023/2024 consisting of 2 classes. The sampling technique uses Total Sampling, namely where part of all the population is made as a sample in the study (Sugiyono 2020). In this study using 2 classes, namely class VII 1 totaling 25 students and class VII 2 totaling 23 students. For class VII 1 as an experimental class, namely a class conducted using the ADI learning model and class VII 2 as a control class as a class using a conventional learning model.

This research goes through several stages in its implementation which include: 1) Initial Stages; This stage begins with determining the sample and choosing which class will be used as a control class and experimental class. Then, it continues to the stage of preparing instruments in the form of essay-shaped questions for pretest and posttest. However, before entering the implementation, the question goes through several processes first such as validity tests and reliability tests. 2) Implementation Stage; This stage begins with giving pretests to students to see the initial ability of students before carrying out the learning process. After giving the pretest then enter the stage of implementing mathematics learning by applying the Argument-Driven Inquiry (ADI) model in the experimental class using the steps that have been made and conducting learning in the control class with a conventional model where these two classes are used to measure students' mathematical critical thinking skills. After that, the researcher conducted a posttest in the control class and experimental class to determine the output / learning outcomes of students after treatment Data Analysis Stage: At this stage, the output (posttest) of the two classes is analyzed so that differences between the two classes can be seen. After that, conclusions can be made on the results of the analysis.

The research instrument used in this study was a test in the form of an objective essay type of 5 items. The aspects measured are students' mathematical critical thinking skills. This aims to determine whether or not there is an effect of the Argument-Driven Inquiry learning model on students' mathematical critical thinking skills.

The data analysis technique in this study uses quantitative data with prerequisite analysis tests which include: a) Normality test. Normality test is used to determine whether the data is normally distributed or not, b) Homogeneity test. Homogeneity test is done to see whether the data is homogeneous or not, c) Hypothesis testing. Hypothesis testing is done using the t test because the data is normally distributed.

A statistical hypothesis is a statement that can be tested statistically regarding the relationship between two or more research variables. Statistical hypotheses have two forms, namely, alternative hypothesis ($H_1$) and null hypothesis ($H_0$).

$H_0$: $a_1 > a_2$ (there is no effect of Argument-Driven Inquiry (ADI) learning model on mathematical critical thinking ability of TUNAS KARYA Batang Kuis Junior High School students.

$H_a$: $a_1 \leq a_2$ (there is an effect of the Argument-Driven Inquiry (ADI) learning model on the mathematical critical thinking ability of TUNAS KARYA Batang Kuis junior high school students.

The data analysis carried out in this study was the two mean difference test. Data analysis was carried out using the Statistical Package for the Social Science (SPSS)24 application.

RESULT AND DISCUSSION

Result

Test Validity Results
The results of the instrument trials in this study were calculated using Microsoft Excel software to test the validity. The number of questions given to students amounted to 5 essay questions and were given to class VIII students totaling 28 students.
Table 2. Test Validity

<table>
<thead>
<tr>
<th>No</th>
<th>r_{xy}</th>
<th>t_{count}</th>
<th>t_{table}</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.62714</td>
<td>4.10553</td>
<td>1.706</td>
<td>Valid</td>
</tr>
<tr>
<td>2</td>
<td>0.59149</td>
<td>3.74055</td>
<td>1.706</td>
<td>Valid</td>
</tr>
<tr>
<td>3</td>
<td>0.62249</td>
<td>4.05568</td>
<td>1.706</td>
<td>Valid</td>
</tr>
<tr>
<td>4</td>
<td>0.77016</td>
<td>6.15664</td>
<td>1.706</td>
<td>Valid</td>
</tr>
<tr>
<td>5</td>
<td>0.74502</td>
<td>5.69503</td>
<td>1.706</td>
<td>Valid</td>
</tr>
</tbody>
</table>

From the results of the table above, it is known that all the items used as research instruments are declared valid so that the test questions can be used as research instruments in this study.

Test Reliability Results

The results of the reliability test are used to see whether the elements in the question are reliable or not. In this study, the reliability test used Microsoft Excel software where if Cronbach Alpha > the significance level where the significance level used is 0.05 then the data is reliable.

Table 3. Test Reliability

<table>
<thead>
<tr>
<th>Reliability Score</th>
<th>Reliability Coefficient Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.697</td>
<td>0.60 &lt; r_{11} &lt; 80</td>
<td>High</td>
</tr>
</tbody>
</table>

From the results of the table above, it is known that r_{11} = 0.697 dan r_{table} = 0.373. It is known that r_{11} > r_{table} then the research instrument is reliable and categorized into high reliability.

Prerequisite Test Analysis

1. Pretest and Posttest Data Analysis

This study was conducted by giving a pretest to students which is the first step taken in this study before an application or treatment is carried out in the learning process. After being given treatment in the learning process, students will be given a posttest question which is to determine the student's final ability.

Table 4. Pretest Descriptive Analysis Data

<table>
<thead>
<tr>
<th>Class</th>
<th>Minimum Values</th>
<th>Maximum Values</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>Varians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>15</td>
<td>65</td>
<td>37.20</td>
<td>35</td>
<td>35</td>
<td>15,489</td>
</tr>
<tr>
<td>Control</td>
<td>10</td>
<td>60</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>13,568</td>
</tr>
</tbody>
</table>

Table 5. Posttest Descriptive Analysis Data

<table>
<thead>
<tr>
<th>Class</th>
<th>Minimum Values</th>
<th>Maximum Values</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>Varians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>25</td>
<td>95</td>
<td>61.20</td>
<td>60</td>
<td>70</td>
<td>427,667</td>
</tr>
<tr>
<td>Control</td>
<td>10</td>
<td>80</td>
<td>40.65</td>
<td>35</td>
<td>30</td>
<td>339,328</td>
</tr>
</tbody>
</table>

From the two tables above, it can be seen that the results of students' pretest and posttest scores are different. It can be seen that the average pretest score of experimental class students is 37.20 and the average posttest score of experimental class students is 61.20. From these results, there is a significant increase in the ability of experimental class students because of the application of the Argument-Driven Inquiry (ADI) learning model in the class. The results of the average pretest and posttest scores of control class students also increased, namely the Pretest score of 30 and the Posttest score of 40.65. The results of the increase were not as significant as those in the experimental class. The average posttest score of experimental and control class students experienced a difference where the average value of experimental students was higher than control class students. From the results of the average
value, it can be concluded that there is an effect of the Argument-Driven Inquiry learning model on students' mathematical thinking skills to increase after treatment.

2. Normality Test
The normality test is carried out to determine whether the data from each group used in the study is normally distributed or not. In this study, it was carried out with the Shapiro Wilk test.

<table>
<thead>
<tr>
<th>Table 6. Pretest Normality Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Experiment Class</td>
</tr>
<tr>
<td>Control Class</td>
</tr>
</tbody>
</table>

Based on the data in the table above, it can be seen that the normality test results for the pretest scores of experimental and control class students with a significant value of the experimental class are 0.246 and the significant value of the control class is 0.207. The significant value of the two data is greater than the significance level of 0.05, so H0 is accepted so that the pretest data of the experimental class and control class are normally distributed.

<table>
<thead>
<tr>
<th>Table 7 Posttest Normality Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Experiment Class</td>
</tr>
<tr>
<td>Control Class</td>
</tr>
</tbody>
</table>

From the results of the posttest data above, it can be seen that the significant value of the experimental class is 0.231 and the significant value of the control class is 0.522. Because the results of the significant value of the two data are greater than the significance value of 0.05, H0 is accepted and the data is normally distributed.

3. Homogeneity Test
Based on the results of the normality test that the data from the students' Posttest scores are normally distributed, the homogeneity test will be carried out to determine whether the data comes from a homogeneous group or not.

<table>
<thead>
<tr>
<th>Table 8. Posttest Homogeneity Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levene Statistic</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>0.510</td>
</tr>
</tbody>
</table>

From these results it is known that the significant value of the homogeneity test results of the two classes is 0.479. The resulting significant value is greater than 0.05, so it can be seen that H0 is accepted and means that the variance of the two class groups is homogeneous.
Table 9. Mathematical Critical Thinking Ability t-test

<table>
<thead>
<tr>
<th>Student Test Result</th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal variances assumed</td>
<td>F = .510, Sig. = .479</td>
<td>t(46) = 3.623, df = 46, Sig. (2-tailed) = .001</td>
<td>Mean Difference = 20.548, Std. Error Difference = 5.672</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>F = 3.640, Sig. = .001</td>
<td>t(57) = 45.9, df = 57, Sig. (2-tailed) = .001</td>
<td>Mean Difference = 20.548, Std. Error Difference = 5.644</td>
</tr>
</tbody>
</table>

From the data results above, it can be seen in the Equal Variances assumed column that the t value = 3.623, df = 46 and the significant value (2 tailed) = 0.001 <0.05. The significant value of the data is smaller than 0.05, so H₀ is rejected, So the proposed hypothesis is tested with data, and it can be concluded that there is an effect of Argument-Driven Inquiry learning model on students' mathematical critical thinking skills.

Discussion

The results of the research that has been done show that there is an influence on the application of the ADI learning model on students' mathematical critical thinking skills. The same thing also happened in the research results (Dani, Aulia, Mujib, Pratiw, & Mardiyah, 2023) that the ADI learning model can improve students' creative thinking skills better than the expository learning model. Based on what has been done in this study is to use 8 syntaxes in accordance with the components in the Argument-Driven Inquiry (ADI) learning model. In the steps or syntax of learning, it is used to direct students to think critically in solving a problem to be able to understand the material studied, namely about social arithmetic. Students are directed to complete tasks by working together that have been directed through the LKS provided.

The results of the study have shown that the mathematical critical thinking ability of experimental class students is higher than the control class, it can be seen from the 4 indicators that become this study in accordance with the indicators in critical thinking ability including: Explaining reasons related to problems, formulating questions, analyzing arguments, and making conclusions. The ADI learning model has an influence on students' mathematical critical thinking skills.

CONCLUSIONS AND SUGGESTIONS

Based on the research results that have been obtained, it can be concluded that the mathematics learning process with the application of the Argument-Driven Inquiry (ADI) learning model is in accordance with students' mathematical critical thinking skills so that students' abilities have increased. The learning process is carried out using the syntax in the norms of the ADI learning model and in accordance with existing indicators in critical thinking skills such as explaining reasons related to problems, formulating questions, analyzing arguments, and making conclusions. Critical thinking
skills are also taught to control class students and the average score produced by control class students is quite low compared to experimental class students.

From the conclusion of the research results above, as a form of improvement for the world of education, especially in learning in the future and related to the mindset of students and a form of attention to teachers, there are some suggestions that the authors can give are as follows: a) For schools, the results of this study can be used as input for schools in making policies as an effort to improve the quality of education, especially in mathematics lessons; b) For teachers, in carrying out the learning process, a teacher should conduct innovative learning according to the learning style and ability of students so that learning is more interesting for students and makes students motivated in the learning process; c) For students, it is hoped that in the application of the ADI learning model students can continue to follow the lessons actively to increase creativity, and have responsibility in learning; d) For researchers, because there are some limitations in the implementation of this study, researchers who want to do further and serve as comparative material in further research.

REFERENCE


