Inovasi Pendidikan Fisika *Vol. 14 No. 1, Februari 2025, 6 - 10*
ISSN 2830-3881 (media 0nline)

The Influence of the Argument-Driven Inquiry Learning Model in Physics Learning with the STEAM Approach on the Scientific Argumentation Ability

Ekaningtyas Wahyu Epriliyani[1] and Utama Alan Deta[2#]
[1,2]Department of Physics, Faculty of Mathematics and Natural Science, Universitas Surabaya
[#]Email: utamadeta@unesa.ac.id

Abstract

Argument-driven Inquiry (ADI) is a laboratory-based learning model in which students can be involved in argumentation activities to increase understanding and practice argumentation skills. This research aims to analyze the influence of Argument-Driven Inquiry in physics learning using the STEAM approach on students' scientific argumentation abilities. This research design uses a pretest and posttest control group design. This research used two class groups: the experimental and control classes. Data obtained through pretest and posttest were tested using SPSS. This research shows that argument-driven inquiry in physics learning with the STEAM approach influences students' scientific argumentation abilities. After implementing the learning, scientific argumentation skills are at level 2.

Keywords: Argument-Driven Inquiry, Scientific Argumentation, STEAM Approach

Abstrak

Argument Driven Inquiry (ADI) merupakan model pembelajaran berbasis laboratorium, peserta didik dapat terlibat dalam kegiatan argumentasi sehingga dapat meningkatkan pemahaman dan melatihkan kemampuan argumentasi. Penelitian ini bertujuan untuk menganalisis pengaruh *Argument Driven Inquiry* dalam pembelajaran fisika dengan pendekatan STEAM terhadap kemampuan argumentasi ilmiah peserta didik. Jenis penelitian yang digunakan adalah control group pretest posttest. Sampel dalam penelitian ini sebanyak 78 orang. Hasil penelitian ini adalah terdapat pengaruh Argument Driven Inquiry dalam pembelajaran fisika dengan pendekatan STEAM terhadap kemampuan argumentasi ilmiah peserta didik. Setelah diterapkan pembelajaran kemampuan argumentasi ilmiah berada pada level 2.

Kata Kunci: *Argument Driven Inquiry*, Argumentasi Ilmiah, Pendekatan STEAM

INTRODUCTION

STEAM is a learning approach integrated with science, technology, engineering, arts, and mathematics to improve students' abilities, namely creativity, innovation, problem-solving, and other cognitive benefits (Liao, 2016). One aspect that is trained on students when learning with the STEAM approach is critical thinking. The basis of thinking in critical thinking skills is analyzing arguments (Nursiti, 2013). This is supported by research (Jannah, 2018) that shows that in critical thinking skills, students are required to practice the ability to analyze arguments.

Argumentation is one of the basic steps in implementing students' critical thinking processes and scientific literature. It is a process that can be used to analyze information on a topic and then communicate it to other people (Deta, 2021). Poorly trained critical thinking makes it difficult for students to express opinions and answer questions that require careful consideration (Idris, 2020). Solutions that can be implemented to improve students' ability to solve problems by creating a fun learning environment (Kartika, 2023).

Argument-driven Inquiry is the development of the inquiry and discussion learning model. Argument-Driven Inquiry can conduct laboratory activities and train students' scientific argumentation skills. Argumentation skills involve the ability to reason information in solving problems, making statements, and making decisions supported by data and evidence in an idea (Cho & Jonassen, 2002). According to Sampson & Gleim (2010), the Argument-driven Inquiry learning model is designed to structure scientific inquiry to develop an argument that provides and supports an explanation for the research question, accompanied by supporting evidence.

Several findings from argument-driven inquiry research conducted by Fatmawati (2019) show that the argument-driven inquiry learning model with problem-

solving gets higher argumentation and critical thinking scores than discussion learning. Irvan's (2019) research shows that the Argument-Driven Inquiry learning model is more effectively used to train and hone students' scientific argumentation skills regarding physics learning. Hanifah's research (2019) shows that there is an increase in the level of scientific argumentation that students can achieve, namely that on average, in the pretest, the level of scientific argumentation of students is at levels 1 and 2, while in the posttest the level of scientific argumentation of students can reach level 3 and 4. Research conducted by Fadillah (2020) shows that the pretest results show that students' scientific argumentation abilities in the experimental and control classes are at levels 1, 2, and 3. Probosari's (2016) research shows that students' argumentation abilities are still in the low category, indicated by the average score at level 1 and a small number at level 2. Thus, the findings in this research can become a new foundation for subsequent research in studying students' scientific argumentation issues and in further research regarding models. Moreover, argumentation learning strategies improve students' scientific reasoning for educators. Based on the description above, no research on Argument-Driven Inquiry uses the STEAM approach in physics learning.

METHOD

The type of research used is quantitative descriptive research. This research design uses a pretest and posttest control group design. This research used two class groups: the experimental and control classes. With this research design, we can describe the results of comparing pretest scores and posttest scores in physics learning using the Argument-Driven Inquiry model with the STEAM approach. The research was conducted in the odd semester of 2022/2023 at one of the state high schools in Sidoarjo. The sample in this study was 78 people. Data obtained through pretest and posttest were tested using SPSS. Parameters for assessing argumentation ability are carried out using written assessment techniques in the form of pretest and posttest by giving points based on the level of argumentation by Erduran. In addition, Toulmin argumentation patterns are used to analyze students' understanding and scientific argumentation skills. The learning material this research uses is energy sources in class X SMA, which is sub-chapter solar energy.

RESULTS AND DISCUSSION

Application of ADI in Learning

Overall, the ADI learning activities went well. Namely, the teacher's activities introduced and taught students to make arguments, which was not easy because students had never gained an understanding of argumentation. The teacher tries to explain and provide examples that are easy to understand for students so that students can make an argument and convey the results of the argument to their friends.

Figure 4.1 Student Discussion Activities

After the teacher explains the concepts and examples of the learning material, students are divided into small groups to carry out discussion activities, as in Figure 4.1, to work on LKPD about Toulmin argumentation patterns.

The following is an example of a student's LKPD answer:

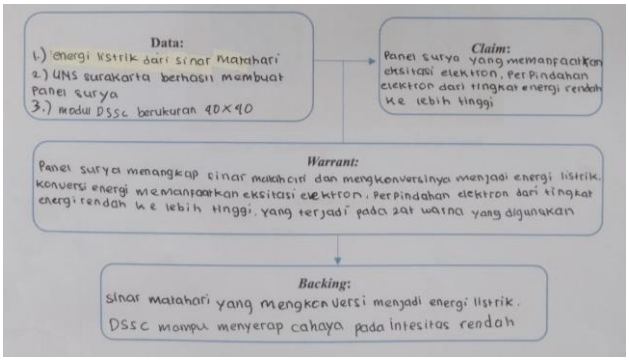

Figure 4.2 Results of LKPD Answers

One of the thinking skills that can be developed in learning is the ability to argue. In presenting arguments, students need to provide evidence in the form of data and theory so that students can analyze physical phenomena scientifically and make decisions (Anwarudin, 2019). In conveying arguments, students need to provide evidence in the form of data and theory so that students can analyze physical phenomena scientifically and make decisions. Argumentation is a thinking process that can be developed through reasoning through group discussions (Osborne, 2010). By holding discussions, students will exchange opinions with each other so that students can learn how to argue.

The application of STEAM in applied learning can be described as follows:

a. Science: Students can learn and implement learning material

b. Technology: Students can make a simple solar panel practical kit
c. Engineering: Students can make measurements with a multimeter
d. Arts: Students can create creativity with the desired shapes and colors
e. Mathematics: Students are proficient in calculations and making graphs

Learning physics cannot be separated from studying abstract concepts and practical activities. Laboratory activities can also practice scientific argumentation so that students participate actively in scientific investigations (Kurniasari, 2017). However, limited equipment in the laboratory is one of the obstacles in this regard, less than optimal learning activities, especially in practicum activities (Deta, 2023). Therefore, the practicum is carried out using a practicum kit made from simple materials, namely cardboard.

In the ADI learning activities using the STEAM approach at the second meeting, students began to be enthusiastic about showing the results of simple practicum project designs, carrying out simple practicums using solar panels, and decorating their respective project designs. As in Figure 4.3, when the practical activity measured the voltage and current of an LED lamp, some students were enthusiastic about measuring, but some students were less confident because they were afraid of being exposed to electricity. However, the teacher provides understanding and opportunities so all students can take measurements.

Figure 4.3 Practical Activities

Figure 4.4 Activities to Decorate Works

Based on Figure 4.4, students carry out activities to decorate the work they have created with their creativity. The work is made from used cardboard and is assembled according to the desired design. Then, decorate the work with your creativity.

Figure 4.5 Activities to Present the Results of The Discussion

From the results of observations, overall, student activities have gone well. However, a few things could still be improved in student activities, such as analyzing data by ideas and making arguments. In students' activities analyzing data, answers still do not match their ideas, so the teacher needs to provide further direction and understanding. Meanwhile, in the activity of students making arguments, there is still inappropriate vocabulary because argumentation is still something new for students to learn. Apart from that, some factors influence students' scientific reasoning, including teacher questions, discussion activities between students, practical activities, class management, students' understanding of concepts, and school activity programs (Megatro, 2021).

Analysis of Students' Scientific Argumentation

This research used pretests and posttests in the control and experimental classes to measure students' scientific arguments. From the results of the pretest and posttest, tests were carried out using SPPS as follows:

Descriptive Statistical Test

Descriptive statistical tests were carried out before normality and homogeneity tests.

Table 4.1 Descriptive Statistical Test Results Normality Test

Class		Mean	Median	Min	Max	Std. Deviation
Control	Pre test	29.3797	29.1700	8.33	45.83	106.872
	Post test	33.4397	33.3300	12.50	50.00	82.684
Experiment	Pre test	33.2262	33.3300	8.33	50.00	104.618
	Post test	61.2177	62.5000	45.83	75.00	76.897

The normality test is used to determine whether the data obtained is normally distributed (Sudjana, 2005). The data used were students' pretest and posttest scores.

Table 4.2 Normality Test Calculation Results

Class		df	Statistic	Sig.	Conclusion
Control	Pre test	39	0.110	0.132	Normal
	Post test		0.108	0.335	Normal
Experiment	Pre test	39	0.124	0.169	Normal
	Post test		0.118	0.072	Normal

Table 4.2 shows that the data is normally distributed because the sig value is > 0.05.

Based on Table 4.4, it is known that there are differences in the data because the sig (2-tailed) value is < 0.05.

Based on the recapitulation results, the scientific argumentation ability of students in the experimental class after the learning was implemented was at level 2 overall. Meanwhile, before the learning was implemented, it was at level 1. Research conducted by Dwiretno (2018) shows that the argumentation ability was at levels 1 and 2. This aligns with research conducted by Irvan (2019), which shows that the argument inquiry learning model is more effectively used to train and hone students' scientific argumentation skills in physics learning. This agrees with research conducted by Nasution (2019), which shows that there has been an increase in scientific argumentation among students by implementing the argument inquiry learning model compared to conventional learning. This research shows that argumentation learning models can influence argumentation skills and understanding of concepts (Amiroh, 2020).

Homogeneity Test

The homogeneity test determines whether the data obtained is homogeneous or not in the sample variance (Arifin, 2010). The data used is from students' pretest and posttest scores.

Table 4.3 Homogeneity Test Calculation Results

		Levene Statistic	df1	df2	Sig.	Conclusion
Students Learning Outcomes	Based on Mean	0.307	3	152	0.820	Homogen

Based on Table 4.3, it is known that the data is homogeneous because the sig value is > 0.05.

Independent t-test

The Independent t-test was carried out to determine whether there were differences in averages between 2 different groups (Setyawarno, 2017).

Table 4.4 Calculation Results of the Independent t-Test

Students Learning Outcomes	Sig.(2-tailed)
Equal variances assumed	0.000

CONCLUSION

Based on the research carried out, it was concluded that Argument-Driven inquiry influences students' scientific argumentation abilities in physics learning with the STEAM approach. After implementing the learning, scientific argumentation skills are at level 2.

Research on the Argument-Driven Inquiry learning model using the STEAM approach that has been carried out has a limited duration of learning syntax, so it is necessary to increase the duration of learning syntax. Apart from that, it also creates semi-closed questions to help students make arguments. Hopefully, this research can help further examine scientific arguments in physics learning.

REFERENCES

Admoko, S., Hanifah, N., Suprapto, N., Hariyono, E., and Madlazim, M. (2021). The implementation of Argument Driven Inquiry (ADI) Learning Model to Improve Scientific Argumentation Skills of High School Students. *Journal Physics Conference Series*, 1747: 012046.

Arifin, Z. (2010). *Metodologi Penelitian Pendidikan Filosofi, Teori dan Aplikasinya.* Surabaya: Lentera Cendekia.

Amiroh, F. and Admoko, S. (2020). Tinjauan terhadap Model-Model Pembelajaran Argumentasi Berbasis TAP dalam Meningkatkan Keterampilan Argumentasi dan Pemahaman Konsep Fisika dengan Metode Library Research. *Inovasi Pendidikan Fisika*, 9(2): 207–214.

Anwarudin, Gabriela, and Admoko, S. (2019). Penerapan Model Pembelajaran Diskusi Kelas Untuk Meningkatkan Argumentasi Ilmiah Materi Getaran Harmonis. *Inovasi Pendidikan Fisika*, 8(3): 804–809.

Cho, K. and Jonnasen, D. (2002). The Effect of Argumentation Scaffolds on Argumentation and Problem Solving. *Educational Technology Research and Development*, 50(3): 5-22.

Deta, U., A., Fahmi, M., N., Nurlailiyah, A., Rusmawati, R., Anggaryani, M., and Jatmiko, B. (2023). Assistance in Making Dynamic Electricity KITs Based on Scientific Argumentation Skills for Physics Teachers in Sidoarjo Senior High School. *Jurnal Pengabdian Masyarakat*, 5(2): 767-774.

Deta, U.A., Yanti, V.K., Misbah., Mahtahari, S., and Alamsyah. (2021). The Scientific Argumentation Profile of Annular Solar Eclipse Phenomenon June 21st 2020 of Physics Undergraduate Student in Universitas Negeri Surabaya. *Journal of Physics: Conference Series,*1796: 012103.

Dwiretno, G. (2018). Pembelajaran Fisika Menggunakan Model Argument Driven Inquiry (ADI) untuk Melatihkan Kemampuan Argumentasi Ilmiah Peserta Didik. *Inovasi Pendidikan Fisika (IPF*), 7(2): 337-340.

Fadillah, (2020). The Process of Developing Students' Scientific Argumentation Skill Using Argument-Driven Inquiry (ADI) Model in Senior High School on The Topic of Elasticity. *Journal Physic Conference Series*, 1491: 012046.

Fatmawati, Z. A., Susilowati, S. M. E. and Prihandono, R. S. I. (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(3): 255-263.

Idris, N. W. (2020). Pengaruh Model Pembelajaran Berbasis Masalah terhadap Kemampuan Berpikir Kritis Peserta Didik. *Jurnal Sains dan Pendidikan Fisika*, 16(1): 39-50.

Irvan, A dan Admoko S. (2020). Analisis Kemampuan Argumentasi Ilmiah Siswa Berbasis Pola Toulmin's Argument Pattern (TAP) Menggunakan Model Argument Driven Inquiry dan Diskusi Pada Pembelajaran Fisika SMA. *IPF: Inovasi Pendidikan Fisika*, 9(3): 318-324.

Jannah, W. N., and Susilawati. (2018). *Pentingnya Kemampuan Metakognitif Siswa Sekolah Dasar Sebagai Generasi Emas*. Prosiding Seminar Nasional Pendidikan FKIP Universitas Muhammadiyah Cirebon.

Kartika, S., dan Lestari, N. A. (2023). Validitas Perangkat Pembelajaran Project-Based Inquiry Science Terintegrasi Pendidikan Lingkungan untuk Meningkatkan Kemampuan Berpikir Kritis. *Jurnal IlmuPendidikan dan Pembelajaran*, 2(1): 1-16.

Kurniasari, I. S., and Setyarsih, W. (2017). Penerapan Model Pembelajaran Argument Driven Inquiry (ADI) untuk Melatihkan Kemampuan Argumentasi Ilmiah Siswa pada Materi Usaha dan Energi. *Jurnal Inovasi Pendidikan Fisika (JIPF),* 6(3): 174-177.

Liao, C. 2016. From Interdisciplinary to Transdisciplinary: An Arts-Integrated Approach to STEAM Education. *Art Education*, 69(6):44-49.

Megatro, T. W. W., Hakim, A. R., Wulansari, N. I., Solahuddin, M. I., and Admoko, S. (2021). Analisis Keterampilan Argumentasi Ilmiah Peserta Didik pada Model Pembelajaran Berbasis Toulmin's Argumentation Pattern (TAP) dalam Memahami Konsep Fisika dengan Metode Library Research. *PENDIPA Journal of Science Education*, 5(1): 79-91.

Nasution, E. S. (2019). Peningkatan Keterampilan Berargumentasi Ilmiah pada Siswa Melalui Model Pembelajaran Argument-Driven Inquiry (ADI). *Jurnal Eksakta Pendidikan*, 3(2): 100-108.

Nursiti & Barat, W. L. J. (2013). *Keterampilan Berpikir Kritis (Critical Thinking Skill) dalam Pembelajaran Ilmu Pengetahuan Sosial*. Jawa Barat: Widyaiswara.

Osborne, J. (2010). *Arguing to Learn in Science: The Role of Collaborative, Critical Discourse*. Washington DC: American Association for the Advancement of Science.

Probosari, and Maya, R. (2016). Profil Keterampilan Argumentasi Ilmiah Mahasiswa Pendidikan Biologi FKIP UNS pada Mata Kuliah Anatomi Tumbuhan. *Bioedukasi: Jurnal Pendidikan Biologi*, 9(1): 29–33.

Sampson, V. and Gleim, L. (2009). Argument Driven Inquiry to Promote the Understanding of Important Concepts and Practices in Biology. *The American Biology Teacher*, 71(8): 465-472.

Sampson, V., Grooms, J. and 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.

Setyawarno, D. (2017). *Uji Statistik untuk Penelitian*. Yogyakarta: Universitas Negeri Yogyakarta.

Sudjana. (2005). *Metoda Statistika*. Bandung: Tarsito.