26 (2), 2025, 987-1006
Jurnal Pendidikan MIPA
e-ISSN: 2685-5488 | p-ISSN: 1411-2531
https://jpmipa.fkip.unila.ac.id/index.php/jpmipa

Analysis of Junior High School Students' Scientific Argumentation Skills in Argument-Driven Inquiry (ADI) Learning Based on Gender

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Abstract: Scientific activities, such as communication, are essential skills in the 21st century. Scientific argumentation is a fundamental component of communication and serves as a foundation for students to engage in a series of scientific processes, leading to valid conclusions based on empirical data. This study aims to examine whether there are differences in the scientific argumentation abilities of male and female students following the implementation of Argument-Driven Inquiry (ADI) learning, as well as to analyze their respective argumentation patterns. This study employs an experimental research design with a pretest-posttest experimental group approach. The sample was selected using a purposive sampling technique. Data collection involved pretest and posttest scores. The analysis of research results was tested using Inter-Rater Reliability (IRR), score conversion, normality test, Mann-Whitney test, and N-Gain test. The study population consisted of eighth-grade students at SMP IT Ihsanul Fikri Mungkid, from which two classes were selected through purposive sampling: VIII D (experimental class 1 - male students) and VIII H (experimental class 2 - female students). The findings indicate that the ADI model effectively enhances students' scientific argumentation skills in both experimental groups. The N-Gain analysis revealed that in the argument completeness aspect, experimental class 1 (male students) achieved an N-Gain of 0.70 (moderate category), whereas experimental class 2 (female students) scored 0.93 (high category). In the scientific validity aspect, experimental class 1 obtained an N-Gain of 0.63 (moderate category), while experimental class 2 scored 0.84 (high category). Regarding overall scientific argumentation, experimental class 1 achieved an N-Gain of 0.67 (moderate category), whereas experimental class 2 reached 0.82 (high category). Further analysis of the argument completeness aspect identified a statistically significant difference between male and female students ($p < 0.05$); However, in the scientific validity aspect, no significant difference was observed between male and female students ($p > 0.05$); In the overall scientific argumentation aspect, a significant difference was found between male and female students ($p < 0.05$).

Keywords: gender, scientific argumentation, argument driven inquiry (ADI).

▪ INTRODUCTION

The advancement of science presents challenges for education, particularly in preparing future generations to face the demands of the 21st century (Lestari 2018; Tamin, Ubadah, and Mashuri 2022). Education is required to develop 21st-century skills, including critical thinking, effective communication, creativity, and collaboration (Mahanal 2017; Zubaidah 2018). One of the essential skills that must be cultivated in the 21st century is argumentation, which is a crucial component of communication skills (Muhajir et al. 2016). In the context of science, argumentation skills are known as scientific argumentation. Scientific argumentation is a fundamental form of communication that students must master, particularly in science learning. It is essential to enhance this skill for the 21st century, as it serves as a foundation for students to learn how to think, act, and communicate like scientists (Anita and Tenriawaru 2019).

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*Email: suwitosinggih@untidar.ac.id
DOI: http://dx.doi.org/10.23960/jpmipa/v26i2.pp987-1006
Received: 27 February 2025
Accepted: 13 March 2025
Published: 04 June 2025

Furthermore, scientific argumentation in science is not merely about observing how a phenomenon occurs; it also requires the ability to explain the phenomenon and formulate predictions about its future implications (Hardini and Alberida 2022). Based on this explanation, scientific argumentation plays a crucial role in the development of science, particularly in the 21st century (Puji Rahayu, Wiyarsi, and Utami 2022). Engaging in argumentation requires logical explanations in interpreting phenomena, which include the ability to critically analyze opinions, construct logical explanations, and defend arguments with supporting evidence. These aspects should be emphasized in every learning process (Roviati and Widodo 2019).

The results of the 2022 PISA survey indicate that the science literacy score of 15-year-old Indonesian students is 383 points, which is below the average of 485 points (OECD 2023). One of the indicators relevant to argumentation skills is the ability to recognize accurate explanations for common scientific phenomena and to apply this knowledge to identify key elements in simple cases and draw valid conclusions based on presented evidence (OECD, 2023). Based on this indicator, Indonesia experienced a 13-point decline compared to the previous year (Wuryanto and Abduh 2022). This condition is consistent with the findings of Siregar & Pakpahan (2020), who stated that junior high school students have low argumentation skills and are not yet able to express or defend their opinions. Furthermore, Mazita (2024) found that only 5% of junior high school students are capable of constructing arguments supported by scientific evidence. This situation is attributed to the lack of instructional practices oriented toward argumentation training. Additionally, Hutasoit (2021) reported that the implementation of the Teacher-Centered Learning (TCL) model is less effective in providing direct learning experiences, as students primarily follow teacher instructions without actively engaging in independent knowledge construction.

Instructional approaches that stimulate argumentation skills in science learning can be implemented through the Argument-Driven Inquiry (ADI) model (Afgani, Hasnunidah, and Surbakti 2020). The ADI model has been proven to enhance scientific argumentation skills, scientific reasoning, and the overall quality of science learning in practice (Fakhriyah et al. 2021; Irvan and Admoko 2020; Mazita et al. 2024; Zahra et al. 2018). To cultivate argumentation skills, Sampson & Gleim (2009) formulated several stages, including identifying the task, data collection and analysis, argument production, argument interaction, investigation report preparation, report review, and report revision.

The development of education directs the formation of an inclusive and equitable learning environment for all students, ensuring responsiveness to gender differences (Rousso 2003; Sulistyowati 2021). Learning in the classroom can be influenced by gender (Eggen and Kauchak 2010). According to Webster's New World Dictionary, gender is defined as the distinction between males and females in terms of values and behaviors. According to Umar (2010), gender is a cultural concept that differentiates the roles, behaviors, mentalities, and emotional characteristics of men and women as they develop in society (Ikhsan 2023). According to Banks (2009), ducation that integrates gender equality promotes better academic achievement and social skills among students (Ikhsan 2023). Male are generally encouraged to be independent, aggressive, and competitive, while female are taught to be more empathetic, cooperative, and responsive to others' needs. These differences contribute to an imbalance in character development (Gilligan, 2016).

From a cognitive and argumentative perspective, female students tend to have better abilities in expressing opinions to others (Erdiana, Bahri Ys, and Akhmal 2019). They also have superior cognitive skills in expressing emotions and are more sensitive to unspoken (nonverbal) cues, whereas male students excel in spatial reasoning and visual tasks (Eti Nurhayati 2014). Additionally, female students demonstrate higher average reasoning and knowledge abilities than male students (Songsil et al. 2019) and perform better in argumentation by articulating claims with logical reasoning (Afifah and Faizah 2023). A review of gender-related academic performance across different indicators—computation (recalling facts), concepts (mathematical analysis), and problem-solving (applying knowledge to solve problems)—shows that female students outperform their male counterparts in computational skills at both elementary and secondary school levels. However, there is no significant gender difference in mathematical conceptual understanding or problem-solving skills, except at the upper secondary level, where male students perform slightly better (Andayani 2008).

Given the persistent low level of students' scientific argumentation skills and the necessity for gender-based inclusive learning, this study aims to examine whether there are differences in the scientific argumentation abilities of male and female students following the implementation of Argument-Driven Inquiry (ADI) learning, as well as to analyze their respective argumentation patterns. Scientific argumentation is assessed in terms of structural completeness and the level of scientific reasoning. The findings of this study are expected to contribute to the development of effective strategies for fostering scientific argumentation skills among students, particularly in schools that implement gender-segregated classroom settings.

▪ METHOD

This study employs a quasi-experimental method with a pretest-posttest experimental group design (Sekaran and Bougie 2013). The population consists of all eighth-grade students at SMP Islam Terpadu Ihsanul Fikri Mungkid, Magelang Regency, for the 2024/2025 academic year, totaling 249 students distributed across eight classes (A–H). The sample selection was conducted using purposive sampling, a technique in which samples are selected based on specific characteristics relevant to the research objectives (Lenaini 2021). The criteria for sample selection included gender homogeneity within each class and an academic background in the science and technology (saintek) track. Based on these criteria, two classes were selected as the research sample: Class VIII D (male science class) as Experimental 1 and Class VIII H (female science class) as Experimental 2.

The data collected in this study consists of pretest and posttest scores. The research instrument includes two open-ended questions developed based on the scientific argumentation framework proposed by Toulmin (2003), as presented in Table 1.

Table 1. Indicators of scientific argumentation skills

No	Indicator	Description
1.	Claim (C)	A claim is an initial statement or opinion expressed by an individual, serving as the foundation of reasoning to be accepted generally. In the process of making a claim, it can either support or refute a

		statement or argument. Students can present their statements based on data that is credible and verifiable.
2.	Data (D)	Following a claim in an argument, data is required as factual support to substantiate the claim. A claim in an argument must be supported by data or evidence to ensure that the statement presented is well-founded and accountable. When providing evidence, it is essential to consider accuracy in addressing the question.
3.	Warrant (W)	Justification refers to logical reasoning intended to support a claim and data as a basis for credibility and widely accepted values. By understanding justification through the claims presented in an argument, students can effectively follow and comprehend the subject matter.
4.	Backing (B)	Support refers to additional information, evidence, and other arguments that further reinforce the warrant. The form of support includes enthusiasm for the previously stated warrant. Support can take the form of rebuttals, suggestions, revisions, or other opinions that align with the given statement.

The classification of argument structure completeness follows the categories established by Dawson and Venville (2009), as shown in Table 2.

Table 2. Analysis of argumentation in terms of organ completeness

Level	Criteria	Score
1	Claim	1
2	Claim, Data	2
3	Claim, Data, Warrant	3
4	Claim, Data, Warrant, Backing	4

Meanwhile, the level of scientific reasoning in argumentation is assessed according to the categorization developed by Cetin (2014), as presented in Table 3.

Table 3. Analysis of argumentation in terms of scientific validity

Level	Criteria	Score
C	Only claim	1
B2	Claim, supported by false scientific arguments	2
B1	Claim, supported by irrelevant arguments	3
A2	Claim, supported by correct scientific arguments	4
A1	Claim, supported by correct and relevant scientific arguments	5

The validity and reliability tests were conducted to ensure the accuracy and consistency of the instrument. The validity test assesses the extent to which an instrument is considered valid (Ali and Khaeruddin 2012). The validity test was carried out through an assessment by five experts and analyzed using Aiken's V test. The results indicated an instrument coefficient V value of 0.90. Referring to the V index table, an instrument evaluated by five experts using a Likert scale of 1–5 is considered valid if the V coefficient value is ≥ 0.8 (Bashooir and Supahar 2018). The reliability test was conducted on 19 students. The analysis was performed by calculating the Cronbach's alpha score using SPSS 22. The Cronbach's Alpha score is presented in Table 4.

Table 4. Result of cronbach's alpha score

Number of Question		Crombach's Alpha	R_{table}	Decision
Organ Completeness	Question 1	0.783	0.456	Reliable
	Question 2	0.750		Reliable
Scientific Validity	Question 1	0.755		Reliable
	Question 2	0.707		Reliable

Research data analysis was conducted using the difference test and N-Gain. The data analysis procedure consisted of the following steps:

1. Analyzing students' responses to determine the completeness of argument components and the level of scientific reasoning.
2. Conducting an Inter-Rater Reliability (IRR) test to ensure the objectivity and reliability of response analysis results. The IRR test assesses the level of agreement among experts on the same object by involving two raters. This test employs Cohen's Kappa coefficient, analyzed using SPSS 22. The reference table for Kappa coefficient categories, as suggested by Regier et al. (2012), is presented in Table 5.

Table 5. Kappa coefficient categories

Value of k	Agreement Criteria
0.00–0.20	Unacceptable
0.20–0.39	Questionable
0.40–0.59	Good
0.60–0.79	Very Good
0.80–1.00	Excellent

3. The pretest and posttest scores are converted to a 1-100 scale using the following formula:

$$\text{Score} = \frac{\text{Total Score}}{\text{Maximum Score}} \times 100$$

4. A normality test is conducted to determine whether the data follows a normal distribution, as this affects the choice of statistical analysis. If the data is normally distributed, parametric statistical tests such as the T-test can be applied. However, if the data is not normally distributed, non-parametric tests such as the Mann-Whitney test will be used (Nuryadi et al. 2017).
5. Subsequently, statistical analysis and N-Gain calculations are performed. The basis for decision-making is based on the criteria of the N-Gain value according to (Hake, 1999) in the following if $g < 0,30$ as low category, if $0,30 \leq g \leq 0,70$ as medium category, and if $g > 0,70$ as high category. Based on the N-Gain test, a learning model is considered effective if the Gain Score obtained is > 0,3 or at least falls into the moderate category (Dewi, Yahya, and Darmawang 2022).

▪ RESULT AND DISSCUSSION

This study focuses on whether there are differences in the scientific argumentation skills of male and female students after the implementation of the Argument-Driven Inquiry (ADI) learning model and how their argumentation patterns differ. Scientific argumentation is examined based on the completeness of argument components and the level of scientific reasoning. The aspect of argument component completeness consists of four levels (Dawson and Venville 2009), meanwhile the aspect of scientific validity consists of five categories (Cetin 2014).

Result

The results of this analysis are then subjected to an Inter-Rater Reliability (IRR) test to ensure the objectivity and reliability of the response analysis. The IRR test measures the level of agreement among experts evaluating the same object by involving two raters. The results of this test are presented in Table 6.

Table 6. Result of inter-rater reliability (IRR)

Class		**Value of k**	**Agreement Criteria**	**Sig.**
Eksperiment 1	Pretest	0.652	Very Good	0.000
	Posttest	0.783	Very Good	0.000
Eksperiment 2	Pretest	0.652	Very Good	0.000
	Posttest	1	Excellent	0.000

Based on Table 6, the Cohen's Kappa coefficient criteria for the inter-rater reliability test in the pretest and posttest indicate a very good and excellent level of agreement. The significance value (sig.) is < 0.05, demonstrating a statistically significant agreement between the two raters. Consequently, the IRR results confirm that the analysis of students' pretest and posttest responses is reliable for use. Following the IRR test, the scores were converted to a 1–100 scale for both argument component completeness and scientific reasoning. The conversion results are presented in Table 7 and Table 8.

Table 7. Scores of scientific argumentation in organ completeness aspect

Score	**Experimental Class 1**		**Experimental Class 2**	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Highest	75	100	75	100
Lowest	25	50	25	50
Average	**47.58**	**84.67**	**47.60**	**95.96**
Std. Dev	17.50	16.68	20.23	11.35

Table 8. Scores of scientific argumentation in scientific validity aspect

Score	**Experimental Class 1**		**Experimental Class 2**	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Highest	60	100	60	100
Lowest	20	40	20	40
Average	**33.23**	**75.81**	**33.87**	**82.26**

Std. Dev	10.76	20.61	11.45	20.11

The next step, after obtaining the scores from both classes for both the pretest and posttest, is to conduct a prerequisite test, namely the normality test. The results of the normality test are presented in Table 9 and Table 10.

Table 9. Results of the normality test calculation for experimental class 1

Result	Sig.	Description
Pretest of Organ Completeness	0.000	Not normal
Pretest of Scientific Validity	0.000	Not normal
Posttest of Organ Completeness	0.000	Not normal
Posttest of Scientific Validity	0.002	Not normal

Table 10. Results of the normality test calculation for experimental class 2

Result	Sig.	Description
Pretest of Organ Completeness	0.000	Not normal
Pretest of Scientific Validity	0.001	Not normal
Posttest of Organ Completeness	0.000	Not normal
Posttest of Scientific Validity	0.000	Not normal

Based on the SPSS output, the significance value (sig.) obtained using the Shapiro-Wilk test is less than 0.05 (sig. < 0.05) for both the pretest and posttest results of Experimental Class 1 and Experimental Class 2. Therefore, it can be concluded that the data are not normally distributed. The appropriate statistical approach for this condition is a nonparametric test, as the assumption of normality is not met. Consequently, the Mann-Whitney test is employed for unpaired data. The results of the Mann-Whitney test are presented in Table 11 and Table 12 below.

Table 11. Results of the mann-whitney test on aspects of organ completeness

Result	Asymp. Sig. (2-tailed)	Decision
Pretest	0.864	There was no significant difference
Posttest	0.002	There is a significant difference

Table 12. Results of the mann-whitney test on aspects of scientific validity

Result	Asymp. Sig. (2-tailed)	Decision
Pretest	0.809	There was no significant difference
Posttest	0.212	There was no significant difference

To determine the magnitude of change in results before and after the treatment, the next step is the Normalized Gain (N-Gain) test. The results of the N-Gain test are presented below.

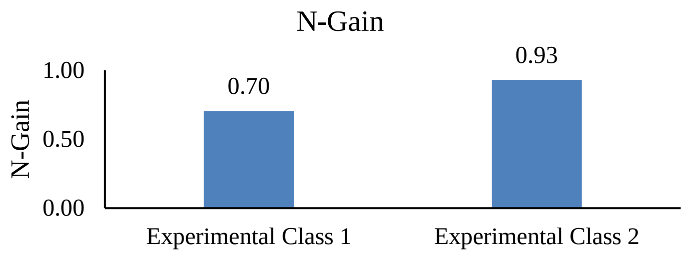


Figure 1. Result of N-Gain Test of Organ Completeness

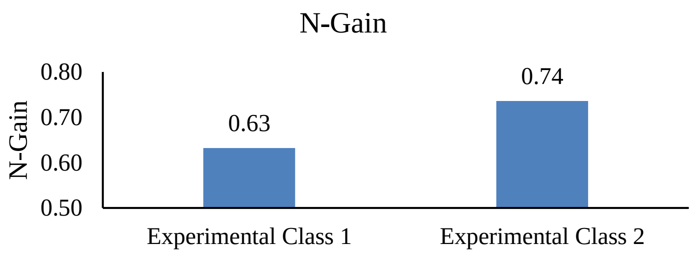


Figure 2. Result of n-gain test of scientific validity

Discussion

Scientific Argumentation in Terms of Organ Completeness

Overall, the experimental class 2, consisting of female students, demonstrated superior argumentation skills in terms of argument structure completeness. As shown in Table 7, the pretest mean score for experimental class 1 was 47.58, while for experimental class whereas for experimental class 2, it reached 95.97. Based on the average scores of argument structure completeness, both experimental classes experienced an overall improvement in argumentation skills.

Based on the output of the Mann-Whitney test for the pretest scores in the aspect of argument structure completeness, the Asymp. Sig. (2-tailed) value was greater than 0.05. This indicates that there was no significant difference in the mean scores between experimental class 1 and experimental class 2 before the treatment was applied, meaning that both classes had similar initial conditions. However, based on the Mann-Whitney test output for the posttest scores in the same aspect, the Asymp. Sig. (2-tailed) value was less than 0.05. This suggests that there was a significant difference in the mean scores between experimental class 1 and experimental class 2 after the treatment, indicating that the intervention led to measurable differences between the two groups.

Based on the results of the N-Gain test, a difference in the improvement of students' scientific argumentation in terms of argument structure completeness was observed between Experimental Class 1 and Experimental Class 2. Experimental Class 2, consisting of female students, demonstrated a greater improvement in argumentation skills in the aspect of argument structure completeness compared to Experimental Class 1, which consisted of male students

The results of scientific argumentation in the first aspect, namely argument structure completeness, were analyzed by focusing on students' responses in constructing claims, data, warrants, and backings. The analysis of argument structure completeness does not evaluate the accuracy of a concept (scientific validity) in the argumentation developed

(Siswanto et al. 2022). This aspect in experimental class 1 there is a pattern of changes in scientific arguments in the two question items presented in the following Figure 3 summary. This is similar in experimental class 2 that there is a pattern of changes in scientific arguments in the two question items presented in the following Figure 4 summary

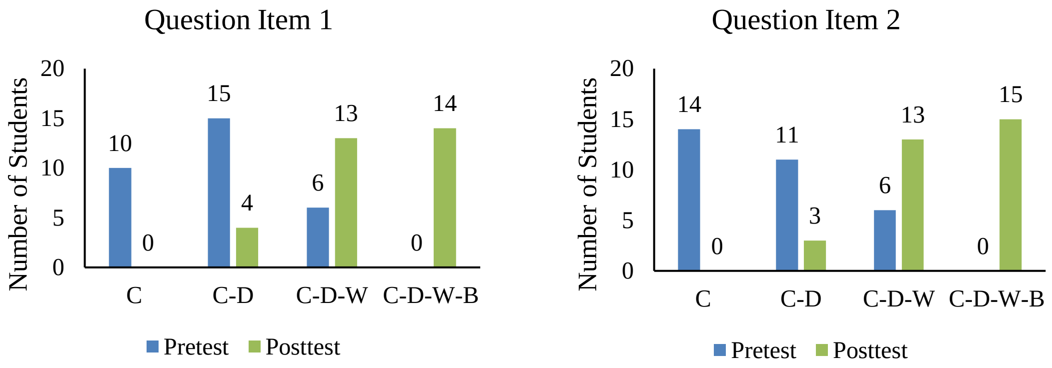


Figure 3. Level of results for organ completeness aspects in experimental class 1

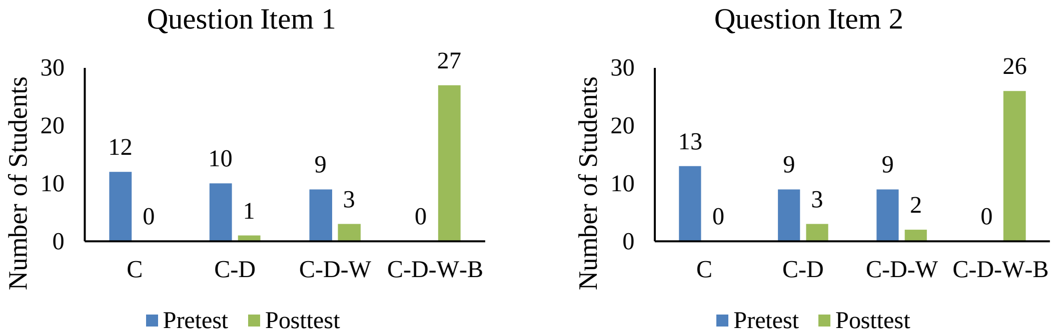


Figure 4. Level of results for organ completeness aspects in experimental class 2

In both Experimental Class 1 and Experimental Class 2, after the implementation of the Argument-Driven Inquiry (ADI) learning model, a shift in argumentation patterns was observed. Prior to the implementation, the majority of patterns were C-D, C-D-W, and C-D-W-B. After applying ADI, the dominant patterns shifted to C-D-W and C-D-W-B, with some distribution still in C-D. The ADI learning model has been proven to facilitate changes and improvements in students' argumentation patterns in terms of argument structure completeness. This finding aligns with the study by Mazita (2024), which demonstrated that the ADI learning model enhances students' scientific argumentation, particularly in the aspect of argument structure completeness.

The patterns of scientific argumentation in the aspect of argument structure completeness are as follows: The C pattern consists of responses such as 'Yes' or 'No' without supporting data, warrants, or backings. Arguments with this pattern are classified at level 1 and receive a score of 1 for both question item 1 and question item 2.

The C-D argumentation pattern consists of a claim such as 'Yes' or 'No, that is incorrect,' accompanied by data derived from the question components. In question item

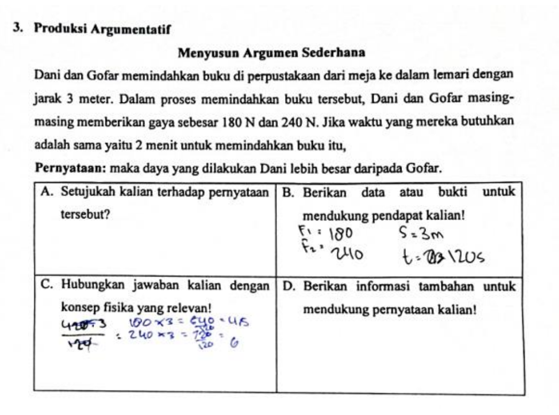
1, the data include the given force value (120 N), the distance traveled by the horse (50 meters), and the time required for the journey (10 minutes = 600 seconds). In question item 2, the data include the resultant force exerted by four individuals ($\sum F = 500$ N), the cart's travel distance (s = 10 meters), and the power exerted (P = 20 J/s). This pattern lacks a warrant and backing. Arguments following this pattern are classified at level 2 and receive a score of 2.

The C-D-W argumentation pattern includes a claim such as 'Yes' or 'No, that is incorrect,' along with data as described previously. Additionally, a warrant is provided, which consists of the concept of work, including the relevant formula. The components from the data are substituted into the power formula to justify the claim. The warrant serves as the logical basis for accepting or rejecting a statement. Arguments with this pattern are classified at level 3 and receive a score of 3.

The C-D-W-B argumentation pattern follows the same structure as C-D-W but includes a backing. In this case, a student might state: 'Power is the amount of work done per unit of time. Based on the power formula, the calculated time is 250 seconds, which confirms the given statement, and I agree with it.' This additional justification serves as the backing, reinforcing the claim and warrant. Arguments with this pattern are classified at level 4 and receive a score of 4.

In the learning process using the Argument-Driven Inquiry (ADI) model, findings from classroom observations indicate differences in how male and female students construct simple arguments. These differences become apparent during the argumentation structuring stage. Female students generally present more structured scientific arguments, providing more comprehensive information about the given phenomenon or problem. Additionally, female students tend to articulate their arguments in greater detail, systematically organizing data and evidence. Their cognitive processes during this learning activity reflect a more systematic approach to constructing arguments compared to their male counterparts.

Male students tend to construct scientific arguments more concisely and succinctly. They focus primarily on the core issue without providing excessive additional details. The argumentation style of male students is more direct, emphasizing the main points of their argument. Although their responses are more brief and compact, they still reflect an understanding of the material. This difference highlights variations in cognitive styles between male and female students. This finding aligns with the research of Cahyono (



3. Produksi Argumentatif

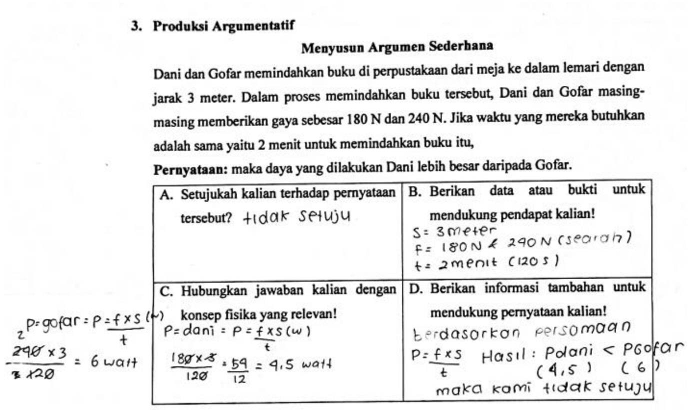
Menyusun Argumen Sederhana

Dani dan Gofar memindahkan buku di perpustakaan dari meja ke dalam lemari dengan jarak 3 meter. Dalam proses memindahkan buku tersebut, Dani dan Gofar masing-masing memberikan gaya sebesar 180 N dan 240 N. Jika waktu yang mereka butuhkan adalah sama yaitu 2 menit untuk memindahkan buku itu,

Pernyataan: maka daya yang dilakukan Dani lebih besar daripada Gofar.

A. Setujukah kalian terhadap pernyataan tersebut?	B. Berikan data atau bukti untuk mendukung pendapat kalian! F1 : 180 S = 3m F2 : 240 t = 120s
C. Hubungkan jawaban kalian dengan konsep fisika yang relevan! 180 × 3 = 540/120 = 4,5 240 × 3 = 720/120 = 6	D. Berikan informasi tambahan untuk mendukung pernyataan kalian!

(a)


3. **Produksi Argumentatif**

Menyusun Argumen Sederhana

Dani dan Gofar memindahkan buku di perpustakaan dari meja ke dalam lemari dengan jarak 3 meter. Dalam proses memindahkan buku tersebut, Dani dan Gofar masing-masing memberikan gaya sebesar 180 N dan 240 N. Jika waktu yang mereka butuhkan adalah sama yaitu 2 menit untuk memindahkan buku itu,

Pernyataan: maka daya yang dilakukan Dani lebih besar daripada Gofar.

A. Setujukah kalian terhadap pernyataan tersebut? tidak setuju	B. Berikan data atau bukti untuk mendukung pendapat kalian! S = 3 meter F = 180 N & 240 N (searah) t = 2 menit (120 s)
C. Hubungkan jawaban kalian dengan konsep fisika yang relevan! P = dani = P = F x S / t (w) 180 x 3 / 120 = 54 / 12 = 4,5 watt	D. Berikan informasi tambahan untuk mendukung pernyataan kalian! berdasarkan persamaan P = F x S / t Hasil : Pdani < PGofar (4,5) (6) maka kami tidak setuju

P = gofar : P = F x S / t (w) 240 x 3 / 120 = 6 watt

(b)

Figure 5. Differences in response structures between male (a) and female (b) students

2017), which revealed that female students tend to express reasoning and evidence in a detailed, comprehensive, clear, and relevant manner while also drawing conclusions and supporting their claims effectively. Similarly, a study by Noroozi et al. (2023) found that female students generally provide stronger arguments than males by formulating factual statements accompanied by supporting evidence. Furthermore, Sulistiana et al. (2013), reinforced this notion by demonstrating that female students tend to excel in verbal abilities, such as vocabulary range, comprehension of complex texts, and fluency in language use, whereas male students exhibit stronger spatial reasoning skills.

Scientific Argumentation in Terms of Scientific Validity

In the pretest, both experimental classes had the same highest and lowest scores, namely 60 and 20, respectively. Similarly, in the posttest, both classes exhibited the same highest and lowest scores, which were 100 and 40, respectively. The average pretest scores for Experimental Class 1 and Experimental Class 2 were 33.23 and 33.87, respectively. However, in the posttest, Experimental Class 2 outperformed Experimental Class 1, with an average score of 82.26 compared to 75.81.

Based on the Mann-Whitney test output for the pretest scores in the scientific argumentation aspect, the Asymp. Sig. (2-tailed) value was greater than 0.05. This indicates that there was no significant difference in the average scores between Experimental Class 1 and Experimental Class 2 before the treatment, meaning that both groups were equivalent prior to the intervention. Similarly, the Mann-Whitney test results for the posttest scores in the scientific argumentation aspect also showed an Asymp. Sig. (2-tailed) value greater than 0.05, indicating no significant difference between the two classes after the treatment.

The N-Gain test results, however, demonstrated that there was a difference in the improvement of students' scientific argumentation skills between Experimental Class 1 and Experimental Class 2. Female students in Experimental Class 2 showed greater improvement in the scientific argumentation aspect compared to male students in Experimental Class 1.

The results of scientific argumentation in the second aspect, namely scientific validity, focus on the correctness or logical reasoning in students' written responses to the given concepts. The levels of scientific accuracy are categorized into five levels: Level

C, B2, B1, A2, and A1, each with specific criteria as previously described. The results of the pretest and posttest of the research in the experimental class 1 there was a change in scientific validity, the scientific aspect is presented in the following Figure 6. This is similar in experiment class 2 that there is a change in the level of scientific argumentation in the scientific aspect of the pretest and posttest. Summary in Figure 7 below.

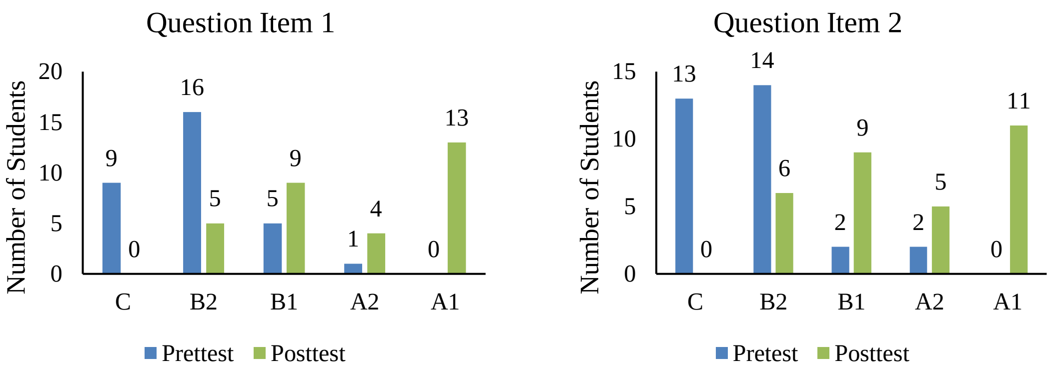


Figure 6. Level of results for scientific validity aspects in experimental class 1

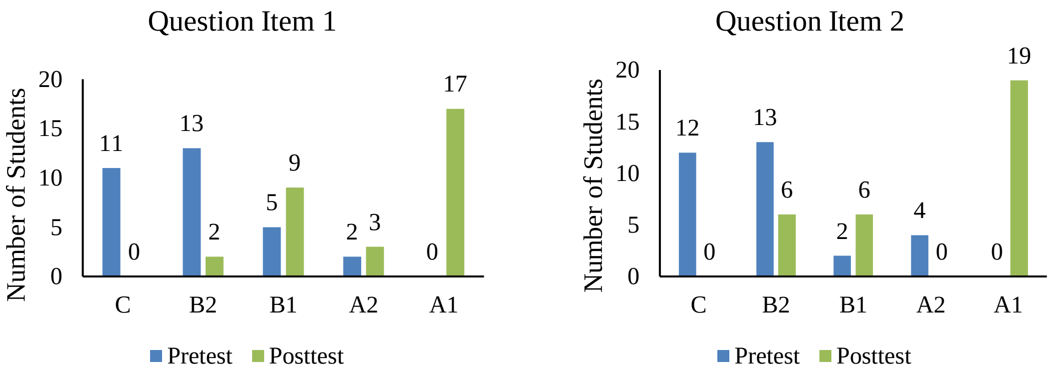


Figure 7. Level of results for scientific validity aspects in experimental class 2

The implementation of the Argument-Driven Inquiry (ADI) learning model in both Experimental Class 1 and Experimental Class 2 resulted in a shift in the levels of scientific argumentation. Before the treatment, pretest results indicated that most students constructed arguments at levels C, B2, and B1, demonstrating limited scientific reasoning and justification. However, after the application of ADI, the majority of students were able to formulate arguments at higher levels, specifically A2 and A1, with a distribution still present in B1 and B2. This finding suggests that the ADI learning model played a significant role in enhancing students' ability to construct scientifically valid arguments.

Students' argumentation regarding scientific validity was assessed through two test items. At Level C, students provided only a claim, such as "Yes" or "No," without any supporting explanation. Responses at this level lacked scientific reasoning and were classified as scientifically unacceptable, receiving a score of 1. At Level B2, students presented a claim along with supporting data derived from the given problem statement. For instance, in test item 1, the problem provided information about the force applied

(120 N), the horse's displacement (50 meters), and the time taken for the journey (10 minutes = 600 seconds). Similarly, in test item 2, the given data included the resultant force exerted by four individuals ($\sum F = 500$ N), the cart's displacement (s = 10 meters), and the power output (P = 20 J/s). However, if the claim was incorrect, or if the claim was correct but the supporting data were inaccurate, the argument was categorized as Level B2, which received a score of 2.

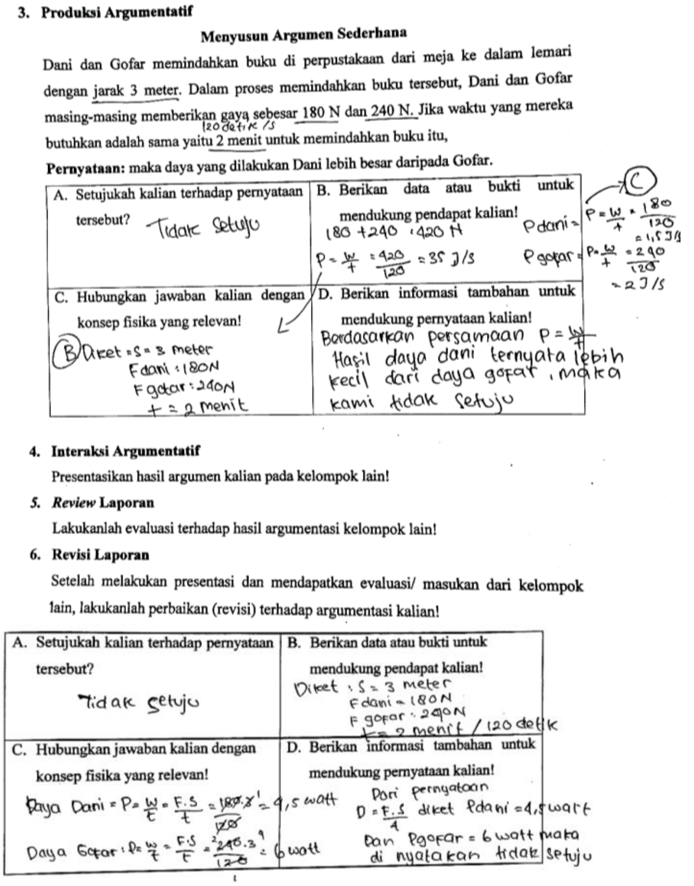
At Level B1, students provided a claim supported by correct data, ensuring that their response was partially acceptable. However, their reasoning lacked depth, as it did not explicitly connect the claim to relevant scientific concepts. Arguments at this level were given a score of 3. Moving to the higher levels, Level A2 consisted of arguments that included a claim, correct supporting data, and a partially accurate reasoning process. Although the explanation demonstrated logical connections, some elements of scientific justification were either incomplete or insufficiently developed. Responses in this category were considered mostly scientifically acceptable and were assigned a score of 4.

At the highest level, Level A1, students formulated arguments that were scientifically valid and well-structured. Their responses incorporated a clear claim, accurate supporting data, and a strong reasoning process that effectively linked the given problem components to fundamental scientific principles. For instance, in test item 1, students utilized the given force, displacement, and time values to apply the concept of work and energy. Similarly, in test item 2, students accurately employed the power equation, integrating the provided data to justify their claim. The inclusion of logical reasoning based on scientific concepts allowed these responses to be categorized as Level A1, earning the highest possible score of 5.

The overall trend observed in both experimental classes indicated that, after implementing ADI, most students were able to construct scientifically sound arguments, with the majority reaching Levels A1 and A2. This progression suggests that the ADI model effectively facilitated students' ability to develop logical explanations, analyze given data, and connect their reasoning with relevant scientific principles. The structured learning process within ADI, which involved group discussions and engagement with scientific texts, played a crucial role in fostering these improvements. Through these activities, students actively examined information, formulated coherent arguments, and refined their understanding of scientific concepts, ultimately enhancing their scientific validity skills.

In the argumentation dialogue session of the ADI learning model, students present their group findings to other groups while defending their arguments. The arguments conveyed are the result of an in-depth analytical and evaluative process conducted within small groups, where students critically examine and refine their reasoning. This dialogue session takes place after group discussions, providing an opportunity for students to articulate and justify their arguments beyond their initial group setting.

During this session, students receive feedback from both peers and teachers, fostering deeper critical thinking and prompting further reflection on the analyses conducted in their small groups. The structured nature of ADI learning not only enhances students' scientific reasoning but also trains them to construct and communicate logical, evidence-based arguments. Through this process, students are actively engaged in generating, critiquing, and evaluating scientific evidence to develop well-founded explanations and arguments (Grooms, Enderle, and Sampson 2015). The findings of this study further emphasize that ADI effectively cultivates students' scientific validity argumentation skills (Bukifan and Yuliati 2021).


3. Produksi Argumentatif

Menyusun Argumen Sederhana

Dani dan Gofar memindahkan buku di perpustakaan dari meja ke dalam lemari dengan jarak 3 meter. Dalam proses memindahkan buku tersebut, Dani dan Gofar masing-masing memberikan gaya sebesar 180 N dan 240 N. Jika waktu yang mereka butuhkan adalah sama yaitu 2 menit untuk memindahkan buku itu,

Pernyataan: maka daya yang dilakukan Dani lebih besar daripada Gofar.

A. Setujukah kalian terhadap pernyataan tersebut? Tidak setuju	B. Berikan data atau bukti untuk mendukung pendapat kalian!
C. Hubungkan jawaban kalian dengan konsep fisika yang relevan!	D. Berikan informasi tambahan untuk mendukung pernyataan kalian! Berdasarkan persamaan P = W/t Hasil daya dani ternyata lebih kecil dari daya gofar, maka kami tidak setuju

4. Interaksi Argumentatif

Presentasikan hasil argumen kalian pada kelompok lain!

5. *Review* Laporan

Lakukanlah evaluasi terhadap hasil argumentasi kelompok lain!

6. Revisi Laporan

Setelah melakukan presentasi dan mendapatkan evaluasi/ masukan dari kelompok lain, lakukanlah perbaikan (revisi) terhadap argumentasi kalian!

A. Setujukah kalian terhadap pernyataan tersebut? Tidak setuju	B. Berikan data atau bukti untuk mendukung pendapat kalian! Diket : S = 3 meter, F dani = 180 N, F gofar = 240 N, t = 2 menit / 120 detik
C. Hubungkan jawaban kalian dengan konsep fisika yang relevan! Daya Dani = P = W/t = F.S/t = 4,5 watt; Daya Gofar : P = W/t = F.S/t = 6 watt	D. Berikan informasi tambahan untuk mendukung pernyataan kalian! Dari pernyataan P = F.S/t diket Pdani = 4,5 watt Dan Pgofar = 6 watt maka di nyatakan tidak setuju

Figure 8. Quality of student responses after the report revision session

The revision session in the ADI learning model allows students to refine their arguments based on feedback received during the argumentation dialogue. This phase encourages students to critically reassess their claims, incorporate relevant evidence, and enhance the logical coherence of their explanations. After the revision session, the quality of student responses shows significant improvement, with more structured reasoning, clearer justification, and stronger connections between data and scientific principles. Figure 8 illustrates this progression, highlighting how students integrate constructive feedback to refine their arguments. The enhanced quality of responses demonstrates the effectiveness of ADI in fostering scientific literacy and critical thinking, as students engage in iterative processes of argument construction and revision.

According to research by Piraksa et al. (2014) and Eymur (2019), the ADI learning model, which integrates argumentation and inquiry, helps students develop scientific thinking habits. In its implementation, both experimental classes actively engaged in peer discussions to enhance the quality of their scientific reasoning. Throughout the learning process, both male and female students demonstrated enthusiasm in constructing and presenting arguments based on the provided data. This activity encouraged students to engage in discussions, fostering a deeper conceptual understanding through critical thinking and resulting in valid (scientific) arguments. Consequently, both experimental groups exhibited improvements in scientific reasoning quality. This finding aligns with the study by Bezci and Sungur (2021), which reported no significant differences in scientific reasoning abilities between male and female students at the secondary school level.

Overall Scientific Argumentation

Overall scientific argumentation is assessed based on the pretest and posttest scores for argument completeness and scientific validity in both experimental class 1 and experimental class 2. This indicates that the results of scientific argumentation ability are derived from the average of these two aspects. A comprehensive analysis of argument completeness and scientific validity has been provided in the previous discussion. The overall scientific argumentation score represents the average value obtained from both argument completeness and scientific validity. This score serves as a measure of students' scientific argumentation ability. The following Table 13 presents the data on scientific argumentation scores.

Table 13. Scores of overall scientific argumentation

Score	Experimental Class 1		Experimental Class 2	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Highest	67.5	100	67.5	100
Lowest	22.5	45	22.5	45
Average	**40.40**	**80.24**	**40.73**	**89.11**
Std. Dev	13.53	17.46	15.48	14.31

Based on the data presented in Table 13, the Overall Scientific Argumentation scores in both Experimental Class 1 and Experimental Class 2 exhibited the same highest and lowest pretest scores, namely 67.5 and 22.5, respectively. Similarly, in the posttest, both classes recorded identical highest and lowest scores of 100 and 45, respectively. The average pretest scores for Experimental Class 1 and Experimental Class 2 were 40.40 and 40.73, respectively. However, in the posttest, Experimental Class 2 demonstrated superior performance, achieving an average score of 89.11, compared to 80.24 in Experimental Class 1. These findings indicate that the Argument-Driven Inquiry (ADI) learning model is effective in enhancing scientific argumentation, as reflected in the significant increase in pretest and posttest scores in both experimental classes.

To further analyze the effectiveness of the intervention, the Mann-Whitney test was conducted to compare scientific argumentation skills in the pretest and posttest. This statistical approach, a type of nonparametric test, was employed due to the data being unpaired and not meeting the prerequisite conditions for parametric testing (non-normal data distribution). The results of the Mann-Whitney test for scientific argumentation are presented in Table 14 below.

Table 14. Results of the mann-whitney test on overall scientific argumentation

Result	Asymp. Sig. (2-tailed)	Decision
Pretest	0.879	There was no significant difference

Posttest	0.028	There is a significant difference

The findings of this study indicate that the hypothesis test for the pretest values was conducted using a nonparametric statistical method, specifically the Mann-Whitney test. The results of this test showed that the Asymp. Sig. (2-tailed) value was greater than 0.05, leading to the acceptance of H0 and the rejection of Ha. This suggests that there was no significant difference in the average pretest scores between Experimental Class 1 and Experimental Class 2 before the intervention, indicating that students in both groups had comparable initial abilities. Conversely, the results of the posttest hypothesis test, also conducted using the Mann-Whitney test, revealed that the Asymp. Sig. (2-tailed) value was less than 0.05. This led to the rejection of H0 and the acceptance of Ha, indicating a statistically significant difference in the average posttest scores between the two experimental groups after the intervention. In both Experimental Class 1 and Experimental Class 2, students were exposed to the same instructional approach.

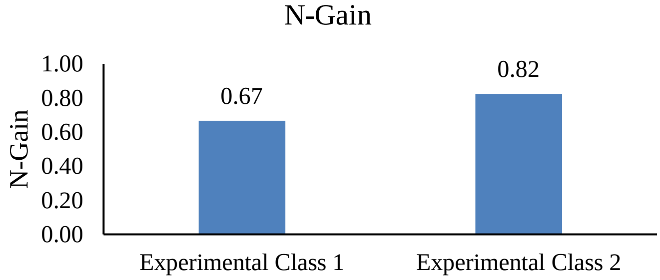


Figure 9. Result of n-gain test of overall scientific argumentation

As presented in figure 9, the application of the ADI learning model resulted in a gain score of 0.67 for Experimental Class 1, categorized as moderate, whereas Experimental Class 2 achieved a higher gain score of 0.82, categorized as high. These findings suggest that the ADI learning model effectively enhances students' scientific argumentation skills in both groups. However, the increase in argumentation quality was more pronounced in Experimental Class 2, where female students demonstrated a greater improvement.

Overall Scientific argumentation in this study was evaluated based on two key aspects: argument completeness and scientific validity. The overall scientific argumentation score was derived from the average of these two aspects. Argument completeness refers to how well students construct an argument structure that includes claims, data, warrants, and backing, ensuring that all components are systematically organized. Meanwhile, scientific validity emphasizes the accuracy and appropriateness of the scientific concepts used in constructing arguments, where each claim must be supported by valid and relevant evidence. These two aspects are interdependent in producing well-structured arguments with a strong scientific foundation, ensuring that the arguments are both logically sound and scientifically acceptable. The integration of both aspects is essential for comprehensive argumentation skills, as argued by Siswanto et al. (2022).

The ADI learning model is designed to support the development of scientific argumentation skills by reinforcing both the structural and scientific validity aspects of argumentation. Through structured stages, the ADI model facilitates group discussions, evidence collection, and argumentation sessions, allowing students to construct arguments that are not only well-organized but also supported by valid scientific evidence. Each phase of the ADI learning process encourages students to refine their reasoning and ensure that their arguments meet both structural and scientific criteria, ultimately leading to a deeper understanding and clearer articulation of ideas (Siswanto et al., 2022).

During the ADI learning process, female students tended to present more structured and detailed arguments, incorporating comprehensive information and logically arranged reasoning. In contrast, male students generally provided shorter and more concise arguments. This difference resulted in a significant variation in argument completeness, with female students demonstrating superior performance in structuring their arguments. Within scientific discussions, students engaged in collaborative activities to search for and analyze correct concepts, thereby improving the quality of their scientific arguments. Furthermore, these discussions facilitated the exchange of scientifically valid and conceptually accurate arguments.

Throughout the study, both Experimental Class 1 and Experimental Class 2 actively participated in peer discussions, producing high-quality arguments. The level of engagement in argumentation-based learning did not differ significantly between the two classes. However, when analyzing the overall scientific argumentation scores, female students in Experimental Class 1 outperformed their male counterparts, despite both groups exhibiting significant improvement. This suggests that, in terms of both argument completeness and scientific validity, there were notable gender-based differences, with female students demonstrating stronger performance. These findings align with the research of Afifah & Faizah (2023), which also found that female students tend to excel in scientific argumentation compared to male students.

▪ CONCLUSION

Based on the results and discussion, this study confirms that the implementation of the ADI learning model is effective in enhancing students' argumentation skills in both Experimental Class 1 and Experimental Class 2. Furthermore, the findings of this study lead to the following conclusions: 1) In the aspect of argument completeness, a significant difference was observed between male and female students, with female students demonstrating superior argument completeness; 2) In terms of scientific validity within argumentation, no significant difference was found between male and female students; 3) Regarding overall scientific argumentation, a significant difference was observed between male and female students, with female students outperforming their male counterparts.

▪ REFERENCES

Afgani, T., Hasnunidah, N., & Surbakti, A. (2020). *Pengaruh model pembelajaran argument-driven inquiry (ADI) dan gender terhadap keterampilan argumentasi siswa SMP pada materi pokok sistem pencernaan manusia*. Jurnal Bioterdidik: Wahana Ekspresi Ilmiah, 8(1), 1-10.

Afifah, H., & Faizah, U. N. (2023). *Analisis kemampuan berpikir ilmiah menggunakan soal berbasis masalah ditinjau dari perbedaan gender*. Jurnal Tadris IPA Indonesia, 3(2), 190-199.

Ali, S., & Khaeruddin. (2012). "*Evaluasi pembelajaran*." i–101.

Amandus Hutasoit, S. (2021). "*Pembelajaran teacher centered learning (tcl) dan project based learning (pbl) dalam pengembangan kinerja ilmiah dan peninjauan karakter siswa*." *Jurnal Pendidikan Indonesia* 2(10):1775–99. doi: 10.59141/japendi.v2i10.294.

Andayani. 2008. "*Review: gender dan performansi kognitif*." *Gender Differences in Human Cognition* 137–52.

Anita, A., & Tenriawaru, A. (2019). *Pentingnya keterampilan argumentasi di era ledakan informasi digital.* In Prosiding Seminar Nasional FKIP Universitas Tanjungpura, August (pp. 1740-1746).

Aza Mazita, S., Singgih, S., Dewantari, N., & Bimo, D. S. (2024). Implementation of argument driven inquiry instructional model to improve cognitive learning outcomes.

Bashooir, K., & Supahar, S. (2018). *Validitas dan reliabilitas instrumen asesmen kinerja literasi sains pelajaran Fisika berbasis STEM.* Jurnal penelitian dan evaluasi pendidikan, 22(2), 219-230.

Bezci, F., & Sungur, S. (2021). How is middle school students' scientific reasoning ability associated with gender and learning environment?. Science Education International, 32(2), 96-106.

Bukifan, D., & Yuliati, L. (2021, March). Conceptual understanding of physics within argument-driven inquiry learning for STEM education: Case study. In AIP Conference Proceedings (Vol. 2330, No. 1). AIP Publishing.

Cahyono, B. (2017). *Analisis ketrampilan berfikir kritis dalam memecahkan masalah ditinjau perbedaan gender*. AKSIOMA: Jurnal Matematika dan Pendidikan Matematika, 8(1), 50-64.

Cetin, P. S. (2014). Explicit argumentation instruction to facilitate conceptual understanding and argumentation skills. Research in Science & Technological Education, 32(1), 1-20.

Dawson, V., & Venville, G. J. (2009). High-school students' informal reasoning and argumentation about biotechnology: An indicator of scientific literacy?. International Journal of Science Education, 31(11), 1421-1445.

Dewi, A. C., Yahya, M., & Darmawang, D. (2022). *Efektifitas model pembelajaran berbasis proyek pada mata kuliah perencanaan pembelajaran kejuruan.* Jurnal Konsepsi, 11(2), 373-379.

Eggen, P. D., & Kauchak, D. P. (2004). Educational psychology: Windows on classrooms. (No Title).

Erdiana, N., Bahri, S., & Akhmal, C. N. (2019). Male vs. female EFL students: Who is better in speaking skill?. Studies in English Language and Education, 6(1), 131-140.

Eti, N. (2014). *Psikologi perempuan dalam berbagai perspektif*.

Eymur, G. (2019). The influence of the explicit nature of science instruction embedded in the argument-driven inquiry method in chemistry laboratories on high school students' conceptions about the nature of science. Chemistry Education Research and Practice, 20(1), 17-29.

Fakhriyah, F., Rusilowati, A., & Susilaningsih, E. (2021). Argument-driven inquiry learning model: a systematic review. International Journal of Research in Education and Science, 7(3), 767-784.

Grooms, J., Enderle, P., & Sampson, V. (2015). Coordinating scientific argumentation and the Next Generation Science Standards through argument driven inquiry. Science Educator, 24(1), 45-50.

Hardini, S. D., & Alberida, H. (2022). *Analisis kemampuan argumentasi peserta didik.* Biodidaktika: Jurnal Biologi Dan Pembelajarannya, 17(1).

Ikhsan, M. H. (2023). *Pendidikan karakter berbasis gender.* INCARE, International Journal of Educational Resources, 4(4), 365-387.

Baharsyah, A. I., & Admoko, S. (2020). *Analisis kemampuan argumentasi ilmiah siswa berbasis pola toulmins argument pattern (TAP) menggunakan model argument driven inquiry dan diskusi pada pembelajaran fisika SMA.* IPF: Inovasi Pendidikan Fisika, 9(3), 318-324.

Lenaini, I. (2021). *Teknik pengambilan sampel purposive dan snowball sampling.* Historis: Jurnal Kajian, Penelitian dan Pengembangan Pendidikan Sejarah, 6(1), 33-39.

Lestari, S. (2018). *Peran teknologi dalam pendidikan di era globalisasi.* EDURELIGIA: Jurnal Pendidikan Agama Islam, 2(2), 94-100.

Mahanal, S. (2014, September). *Peran guru dalam melahirkan generasi emas dengan keterampilan abad 21.* In Seminar Nasional Pendidikan HMPS Pendidikan Biologi FKIP Universitas Halu Oleo (Vol. 1, pp. 1-16).

Nurisyani, A. (2019). *Penerapan model pembelajaran argument driven inquiry untuk meningkatkan keterampilan berpikir kritis peserta didik pada materi usaha dan energi* (Doctoral dissertation, UIN Sunan Gunung Djati Bandung).

Muhajir, S. N., Oktaviani, V., Yuningsih, E. K., & Mulhayatiah, D. (2016, December). *Profil keterampilan argumentasi ilmiah mahasiswa pendidikan fisika dengan bantuan ICT.* In Seminar Kontribusi Fisika 2016 (pp. 447-450).

Noroozi, O., Banihashem, S. K., Taghizadeh Kerman, N., Parvaneh Akhteh Khaneh, M., Babaee, M., Ashrafi, H., & Biemans, H. J. (2023). Gender differences in students' argumentative essay writing, peer review performance and uptake in online learning environments. Interactive Learning Environments, 31(10), 6302-6316.

Nuryadi, N., Astuti, D., Utami, S., & M Budiantara, M. B. (2017). Dasar-dasar statistik penelitian.

OECD. 2023. "PISA 2022 Results factsheets Indonesia." *The Language of Science Education* 1:1–9.

Piraksa, C., Srisawasdi, N., & Koul, R. (2014). Effect of gender on student's scientific reasoning ability: A case study in Thailand. Procedia-Social and Behavioral Sciences, 116, 486-491.

Rahayu, D. P., Wiyarsi, A., & Utami, A. (2022). *Eksplorasi keterampilan argumentasi ilmiah mahasiswa melalui media sosial: topik kasus bioteknologi.* Jurnal Pendidikan MIPA, 12(3), 859-867.

Regier, D. A., Narrow, W. E., Clarke, D. E., Kraemer, H. C., Kuramoto, S. J., Kuhl, E. A., & Kupfer, D. J. (2013). DSM-5 field trials in the United States and Canada, Part II: test-retest reliability of selected categorical diagnoses. American journal of psychiatry, 170(1), 59-70.

Rousso, H. (2003). "Education for All: A gender and disability perspective." *Paper Commissioned for the EFA Global Monitoring Report 2003/4, The Leap to Equality* 1–35.

Roviati, E., & Widodo, A. (2019). *Kontribusi argumentasi ilmiah dalam pengembangan keterampilan berpikir kritis.* Titian Ilmu: Jurnal Ilmiah Multi Sciences, 11(2), 56-66.

Sampson, V., & Gleim, L. (2009). Argument-driven inquiry to promote the understanding of important concepts & practices in biology. The American biology teacher, 71(8), 465-472.

Sekaran, U. (2016). Research methods for business: A skill building approach. John Wiley & Sons.

Siregar, N., & Pakpahan, R. A. (2020). *Kemampuan argumentasi ipa siswa melalui pembelajaran argument driven inquiry* (ADI). LENSA (Lentera Sains): Jurnal Pendidikan IPA, 10(2), 94-103.

Siswanto, S., Hartono, H., Subali, B., & Masturi, M. (2022, September). *Analisis keterampilan berargumentasi mahasiswa calon guru ipa dari aspek keilmiahan dan kelengkapan organ.* In Prosiding Seminar Nasional Pascasarjana (Vol. 5, No. 1, pp. 988-992).

Songsil, W., Pongsophon, P., Boonsoong, B., & Clarke, A. (2019). Developing scientific argumentation strategies using revised argument-driven inquiry (rADI) in science classrooms in Thailand. Asia-Pacific Science Education, 5(1), 1-22.

Sulistiana, S., Sriyono, S., & Nurhidayati, N. (2013). *Pengaruh gender, gaya belajar, dan reinforcement guru terhadap prestasi belajar fisika siswa kelas XI SMA Negeri se-Kabupaten Purworejo Tahun Pelajaran 2012/2013.* Radiasi: Jurnal Berkala Pendidikan Fisika, 3(2), 102-106.

Sulistyowati, Y. (2020). *Kesetaraan gender dalam lingkup pendidikan dan tata sosial.* Ijougs: Indonesian Journal of Gender Studies, 1(2), 1-14.

Tamin, K. B., Ubadah, U., & Mashuri, S. (2022). *Tantangan pendidikan dalam era abad 21.* Prosiding Kajian Islam dan Integrasi Ilmu di Era Society (KIIIES) 5.0, 1(1), 338-342.

Toulmin, S. E., (2003). The uses of argument: updated edition.

Wuryanto, H., & Abduh, M. (2022). *Mengkaji kembali hasil PISA sebagai pendekatan inovasi pembelajaran untuk peningkatan kompetensi literasi dan numerasi.* Direktorat Guru Pendidikan Dasar.

Zahara, I. K., Rosidin, U., Helina, K., & Hasnunidah, N. (2018). *Pengaruh penerapan model argument driven inquiry (ADI) pada pembelajaran IPA terhadap keterampilan argumentasi siswa SMP berdasarkan perbedaan kemampuan akademik.* Jurnal Ilmu Fisika dan Pembelajarannya (JIFP), 2(2), 53-61.

Zubaidah, S. (2016, December). *Keterampilan abad ke-21: Keterampilan yang diajarkan melalui pembelajaran.* In Seminar Nasional Pendidikan (Vol. 2, No. 2, pp. 1-17).