Paedagoria : Jurnal Kajian, Penelitian dan Pengembangan Kependidikan
http://journal.ummat.ac.id/index.php/paedagoria
Prefix DOI: 10.31764

ISSN 2086-6356 (Print)
ISSN 2614-3674 (Online)
Vol. 16, No. 2, April 2025, Hal. 243-248

ARGUMENT-DRIVEN INQUIRY LEARNING MODEL ON STUDENTS` ABILITY TO SCIENTIFIC ARGUMENTATION SKILLS ABOUT REACTION RATE MATERIAL

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INFO ARTIKEL

Riwayat Artikel:

Diterima: 11-02-2025
Disetujui: 04-04-2025

Kata Kunci:

Argument Driven Inquiry; Scientific Argumentation Skills; Reaction Rate

ABSTRAK

Abstrak: Program pendidikan saat ini dirancang untuk membangun kompetensi abad ke-21, dengan salah satu pendekatannya adalah pelatihan keterampilan argumentasi untuk mempertajam kemampuan berpikir kritis. Tujuan dari penelitian ini adalah untuk mengetahui bagaimana model pembelajaran *Argument-Driven Inquiry* (ADI) memengaruhi kemampuan siswa dalam membuat argumen. Penelitian ini menggunakan desain eksperimen semu dengan tipe *static group comparison design*. Hasil uji *independent t-test* menunjukan nilai sig. sebesar 0,001 lebih kecil dari 0,05 yang mengindikasikan adanya perbedaan signifikan antara rata-rata hasil test argumentasi pada kelas eksperimen dan kelas kontrol. Temuan tersebut menunjukan bahwa model pembelajaran ADI secara signifikan memengaruhi kemampuan argumentasi siswa pada materi laju reaksi.

Abstract: *The current education program is designed to develop 21st-century skills, with one approach being the training of argumentation skills to sharpen critical thingking skills. The purpose of this research is to find out how the Argument-Driven Inquiry (ADI) learning model affects students ability to make arguments. This research uses a quasi experimental design with a static group comparison design type. The results of the independent t-test showed a sig. value of 0.001 smaller than 0.05 which indicated a significant difference between the average argumentation test result in the experimental and control classes. These findings indicate that the ADI learning model significantly impacts students argumentation skills.*

A. INTRODUCTION

In the 21st century, learning is designed with various skills to create globally competitive student. These 21st century skills include critical thinking and problem-solving skills, communication and collaboration skills, creation and renewal skills, and information and communication technology literacy skills (Prastika et al., 2024). According to Romero Ariza et al. (2024), critical thinking skills are a key competency in the 21st century. One of the contribution in supporting the improvement of critical thinking is training to argue. Effective argumentation skills are a core component of critical thinking and involve student making arguments about agreeing and disagreeing based on evidence and supporting reasons (Cahyani et al., 2024).

Initial research at SMA Negeri 5 Samarinda showed that students had low argumentation skills in chemistry. This is due to a lack of understanding of chemical concepts, low learning motivation, and less engaging media and teaching materials (Ramadhan et al., 2022 and Wahidah et al., 2024). According to Viyanti et al. (2016), argumentation is an important tool in learning because it can help develop students critical thinking and conceptual understanding. This research is important to address the problem of low students argumentation skills, which affects their understanding of chemistry concepts at SMA Negeri 5 Samarinda.

Instead of traditional methods, the Arguments Driven Inquiry (ADI) model can be used to develop students scientific argumentation skills (Hadiwidodo et al., 2017). According to Admoko et al. (2021), the ADI learning model is a laboratory-based learning model designed to encourage students to engage in experiments and scientific argumentation. The main focus of ADI learning model is the active participation of students in constructing and

validating knowledge through the investigation process. According to Grooms et al. (2016), the syntax of the ADI learning model are : identifying a task and guiding question, designing methods and collecting data, analysing data and developing a tentative argument, argumentation session, explicit and reflective discussion, writing an investigative report, double-blind peer review, and revising the report.

In recent years, many studies have examined the impact of the Argument Driven Inquiry (ADI) learning model on studies argumentation skills in chemistry learning. Most of these studies have focused on other chemistry topics, such as colloids and heat. However, only a few studies have addressed the topic of reaction rate. For example, sari's research (Sari et al., 2021) shows that the ADI model can improve students argumentation skills on temperature and heat material. Meanwhile, putri's research (Putri et al., 2020) examined the effectiveness of the ADI model in improving argumentation skills on the topic of reaction rates, but did not discuss in depth the indicators of argumentation skills involved. Therefore, this study aims to fill this gap by focusing on reaction rate as the main topic learning. Learning about reaction rates requires the ability to think critically, analyse, and process data, which are important steps to improve students argumentation skills. The purpose of this study was to determine the Argument-Driven Inquiry (ADI) learning model affects students' ability in argumentation skills with the learning topic of reaction rate.

B. RESEARCH METHOD

This research was conducted at SMA Negeri 5 Samarinda in the 2024/2025 academic year, focusing on the subject of reaction rate. This study employed a quasi-experimental design with a static group comparison design (Nurfadhilah et al., 2024). The population in this study was all eleventh-grade students at SMA Negeri 5 Samarinda, consisting of 10 classes in the second semester of the 2024/2025 academic year. Classes XI-2 and XI-3 were chosen s the sample. Class XI-2 was designated as the experimental group and received the treatment, whereas class XI-3 served as the control group and did not receive the treatment. The sampling technique used in this study was purposive sampling. Data was collected using a test consisting of five essay questions contructed based on argumentation skills indicators of argumentation skills include claim, evidence, reasoning, backing, and rebuttal. The assessment of argumentation skills is analysed for each indicator based on the percentage score obtained divided by the maximum percentage score. The result of the percentage assessment of argumentation skills are categorized in the Table 1.

Table 1 Guidelines of argumentation skills level categories

Average score (%)	Category
$80 < x \leq 100$	Very High
$60 < x \leq 80$	High
$40 < x \leq 60$	Moderate
$20 < x \leq 40$	Low
$0 < x \leq 20$	Very Low

The data analysis technique in this studi used normality test, homogeneity test, and hypothesis test to see the difference between the experimental class that was treated with ADI learning model and the control class that learned with direct instruction learning model using practicum method.

C. RESULT AND DISCUSSION

Grade XI students at SMA Negeri 5 Samarinda demonstrated relatively weak argumentation skills, as evidenced by their average score of 28 out of 100 on an initial argumentation skills test. After determining the class sample, the researcher conducted an analysis to prove that the two classes had the same initial ability by using an independent t-test which resulted in a significance value of 0.464 > 0.05, indicating no significant difference.

Both classes were then given treatmen for three meetings. Post-treatment, a test evaluating students argumentation skills regarding reaction rates revealed a significant difference between classes. The experimental class averaged 74.7, while the control class averaged 61.8. Before performing an independent t-test, the data must be tested for normality and homogeneity. The normality test result, showing a significance level of 0.072, indicated that the data met the assumption of normal distribution. Furthermore, the homogeneity test was carried out which resulted in a sig. value of 0.236 indicating that the data had a homogeneous variance. After all prerequisite tests were met, an independent t-test was conducted for the test results

of the two classes. The independent samples t-test results demonstrated a statistically significant difference in mean argumentation test score between the experimental group (ADI learning model) and the control group. The obtained sig. value (2-tailed) of 0.001 was less than the alpha level of 0.05. This finding provides strong evidence for the positive influence of the ADI learning model on students argumentation abilities.

In this study, the average score of students argumentation skills using the ADI model was higher than that of students using the direct instruction model. Fitriana & Yuberti (2019) and Zuhaida (2018), stated that the practicum method can improve concept understanding because it helps students understand learning materials. In the syntax of the ADI learning model, there are experimental activities at the stage of designing and collecting data. Although both the experimental and control classes were instructed using an experimental learning methodology, the experimental class demonstrated superior performance, as evidenced by a higher average score. One of the reasons is that the use of the ADI model involves students in building and exploring their own knowledge by determining data collection method, analysing data, expressing findings, and giving opinions on other students findings. In addition, the ADI model allows students to engage in argument making, group discussion, and report writing and revision, which can help students discover the concept of reaction rate material. This research is line with the findings of Bukifan & Yuliati (2021), Dianti et al. (2023), and Salsabila et al. (2019) which concluded that the ADI model is conducive to the development of a deeper understanding of subject matter content.

Table 2 Recapitulation of student` improvement in scientific argumentation skill for each indicator

Indicators	**Posttest Average (%)**	
	Control class	**Experimental class**
Claim	65.8	81.6
Evidence	53.5	72.8
Reasoning	52.6	61.4
Backing	43.0	55.2
Rebuttal	36.8	49.1
Average	**50.34**	**64.02**

As shown in Table 2, a clear difference in scientific argumentation emerged. The treated experimental class reached 64.02% (high category), while the control class only reached 50.34% (medium category). The percentages analysis of each indicator in Table 2 shows that students who participated in learning with the ADI model have a fairly good ability to construct scientific arguments about reaction rates. This is indicated by the achievement of the 'very high' category on the claim indicator and the 'high' category on the evidence, reasoning, and backing indicator. However, the rebuttal indicator still requires more attention as it is still on the 'moderate' category. Thus, it can be seen that some students still have difficulty in providing rebuttals when making argument. This is in line with research (Agusni et al., 2023; Hardini & Alberida, 2022; Olii et al., 2025) which states that in the rebuttal indicator, only a small proportion of students are able to provide responses correctly.

The ADI learning model consist of eight syntaxes, namely problem identification, design and data collaction, data analysis and tentative argument generation, argumentation sessions, explicit and reflective discussions, report writing, double blind peer review, and report revision. According to Nurhidayati et al. (2023) each syntax in the ADI learning model can train argumentation skills. The problem identification stage is the initial stage of the core learning activities. At this stage, students are reminded of chemical reaction material and given guiding questions about the reaction rate. Students then make hypotheses based on the questions given, which supports the practice of claim indicators because the hypothesis is an initial claim that needs to be proven correct.

The design and data collection stage trains students to strengthen claims by producing evidence. At this stage, students are directed to design experimental procedures and conduct experiments on factor that affect the reaction rate to ensure the correctness of the formulated hypothesis. This activity helps students collect data that can be used as evidence to support claims, thus developing argumentation skills in the evidence aspect. At the stage of making tentative argument, students analyse the data obtained previously. Students then compose arguments based on an argumentation scheme consisting of claims, evidence, and reasons. Claims contain simple statements of experimental results, data contain facts from experiments, and

reasons contain opinions that support data to strengthen claims. The syntax of making tentative arguments supports students to discuss in groups, make simple arguments, thus supporting argumentation skills such as making simple conclusions (claims), providing evidence to support claims (evidence), and providing rational reasons that the evidence provided is accurate and connect claims and data (reasoning).

The argumentation session is the stage where the result of the arguments that have been made by each group are presented. In this session, groups that are not presenting can provide input suggestions and rebuttals to the arguments presented. Students can express rebuttals and improve their arguments if there are deficiencies in the results of the argumentation. The existence of this argumentation session allows students to practice communication skills and compose good arguments (Susanti et al., 2016). Through this stage, students argumentation skills can improve, especially in the ability to provide reasoning, backing, and rebuttal.

The next stage is making an experiment report. Students are directed to make a report based on the results of data analysis from each group and the results of the argumentation abtained during the argumentation session. The report is made in accordance with the directions and instructions on the students worksheet and students are instructed to continue making report at home. This stage of report writing provides an opportunity for students to express their findings, idea, and arguments that have been obtained during learning, thus strengthening their understanding of concepts and improving their writing skills (Wulandari et al., 2021). After report generation, students review the inquiry report written by other groups and decide whether to revise the reports based on the criteria provided by the teacher. This double-blind peer review satge helps develop students skills in the rebuttal aspect because they are given the opportunity to provide comments or oponions on reports that are considered less precise (Monica et al., 2018). Students also revise their experimental reports based on the results of peer review.

The last stage in the learning with the ADI model is explicit and reflective discussion. At this stage, teachers and students discuss the reaction rate material and the experimental process that has been carried out explicitly. In addition, students can re-explain the material that has been obtained during the learning process. Aspect of argumentation skills that can be improved at this stage include the claim indicator, where students answer simple questions from the teacher and provide reinforcement with evidence. Furthermore, the backing and rebuttal indicators are also improved by providing supporting opinions and rebuttals that are in accordance with the questions asked by the teacher. The foregoing explanation supports the conclusion that each phase of the ADI learning process plays a role in enhancing specific facets of students argumentation proficiency. This is in line with research conducted by Fatmawati et al. (2019), Fuadah et al. (2021), and Satriya & Atun (2024), which state that the use of the ADI learning model can be an effective alternative to improve.

D. CONCLUSIONS AND SUGGESTIONS

The analysis and discussion of the data lead to the conclusion that the Argument-Driven Inquiry (ADI) learning model has a demonstrable effect on the development of students scientific argumentation skills when studying reaction rate. This is evidenced by the results of the independent t-test on posttest data which shows a sig. Value 0.001 < 0.05, which strengthens the conclusion that the ADI learning model has a significant effect on students argumentation skills. Future researchers are advised to conduct research using the ADI model on other chemistry subject so that it can be known whether the ADI model can be applied universally or only on certain subjects. In addition, researchers can also combine the ADI model with other learning methods or strategies, such as debate-based learning.

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