

Argumentation and Critical Thinking Skills with Argument-Driven Inquiry (ADI) Learning Model: A Literature Review

Stella Afrilita Limbong^{a, *}, I Wayan Dasna^b, Munzil Munzil^b

^a Student of Master Chemistry Education Study Program, Departement of Chemistry, Universitas Negeri Malang, Malang, East Java, Indonesia

^b Chemistry Education, Departement of Chemistry, Universitas Negeri Malang, Malang, East Java, Indonesia

**Corresponding author's e-mail: stella.afrilita.2203318@students.u.ac.id*

Abstract

The development of globalization affects all aspects of life, including education. The world of education entering the fifth revolution is characterized by the use of digital devices and the internet in learning. This results in demands and responsibilities for teachers and students to train the framework of creativity, communication, collaboration, and critical thinking known as 4C. One effective way to enhance students' critical thinking and communication skills is through the implementation of the ADI (Argument-Driven Inquiry) learning model. The application of the ADI model is focused on the activities of students in building their knowledge independently to convey the results of their findings as a form of communication. Implementing ADI in chemistry learning will train students to find a finding based on scientific evidence. However, implementing the ADI learning model has obstacles to achieving learning objectives. One is that students are less accustomed to arguing during learning. This causes the ADI learning model to need to be assisted by other approach models in order to increase the effectiveness of ADI learning. This literature review applies Systematic Literature Review (SLR) by reviewing the results of previous research and adjusting to the focus of the study. The results of the review of some of these studies indicate that applying the ADI learning model with the help of several approaches, such as metacognitive and practicum-assisted learning chemistry, provides better results in increasing students' critical thinking skills and scientific argumentation.

Keywords: *Scientific Argumentation; Critical Thinking; Argument-Driven Inquiry*

I. Introduction

The rapid development of globalization that occurs today certainly affects various fields of life, including education. The existence of globalization is a good thing because it can open up insights to new insights and views. However, the rapid globalization that enters Indonesia is also a challenge for all Indonesian citizens to filter helpful information that can be applied to Indonesian culture, including in the world of education. The development of globalization, of course, can always be connected to the industrial era 4.0. The world of education has entered the fifth revolution marked by the use of digital devices and the internet in learning (1).

The development of a revolution in education demands that students become individuals with information literacy skills to communicate all their knowledge critically. This has led to the emergence of a learning *framework* in the 21st century. The learning framework, the 4C skills, consists of critical thinking, communication, collaboration, and creativity skills. Learners will need the 4C skills to sort out the correct information in the era of rapid incoming information and be able to process the information critically. Therefore, it is essential for teachers as educators in schools to familiarize themselves with the learning model in the transfer of knowledge carried out in order to improve the 4C skills of students (2).

In today's world, possessing critical thinking and effective communication skills is vital for learning. This is because critical thinking skills can help individuals to become more aware of how they process and evaluate various information, thereby enabling them to differentiate between true and false information. Moreover, communication skills are equally important as they allow individuals to effectively share their knowledge and insights with a wider audience, thereby contributing to the betterment of society as a whole (3). Therefore, teachers as educators are also expected to be able to apply appropriate learning models in training students' critical thinking and communication skills, especially in learning chemistry, one of which is the ADI (*Argument-Driven Inquiry*) learning model.

The ADI learning model is a model that centers learning activities in argumentation sessions. The application of ADI learning in the classroom can be assumed as appropriate learning because it can provide an activity for students to carry out good communication and build knowledge independently and through the process of learning independently (4). The ADI learning model is used in chemistry education to establish a connection between claims and data using empirical or theoretical evidence. By utilizing this model, students are encouraged to search for a scientific theory that can be used as evidence to prove a claim. This activity helps students to independently develop their critical thinking skills (5).

The ADI learning model can be applied to achieve chemistry learning objectives. Methods contained in ADI learning, such as claims, data, and *warrants*, can direct students to understand the basic concepts of chemistry material that can be connected contextually. The ADI learning model also has an argumentation section that aims to provide opportunities for students to communicate new knowledge with facts found personally. Arguments put forward by learners can be developed into good scientific argumentation. This can improve learners' communication skills in the future (6).

A learning model can run well due to the role of the teacher in preparing the learning and the student's readiness to be taught the learning model. Implementing the ADI learning model in schools tends to be less able to achieve the objectives of measuring students' scientific argumentation. While implementing the ADI learning model, students can only achieve level 1 and level 2 argumentation. This also causes students to have low critical thinking skills during ADI learning. So, the ADI learning model must be combined with several approaches, such as metacognitive or practicum-assisted approaches, to achieve ADI learning objectives (7).

Thus, this *literature review* aims to provide new images for teachers, students, and a broad audience with specific needs for integrating the ADI learning model in chemistry learning. Thus, the ADI learning model is optimally useful for building critical thinking skills and scientific argumentation. Therefore, the problem formulation of the study in this research is: How is the impact of applying the ADI learning model on chemistry education? How does the ADI model enhance students' scientific argumentation and critical thinking abilities in chemistry?

II. Method

The *literature review* in this journal was created using the *Systematic Literature Review* (SLR) method. This refers to a specific research methodology that aims to collect data and evaluate research tailored to the literature review being reviewed. Using the SLR method has several advantages, such as providing in-depth information on a study, easy access to resources such as online *databases* and competent references, and the ability to use the developed *review* as the basis for a new research project (8).

The competent references used in this *review* were developed with the help of ERIC (*Education Research Information Center*), PoP 7 (*Publish or Perish*) with Google Scholar, and *Taylor & Francis*. The use of ERIC, PoP 7, and *Taylor & Francis* in the development of a *literature review* can assist in providing the latest and *updated* journals with quality that is adjusted to international standards, where in this study, a publication range of the last 12 years is used (9).

Journals obtained with the help of ERIC, PoP 7, and *Taylor & Francis* produced more than 1000 journals. Through the PoP *database* assisted by *Google Scholar* search, 1000 articles were obtained;

through the ERIC database with the *peer-reviewed-only* category, 2822 articles were obtained; and through the *Taylor & Francis database*, 1 article was obtained. All articles were selected based on the titles, abstracts, and content obtained from the collected articles so that the journals most suitable for the study were selected. The *screening* was based on several *keywords: interactive media learning, media learning in chemistry, and learning outcomes*. Especially in the ERIC database, article *screening* is carried out by selecting journals that have been *peer-reviewed*. This is done so that the articles obtained are of good quality and by the standards of chemistry learning in schools.

The *screening* stage was continued using the Schimago website to determine which journals were included in quartiles (Q) 1 - 4. Based on the *screening* using Schimago, several journals from the previous *database* were not included in the quartiles, so they could not be included in the article *review*. All activities were conducted to find and *screen* suitable journals from September 5 to November 10, 2023. In this study, all journals were reviewed using codes A1 - A9. All journals selected by reading and summarizing in tabular form resulted in 9 articles used as the basis for developing a *literature review*, as seen in Table 1.

Table 1.
Selected Articles and Journals

Author	Journal Code	Database
Antonia <i>et al.</i> , 2021	A1	ERIC
Hosbien <i>et al.</i> , 2021	A2	ERIC
Wulandari <i>et al.</i> , 2021	A3	ERIC
Giri & Paily, 2020	A4	ERIC
Demircioglu, 2015	A5	PoP
Antonio, 2020	A6	PoP
Memis & Akkas, 2020	A7	PoP
Sonmez <i>et al.</i> , 2019	A8	T&F
Kaylon & Yilmaz, 2023	A9	PoP

Figure 1 below shows the article search process as described above.

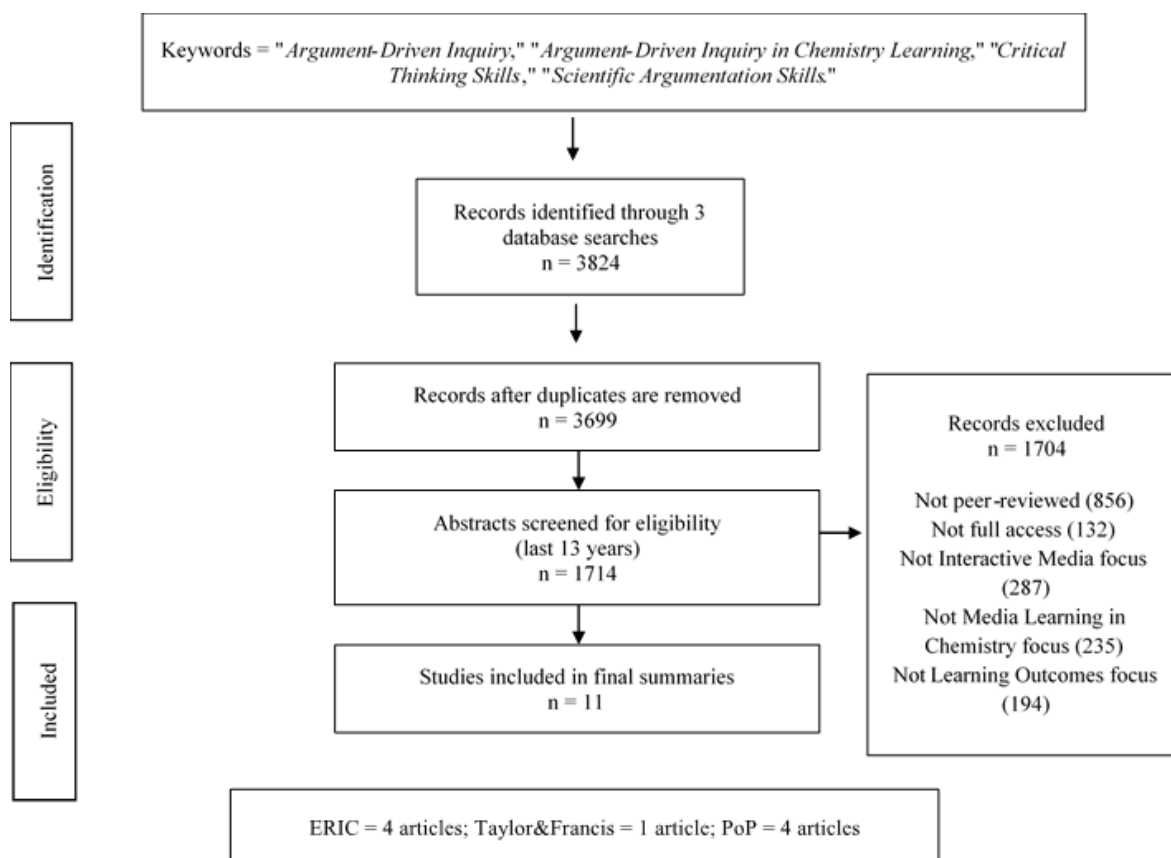


Figure 1. Article Search Matrix

III. Results and Discussion

According to the *review* of various journals, the ADI (*Argument Driven Inquiry*) learning model has proven to be effective in enhancing students' scientific argumentation skills. The research study conducted a *review* to measure the increase in critical thinking and scientific argumentation skills of students after being taught the ADI learning model. The study reviewed several articles, and the results are as follows.

Table 2

Implementation of ADI Learning Model on Scientific Argumentation Ability

Researcher	Results
Antonia, R.P & Prudente, M.S., 2021	There is a significant increase in students' scientific argumentation skills after being taught the MADI (Metacognitive Argument-Driven Inquiry) learning model.
Hosbein, K.N., Lower, M.A. & Walker, J.P., 2021	There is an increase in scientific argumentation skills and student focus during learning with the ADI learning model assisted by ASAC (Assessment of Scientific Argumentation in the Classroom).
Demircioglu, T., 2015	There is an increase in argumentation skills and learning outcomes through the ADI learning model assisted by scientific practicum modules.
Kaylon, D.S. & Yilmaz, Y.O., 2023	Prospective teacher students taught with the ADI model and practicum

Based on the study in Table 2, the implementation of the ADI learning model is able to improve the scientific argumentation skills of students. The findings obtained by Antonia & Prudente (10), state that the application of ADI model learning can be done with metacognitive assistance to students. Based on the results of the research analysis using Wilcoxon, the r value is 0.567. The results of this analysis indicate that there is a significant increase in students' argumentation skills after being taught the MADI model. The argumentation ability can be seen in the development of students in finding data, processing facts based on data and argumentation skills that increase significantly.

Implementing the ADI learning model with metacognitive approach improves scientific argumentation skills of students. The findings obtained by Antonia and Prudente (10) state that the application of ADI model learning can be carried out with metacognitive assistance to students. Based on the research analysis results using Wilcoxon, the r -value is 0.567. The results of this analysis indicate a significant increase in students' argumentation skills after being taught the MADI model. The argumentation ability can be seen in the development of students in finding data, processing facts based on data, and increasing argumentation skills significantly.

In the research conducted by Hosbein (11), researchers applied the ADI learning model assisted by scientific practicum modules to students. Through the research, students' scientific argumentation skills improved after being taught with the ADI learning model assisted by scientific practicum modules. This is based on the analysis results using *N-Vivo Kappa* of 0.70. Improved cognitive, epistemic, and social abilities support the increased ability of students in scientific argumentation. These three abilities are the basis for developing students' scientific argumentation skills. In addition,

the increase in students' argumentation skills also encourages students to be more focused during learning. This will help students evaluate learning systematically.

The study conducted by Demircioglu (12) compared the scientific argumentation skills of experimental and control classes using the practicum-assisted ADI learning model. The analysis results conducted using *ANCOVA* showed an increase in the experimental class taught with the practicum-assisted ADI learning model compared to the control class taught with the conventional learning model. The increase in students' scientific argumentation skills is also seen in the argumentation component, where students can compile and develop scientific argumentation up to the *rebuttal* stage.

There is also an implementation of the ADI learning model assisted by a practicum conducted by Kaylon and Yilmaz (13). Applying the ADI learning model in laboratory learning can significantly improve the understanding of prospective teacher students. Increasing students' understanding of laboratory experiments can have a significant positive impact on their scientific argumentation skills. This can be seen from the increasing level of student argumentation to be more valid due to students' increasing scientific literacy skills.

Table 3

Implementation of ADI Learning in Improving Critical Thinking Skills

Researcher	Results
Wulandari <i>et al.</i> , 2021	Applying the ADI learning model effectively improves the critical thinking skills of prospective teachers on reaction rate material.
Giri & Paily, 2020	Applying the scientific argumentation learning model with the TAP model can build the critical thinking skills of high school students.
Antonio, 2020	Applying the metacognitive-assisted ADI learning model can improve reflective thinking skills so that there is also an increase in students' critical thinking skills.
Memis & Akkas, 2020	Implementation of inquiry-based argumentation learning model in science learning can improve students' critical thinking skills.
Sonmez <i>et al.</i> , 2019	The application of the inquiry-based argumentation learning model in the experimental class can provide an increase in students' critical thinking skills.

Based on the review in Table 3, implementing the ADI learning model through research conducted by Wulandari *et al.* (14) on prospective teacher students can improve the critical thinking skills of prospective teachers. Data analysis conducted with Wilcoxon's assistance gave a value of 0.00. This shows that the critical thinking skills of prospective teacher students have increased. In addition, the N-Gain test of 0.40 also showed that the ADI learning model successfully increased students' critical

thinking skills. The increase in students' critical thinking skills can be seen in deduction skills, such as focusing on questions, analyzing arguments, and determining actions, which have increased significantly.

A study conducted by Giri and Paily (15) revealed that when a scientific argumentation learning model was applied in experimental classes using the *Toulmin Argumentation Pattern* (TAP), it led to a significant improvement in critical thinking skills of the students. According to the study, the use of the TAP model has a positive impact on enhancing students' critical thinking skills. The study showed that students' critical thinking skills improved significantly, with a significance value of 0.533, which is greater than the standard value of 0.05. The implementation of the scientific argumentation learning model along with the TAP model can also train students' critical thinking skills, as per the *Watson-Glaser Form S* indicator.

The application of the metacognitive-assisted scientific argumentation learning model (MADLE) conducted by Antonio (10) showed reflective thinking skills in experimental class students. The results are further backed up by the higher *post-test* scores achieved by the experimental class as compared to the control class. This indicates that reflective thinking skills have improved in addition to the critical thinking skills of students. Moreover, the use of ABI-based *argumentation* learning model (*Argumentation-Based Inquiry*) has been found to enhance the flow of critical thinking.

Memis and Akkas's (16) research shows that applying an inquiry-based argumentation learning model in laboratory learning can improve critical thinking skills. The study shows that students' critical thinking abilities have improved, as evidenced by their enhanced problem-solving and decision-making skills. This study supports the research by Sonmez, Kabatas, and Yerlikaya (17), which found that using inquiry-based argumentation as a learning model significantly improved critical thinking skills in the control group. Interviews conducted in the experimental group also revealed a substantial improvement in their critical thinking abilities. Therefore, through all the results of the studies conducted from several studies, it was found that the ADI (*Argument-Driven Inquiry*) learning model assisted by a metacognitive approach and practicum was very effective in learning chemistry. The implementation of ADI learning assisted by metacognitive and practicum in chemistry material is effectively used to train and develop students' and college students critical thinking skills and scientific argumentation.

IV. Conclusion

In this century's education development, students must master 4C skills, especially in the critical thinking and communication section. It is intended that students in the future will not be easily carried away by the flow of globalized information and will be able to convey the information obtained based

on the knowledge obtained independently. Thus, applying learning models is an essential element in school implementation. An effective learning process to be implemented in order to improve scientific argumentation skills and critical thinking skills is ADI (*Argument-Driven Inquiry*). The ADI learning model, which combines metacognitive and practicum approaches, can help students develop critical thinking skills and scientific argumentation in chemistry independently.

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