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THE EFFECT OF THE ARGUMENT DRIVEN INQUIRY (ADI) MODEL ON STUDENTS' ARGUMENTATION SKILLS IN SCIENCE LEARNING

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Abstract

This study aims to analyze the effectiveness of the Argument Driven Inquiry (ADI) learning model in improving students' argumentation skills in science learning. The method used is a systematic literature review (SLR) with reference to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The review process was carried out through four stages, namely identification, screening, eligibility determination, and inclusion, so that relevant articles were published in the range of 2018 to 2025. The results of the study show that the ADI model is consistently able to improve students' skills in building data-based arguments, evaluating peer arguments, and reflecting on conceptual understanding. Compared to conventional learning and regular inquiry models, ADI has proven to be more effective because it integrates scientific practice, collaboration, and critical thinking skills. A number of studies have also reported a significant increase in posttest results and are inclusive of students with different academic abilities. Thus, the ADI model can be used as an effective learning strategy in supporting the mastery of science concepts as well as the development of 21st-century competencies, including critical thinking, creativity, problem-solving, and communication.

Keywords: Argument Driven Inquiry (ADI) Model, Scientific Argumentation, and Argumentation,

Introduction

The advancement of science and technology in the 21st century has had a profound impact on human life. The development of science and technology encourages humans to develop their personal abilities and qualities. The main goal of 21st-century education is to equip students with essential competencies that enable them to cope with the dynamics and challenges of the modern world. Ideally, the educational framework in this era focuses on the development of six key skills: critical thinking, collaboration/cooperation, communication, creativity, culture, and connectivity (Anugerahwati, 2019). Communication skills occupy a very important position because they are the foundation for students to convey, exchange, and develop ideas effectively. The most essential communication ability in science learning is scientific argumentation (Zahara et al., 2018). In accordance with the demands of today's times, the government designs learning that is able to improve the quality of education through curriculum development, the 21st century curriculum needs to adapt to the diverse needs of students, while encouraging creativity, critical thinking, cooperative skills, problem-solving, digital literacy, and the ability to adapt to rapid change(Lubis et al., 2023).

The Independent Curriculum places the ability to think creatively and critically reason as one of the main competencies in the dimension of the Pancasila Student Profile. The application of scientific arguments in science learning is in line with this orientation because it encourages students to construct knowledge independently while strengthening communication and critical thinking skills. The integration of scientific argumentation reflects the goals of 21st-century education that emphasize effective communication, collaboration, and problem-solving as a provision to face future challenges. (Muhiddin et al., 2023). Scientific argumentation is a key component in science learning that helps students develop the ability to think, act, and communicate like scientists. In the implementation of science learning, the application of scientific argumentation plays a role in increasing students' knowledge and understanding (Siregar et al., 2020). In the science learning process, argumentation activities are needed so that students can argue by connecting the concepts and principles of science with problems in daily life (Handayani et al., 2022). Argumentation can be a solid foundation to understand a concept thoroughly and precisely by relying on existing facts.

A number of studies show that students' argumentative skills are still relatively weak, even some students are not actively involved in argumentative activities in science classes (Physics et al., 2018). The 2022 PISA results strengthen these findings by showing that Indonesia is only ranked 66th out of 80 participating countries in the field of science literacy with a score of 383, far below the international average score of 485 (Ministry of Education and Culture, 2019; OECD, 2023). This low achievement indicates that students are not optimal in understanding concepts, reasoning, and relating knowledge to real situations. These weaknesses are closely related to scientific argumentation skills, as argumentation requires students to use evidence, formulate logical reasoning, and communicate understanding critically, which is essentially the core of science literacy.

The demands of the 21st century require a learning approach that can improve students' ability to argue effectively. According to Imanier et al., (2019). In improving argumentation skills, it cannot be done using conventional learning strategies. Argument-Driven Inquiry (ADI) is a learning model developed to strengthen students' abilities in scientific argumentation. As one of the innovative instructional approaches, ADI provides structured opportunities for students to construct, evaluate, and communicate scientific arguments effectively (Demircioglu et al., 2015). ADI is a student-centered science learning model based on investigation and reasoning. Students are allowed to debate through inquiry activities, including identifying problems, designing experiments, collecting and analyzing data through observation and measurement, recording, data

interpretation, argumentation, review, and report writing (Siregar et al., 2020). This instructional approach supports the development of meaningful arguments and demonstrates its role in shaping scientific understanding through collaborative inquiry (Demircioglu et al., 2015). Students can develop a trained scientific argument through a process of inquiry. This approach is intended to encourage student argumentation that is connected to real-life contexts and illustrates how collaborative discourse shapes scientific knowledge through inquiry (Jonathon et al., 2011). Through the process of inquiry, students can strengthen their scientific argumentation skills.
Based on this, it is necessary to conduct a literature review to investigate the extent to which the *Argument Driven Inquiry* model supports the development of students' skills in making arguments in science learning

Research Methods

This study uses a systematic literature review method as explained by Snyder (2019). The research procedure refers to the guidelines of PRISMA (The Preferred Reporting Items for Systematic Reviews and Meta-Analysis) developed by Page et al., (2017). There are four main steps in this process, namely: (1) identification, carried out by identifying several literature that is suitable for using the selected keywords and searching articles from various academic databases. Data retrieval from articles taken from *Google Scholar (*2) screening, at this stage, a selection of articles that have been selected whether they are in accordance with the specified criteria or not (3) eligibility determination, this stage is carried out by thoroughly reading the articles that have been selected in the previous step. According to Moher et al. (2015), the purpose of this stage is to assess the suitability of the collected articles as well as evaluate their quality. The process ensures that the selected articles meet the established methodological standards and (4) inclusion, at this stage an analysis process is carried out based on the selected articles from the feasibility determination stage to be able to draw conclusions. The stages carried out in this process are:

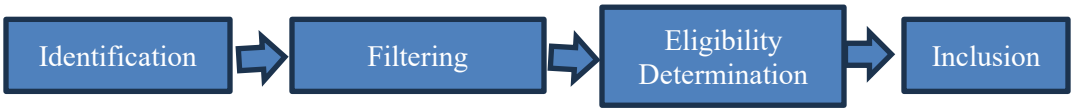

Figure 1. PRISMA Method Research Flow

Stage 1: Identification

At this stage, the standard of article compatibility is determined through inclusion criteria (IC) and the determination of the data source to be used. The inclusion criteria set include:

1. IC1: The article obtained comes from original research that was studied and written in Indonesian.
2. IC2: The article was published with a time range of 2018 – 2025
3. IC3: Relevant articles according to the research topic, namely the influence of *the Argument Driven Inquiry* model on students' argumentation skills in science learning

Data Determination:

1. The article was obtained from an academic study database, namely *Google Scholar.*
2. Based on articles that are in accordance with the provisions of the IC, a search of the content is carried out to see if it is compatible with the research being conducted.

Stage 2: Screening

1. Determining keywords, the keywords used are *the Argument Driven Inquiry model,* scientific argumentation, and science learning
2. To search and determine relevant titles, article analysis and filtering is carried out through abstract sections and keywords based on predetermined criteria

3. Conduct a review of part or all of the content of the article that has been obtained from the selection results at the previous stage, to obtain suitable articles for further study.
4. Articles that pass the review list are then reviewed to find relevant research in the third to fourth stages.

Stage 3: Determination of Eligibility, articles that have passed the screening process are then examined in more depth to ensure their suitability with the research focus

Stage 4: The inclusion of articles that have been declared eligible is then included in the final list as the main study material.

Thus, articles that have passed each stage of the PRISMA method become the basis for the main study in this study and will then be used as a reference in the discussion section.

Results and Discussion

According to the analysis of the available literature, *the Argument Driven Inquiry* (ADI) model affects student learning outcomes in science learning, especially in improving students' arguments. The following is an analysis of articles that are in accordance with the research objectives. Table 1 presents the summary of the reviewed studies:

Table 1. Literature Study Results

Yes	Article Title	Author and year of publication
1	Science Argumentation Skills for Students through *Argument Driven Inquiry* (ADI) learning	(Siregar & Pakpahan, 2020)
2	The Effect of *the Argument-Driven Inquiry* (ADI) Model on Students' Argumentation Skills	(Safira et al., 2018)
3.	The Effect of *the Argument-Driven Inquiry* (ADI) Learning Model on Improving Argumentation Skills and Science Learning Outcomes	(Arfiany et al., 2021)
4	Improving Scientific Argumentation Skills in Students Through the Argument-Driven Inquiry *(ADI)* Learning Model	(Nasution, 2019)
5	Improving Argumentation Skills Through *Argument-Driven Inquiry* (ADI) Model	(Aminatur et al., 2023)
6	The Effect of the Argument-Driven Inquiry *(ADI) Model on High-Level Thinking Ability Based on Differences in the Learning Styles of Junior High School Students on Excretory System Materials*	(Hidayanti et al., 2022)
7	Application of the Argument-Driven Inquiry *(ADI)* Learning Model to Scientific Argumentation Skills	(Utami et al., 2022)

From the literature reviewed, it was found that the model has been extensively carried out to test the improvement of students' ability to build arguments, particularly in science learning. In addition, this learning model also builds students' understanding of concepts based on evidence and rebuttals, with

this learning model also helping students in improving concept understanding.

The results of the study (Siregar & Pakpahan, 2020) revealed that the *Argument-Driven Inquiry* model showed a considerable influence of the effectiveness on students' reasoning skills. This was evidenced by the increase in posttest scores in both experimental and control classes, which showed an increase in students' argumentation skills. That is to improve students' argumentation skills. The *Argument-Driven Inquiry* (ADI) model is very suitable for application to science learning, especially practice-based learning, because the ADI model provides students with a scientific and real practicum experience, while expanding their understanding of this learning model, so that students are more critical of the data obtained in practice.

Based on the results of the study (Safira et al., 2018), the model has a great impact on the development of students' argumentation skills. However, in this article, it was also found that there was no difference in the argumentative ability of low academic students and high academic. The argumentative competencies of academically proficient students and academically capable students show learning outcomes comparable to those achieved through ADI. The findings of this study show that the application of the ADI learning model significantly improves students' argumentative abilities, regardless of their level of academic achievement.

Based on the research findings presented in this article by Nasution (2019), it can be observed that an improvement in students' argumentative ability can be observed after applying this instructional approach. This can be seen from the student argumentation performance assessment sheet. This can be seen from the results of the students' own investigations. However, the results of the research in this article are not optimal because the average student skills in the support and refutation categories are still lacking. This situation arises because teachers, as learning facilitators, have not implemented the ADI model in their teaching practices. As a result, students still have difficulty engaging with the ADI approach, as the process feels unfamiliar and relatively new to them.

Based on the results of the study (Aminatur et al., 2023) the results show that It shows that this educational model affects students' ability to build arguments. This model is more effective in improving argumentation skills; the results of this study were obtained from quasi-experimental research with this percentage of differences in students' argumentation ability in the control and experimental classes. In addition, there is also an increase in students' ability to compile reports and provide reviews of classmates' arguments. Based on the difference in students' argumentation skills applied with the ADI and conventional models. Evidence suggests that the ADI approach improves students' argumentation skills, with an adjusted average result 11.75% greater than conventional methods.

Based on the results of the study (Arfiany et al., 2021), the results of the study show that this instructional model can have a meaningful impact on the development of students' argumentative skills, this can be seen from the results of *the posttest* between the control class and the experiment, the low level of argumentation ability in the control class is caused by syntax in conventional learning not practicing argumentation skills in students in the classroom. In addition to the results of descriptive statistical analysis, to prove that *the Argument-Driven Inquiry* approach has a beneficial impact on students' argument construction ability, inferential statistical analysis is carried out in the form of hypothesis testing.

Based on data and research results (Utami et al., 2022), scientific argumentative skills students' skills show significant improvement through the application of the ADI model. This is evidenced by

ANOVA's bidirectional analysis, which shows a significant difference between the experimental class that applies the ADI model and the control class that uses the Inquiry model, with a significance value of 0.011 (<0.05). These results reinforce previous findings (Siregar & Pakpahan, 2020; Aminatur et al., 2023) that ADI is not only able to significantly increase posttest scores but is also superior to conventional learning models and ordinary inquiry. In this study, it can be seen that the advantage of ADI lies in its syntax structure, which systematically directs students to build data-based arguments, conduct critical evaluations of peer arguments, and reflect on conceptual understanding. Thus, the effectiveness of ADI in various studies is not only statistically proven but also supported by learning mechanisms that encourage critical thinking, collaboration, and problem-solving skills scientifically.

Based on the literature review analyzed, the *Argument-Driven Inquiry* (ADI) model has proven to be effective in improving students' argumentative skills in science learning. Siregar & Pakpahan's (2020) research showed that the application of ADI was able to significantly improve students' reasoning skills through *posttest results*, while Safira et al. (2018) found that the impact of ADI was inclusive, because there was no difference in argumentation skills between students with high and low academic achievements. This finding is strengthened by Nasution (2019), who identified an increase in argumentation skills after the implementation of ADI, although skills in the aspects of support and rebuttal are still limited due to limited teacher facilitation. This shows that the success of the implementation of ADI does not only depend on the design of the model, but also on the role of teachers in directing the learning process.

Quasi-experimental research by Aminatur et al. (2023) showed that students' argumentative skills in ADI classes were 11.75% higher than conventional learning, with additional improvements in report writing skills and providing peer argument reviews. These results are in line with Arfiany et al. (2021), who confirmed through inferential analysis that significant differences appear in argumentation skills between experimental and control classes. The strongest evidence was shown by the study of Utami et al. (2022), which used two-way ANOVA analysis and produced a significance value of 0.011 (<0.05), indicating the superiority of ADI over ordinary inquiry. Thus, the common thread of the entire literature shows that the effectiveness of ADI is not only statistically proven but also supported by practice-based learning mechanisms, collaboration, and systematic critical evaluation in building students' scientific arguments.

Thus, the effectiveness of ADI is not only statistically proven, but also supported by systematic learning mechanisms. ADI's syntax encourages students to build data-driven arguments, conduct critical evaluations of peer arguments, and reflect on conceptual understanding. This makes ADI superior to conventional learning because it is able to integrate scientific practice, collaboration, and critical thinking skills in a unified learning process.

Conclusion

The results of the literature review show that the application of Argument Driven Inquiry (ADI) has been proven to be able to improve students' argumentation skills in science learning. Through structured learning steps, ADI directs students to formulate arguments based on data, analyze peer arguments, and reflect on the conceptual understanding gained. This advantage makes ADI more effective than conventional approaches and traditional inquiry, because it integrates scientific practice, cooperation, and critical thinking skills as a whole.

The implementation of ADI is in line with the demands of 21st-century skills that emphasize critical thinking, problem-solving, creativity, and communication skills. This approach not only supports the understanding of science concepts but also strengthens students' skills in drafting reports, delivering rebuttals, and defending arguments logically. Therefore, ADI can be implemented as the right learning

approach to improve the quality of science education in schools**.**

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