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The role of ALIVP model in developing pesantren students' argumentation abilities on temperature and heat concepts

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Abstract
Argumentation abilities are critical for students to develop in physics learning, yet most studies focus on students outside *pesantren*. This research investigates the argumentation abilities of *pesantren* students on the topics of temperature and heat. The study employs a pre-experimental design with a one-group pretest-posttest approach. The instrument used is a test comprising six essay questions assessing argumentation abilities. The data in this study were examined using a paired sample t-test, effect size calculation, and N-gain analysis to assess changes in students' argumentation abilities. The findings demonstrated a significant enhancement in students' argumentation abilities following the implementation of the ALIVP learning model. The effect size analysis indicated a very large impact, while the N-gain results classified the improvement as high. A detailed examination of argumentation indicators revealed that the highest increase occurred in claim accuracy, followed by the completeness and credibility of data, strength of backing, and strength of evidence. These findings suggest that the ALIVP model successfully enhances the argumentation abilities of *pesantren* students in physics learning, bridging a gap in current research. This study underscores the potential of integrating argumentation-focused learning models in *pesantren* to foster critical thinking in scientific contexts.

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1. Introduction

Developing students' argumentation abilities is an essential aspect of physics learning. Argumentation plays a crucial role in physics as it engages students in scientific reasoning and critical thinking, ultimately supporting a deeper understanding of concepts (Amiruddin et al., 2023; M. Muslim et al., 2024; Parra Zeltzer et al., 2024; Rachmawati et al., 2024; Zhang & Browne, 2023). Various studies show that argumentation abilities positively correlate with mastery of physics concepts. Students with stronger argumentation abilities tend to understand physics concepts more effectively (Antonio & Prudente, 2021; Erduran & Park, 2023; Jin & Kim, 2021; Parra Zeltzer et al., 2024; Yang et al., 2023).

In formal education settings, including public schools and religious institutions, various learning models are employed to enhance argumentation abilities. One such model is Argument-Driven Inquiry (ADI), ADI has been found to significantly improve the quality of students' scientific arguments. For instance, students demonstrated better disciplinary engagement and produced higher quality arguments after participating in ADI activities (Admoko et al., 2022; Bestiantono, 2020; Suliyanah et al., 2020). Another study showed that students' verbal argumentation abilities also improved, with a notable increase in their ability to provide claims supported by evidence (Suliyanah et al., 2020). Additionally, the Argument-Generating (AG) learning model, which incorporates Toulmin's Argumentation Pattern, plays a crucial role in fostering students' argumentation abilities (M. Muslim et al., 2024). The implementation of physics argumentation-based computer-supported collaborative hybrid learning (PABCSCHL) model to enhance argumentation abilities (Murdani et al., 2023).

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Despite the growing body of research on developing argumentation abilities in formal educational contexts, there is a noticeable gap in its application within Islamic boarding schools (*Pesantren*). Pesantren-based education presents unique challenges and opportunities, especially when integrating Islamic values into physics learning (Purwati et al., 2018; Sollereder, 2019). Studies have shown that integrating Islamic values into science education can significantly improve students' learning outcomes and make the learning experience more meaningful (Purwati et al., 2018, 2023; Wulan et al., 2021). Students develop better metacognition skills and a deeper understanding of scientific concepts when these are linked to their religious beliefs (Purwati et al., 2023).

Existing instructional models in physics education that aim to develop students' argumentation abilities predominantly rely on argument-based learning and problem-based learning approaches (Admoko et al., 2021; Fuadah et al., 2023; Jumadi et al., 2021). While these strategies have been shown to enhance students' argument abilities, they remain insufficient in the context of Pesantren education, where the integration of Islamic values is a fundamental aspect of learning (Fitriah, 2020; Purwati et al., 2018). Traditional physics instruction in Pesantren has primarily emphasized the assimilation of scientific knowledge with Islamic teachings, often lacking explicit frameworks that facilitate structured argumentation and problem-solving. Consequently, there is a critical need for a pedagogical model that not only supports scientific argumentation and inquiry-based learning but also aligns with the unique epistemological and cultural foundations of Pesantren education.

To address this gap, this study introduces the Argument Learning and Islamic Values in Pesantren (ALIVP) model, a novel instructional approach that synthesizes argument-based learning, problem-based learning, and the integration of Islamic values (Budiyono et al., 2023). By embedding structured argumentation practices within problem-solving activities while maintaining a strong connection to Islamic perspectives, the ALIVP model aims to create a more holistic and culturally responsive learning experience. This integrated approach is expected to bridge the gap between scientific argument and Islamic values, fostering a learning environment where students can critically engage with physics concepts while reinforcing their theological and ethical understanding. This study introduces the ALIVP model, which synergizes scientific reasoning with Islamic principles to enhance students' ability to construct, evaluate, and justify arguments in physics learning. To assess its effectiveness, This study aims to address the following research questions: (1) How substantial is the effect size of the ALIVP model on students' argumentation abilities in the context of temperature and heat? (2) To what degree does the ALIVP model enhance students' argumentation abilities in the context of temperature and heat? Therefore, this research focuses on investigating the influence of the ALIVP model on students' scientific argumentation abilities within the Pesantren setting.

2. Method

This study utilized a quasi-experimental design with a one-group pretest-posttest approach to evaluate changes in students' argumentation abilities (Egista et al., 2025; Maria Chona Z. Futalan et al., 2025) involving 57 class XI students at a Madrasah Aliyah (MA) within a *Pesantren* in Pamekasan, Indonesia. Unlike students in general schools, *Pesantren* students lived in a boarding environment where Islamic studies constituted a major portion of their curriculum, while science subjects, including physics, received relatively less emphasis. This distinct educational setting made *Pesantren* students an appropriate focus for this study, as it aimed to examine the impact of the ALIVP model in integrating scientific argumentation with Islamic values within their learning experience.

The ALIVP model utilized in this study was a learning approach that integrated four key components. First, it incorporated Islamic values through the use of relevant Quranic verses and hadiths. Second, it adopted the Bahtsul Masail framework, which consisted of several stages: opening, reading the problem description, expressing opinions, engaging in argumentation, receiving comments from the kyai, drawing conclusions, and concluding with Al-Fatihah (Adib, 2022; Hasyimi, 2023). Third, it incorporated elements of the Problem-Based Learning (PBL) model, which included defining the problem, diagnosing the issue, formulating alternative strategies, determining and implementing solutions, and conducting evaluations (Eldy et al., 2023; Nicholus et al., 2023), and The SWH model consists of several stages, beginning with the exploration of students' initial understanding before instruction. This is followed by active participation in laboratory activities. Afterward, the negotiation phase occurs in several steps: first, students individually reflect and write about their personal interpretation of the laboratory activities; next, they share and compare their data interpretations in small groups. Following this, students review and compare scientific ideas with information found in textbooks or other printed sources. Finally, the process concludes with individual reflections and writing, leading to an exploration of their understanding after instruction. (Keys et al., 1999). hese components were systematically combined to create a structured learning experience that emphasized both scientific and religious perspectives, fostering students' argumentation skills within the Pesantren learning environment. To measure argumentation abilities, this study adopted five assessment indicators: accuracy of claims, completeness of data, credibility of data, strength of backing and strength of evidence (Muslim & Suhandi, 2012). These indicators were derived from the Toulmin Argumentation Pattern, which provided a structured framework for evaluating students' scientific argumentation skills (Admoko et al., 2023).

The ALIVP model is structured to enhance students' argumentation abilities through a series of well-defined stages. The ALIVP model consists of seven phases, namely Opening, Integrating, Orientating, Claiming, Negotiating & Scientific experiencing, Argumentating and Inferencing & Alfatihah. In the Opening and Integrating phases, students develop the accuracy of their claims by engaging with the learning objectives and connecting the topic to relevant Islamic values. The Orientating phase further strengthens claim accuracy while also fostering the adequacy of data as students explore real-world problems related to physics concepts in their *pesantren* environment. During the Claiming stage, students refine their ability to construct precise claims. The Negotiating & Scientific Experiencing phase plays a crucial role in improving multiple aspects of argumentation, including data adequacy, data quality, justification quality, and the strength of supporting evidence, as students engage in discussions, experiments, and collaborative learning. The Argumentating phase deepens these skills by reinforcing the quality of data, justification, and support through structured debate and peer feedback. Finally, the Inferencing & Alfatihah stage consolidates students' argumentation by focusing on justification quality and the strength of supporting arguments, while also integrating Islamic reflections to contextualize scientific learning within their *pesantren* environment.

The ALIVP model incorporated Islamic values, the Bahtsul Masail approach, Problem-Based Learning (PBL), and the Scientific Writing Heuristics (SWH) framework to promote problem-based argumentation, ensuring that students in *pesantren* could effectively develop their argumentation abilities in physics learning. This model highlighted the significance of argumentation in understanding physics concepts while integrating Islamic perspectives and the Bahtsul Masail process to enrich students' learning experiences. The ALIVP model, which integrated elements of PBL and SWH, provided a structured framework for students to engage in problem-solving while constructing scientific arguments. This approach encouraged students to develop their argumentation abilities by formulating claims, analyzing data, and justifying their reasoning based on evidence. In this study, the model was applied to physics learning, specifically covering the topic of temperature and heat. The subtopics explored included temperature and thermal expansion, the impact of heat on phase transitions, Black's principle, and heat transfer. Through this structured learning process, students were guided to critically evaluate concepts, support their arguments with scientific principles, and enhance their overall understanding of physics.

2.1. Procedures for data collection

This study employed an argumentation abilities test instrument specifically designed for the topic of temperature and heat. The test comprised six essay questions and demonstrated a reliability coefficient of 0.627 based on Cronbach's alpha. The questions addressed various subtopics, including temperature and expansion, the impact of heat on phase changes, Black's principle, and heat transfer. Each item was structured to evaluate students' argumentation abilities using predetermined assessment indicators. Figure 1 presents a detailed overview of the research procedure. Initially, a pretest was conducted to evaluate students' baseline argumentation abilities. The ALIVP model was then implemented over four learning sessions. Upon completion of the learning process, a posttest was administered to assess the students' final argumentation abilities.

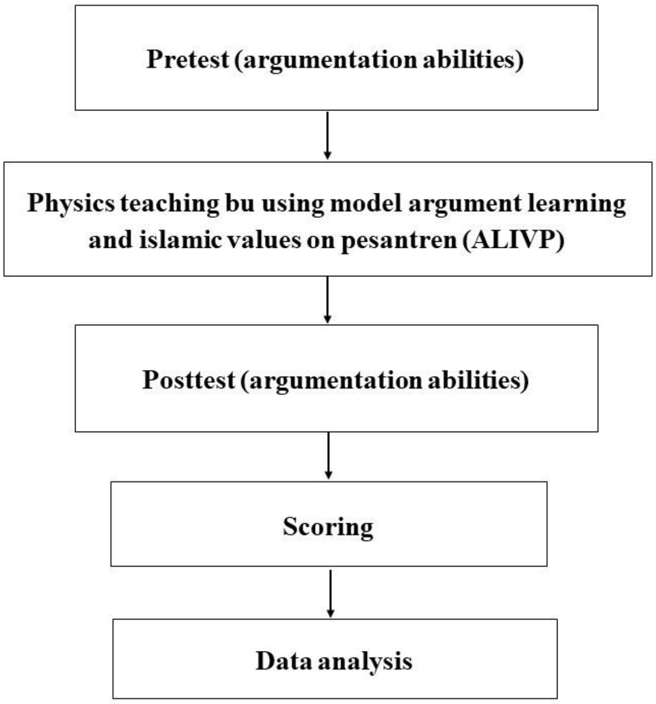

Figure 1. Procedure Research

Figure 1 illustrates the detailed flow of the research conducted in this study. The research began with a pretest designed to assess students' argumentation abilities before the implementation of the instructional model. This initial test served as a baseline to evaluate students' argumentation abilities at the outset. Subsequently, the ALIVP instructional model was applied throughout the learning process. The model was designed to integrate Islamic values with physics learning and encourage students to develop their argumentation abilities through discussions grounded in both scientific and Islamic principles.

After the implementation of the ALIVP model, a posttest was administered to again assess students' argumentation abilities. The purpose of the posttest was to compare the results with the pretest and determine whether Students' argumentation abilities showed an enhancement after the application of the model. Table 1 represented the assessment rubric for evaluating students' performance on the pretest and posttest, which indicated their obtained scores in argumentation abilities (Muslim, 2014). These scores were then analyzed using appropriate statistical methods to determine the extent to which the ALIVP instructional model had improved students' argumentation abilities. This data analysis was a crucial step in evaluating the effectiveness of the proposed learning model.

Table 1. Assessment Rubric for Argumentation Ability Test

No	Argumentation Component	Aspect	Score 1	Score 2	Score 3
1	Claim	Accuracy of claim	The claim was completely inaccurate	The claim was partially accurate	The claim was fully accurate
2	Data	Completeness of data	Included data, but it was irrelevant to support the claim	Included data, but it was insufficient to support the claim	Included sufficient data to support the claim
		Credibility of data	Data was present but not analyzed to support the claim	Data was partially analyzed to support the claim	Data was fully analyzed to support the claim
3	Backing	Strength Of backing	The reasoning used to establish the connection between the data and the claim was insufficient to effectively support the claim.	The justification partially supported the claim	The justification fully supported the claim

No	Argumentation Component	Aspect	Score 1	Score 2	Score 3
4	Evidence	Strength of evidence	The evidence provided for the justification did not reinforce the claim	The evidence partially reinforced the claim	The evidence fully reinforced the claim

2.1.1. Data analysis

The data from the pretest and posttest on students' argumentation abilities were evaluated using an assessment rubric, where scores ranged from a minimum of 1 to a maximum of 3. To determine the significant difference before and after implementing the ALIVP model, a paired sample t-test was performed. The developed equation 1 Cohen (2009) was used to calculate the effect size, which further assessed the effectiveness of the ALIVP model.

$$d = \frac{M_{posttest} - M_{pretest}}{\sqrt{\frac{SD^2_{posttest} + SD^2_{pretest}}{2}}} \quad (1)$$

The interpretation of effect size was categorized into several levels. An effect size of less than 0.2 was considered negligible, while values between 0.2 and 0.5 indicated a minor effect. If the effect size ranged from 0.5 to 0.8, it was classified as moderate. A substantial effect was identified when the value was between 0.8 and 1.0, whereas an effect size equal to or greater than 1.0 was regarded as significant. This interpretation was used to analyze the impact of the ALIVP model on students' argumentation abilities.

The next stage of analysis focused on determining the mean normalized gain (<g>) to evaluate the enhancement of students' ability to construct arguments after applying the ALIVP approach. This calculation was performed using Equation 2 as formulated by (Hake, 1998), to measure the effectiveness of the learning intervention in enhancing students' argumentation abilities. This approach provided a standardized measure of students' learning improvement, allowing for the classification of their progress into different categories based on the extent of their score increase.

$$< g > = \frac{<Posttest\ score> - <Pretest\ score>}{<Ideal\ score> - <Pretest\ score>} \quad (2)$$

The classification of N-gain scores was used to interpret the extent of improvement in students' argumentation abilities. An N-gain score greater than 0.70 indicated a high level of improvement, reflecting a significant enhancement in students' argumentation abilities. Scores ranging from 0.30 to 0.70 were categorized as medium, signifying a moderate increase in argumentation abilities. Meanwhile, an N-gain score below 0.30 was classified as low, suggesting minimal progress. This categorization offered a more structured basis for assessing how the ALIVP model contributed to enhancing students' ability to formulate arguments.

3. Results and Discussion

3.1. Students' argumentation abilities on the topic of temperature and heat

Before conducting the statistical analysis, a normality test was performed to verify that the pretest and posttest scores met the required assumptions. The results indicated that both sets of scores followed a normal distribution. Subsequently, a paired sample t-test was employed to examine changes in students' ability to construct arguments after engaging in learning activities on temperature and heat using the ALIVP model. This test facilitated the comparison of pretest and posttest scores, enabling the identification of significant differences in students' argumentation skills following the instructional process. The Kolmogorov-Smirnov test yielded a statistic of 0.088 for the pretest and 0.088 for the posttest, with an exact significance (2-tailed) value of 0.200 for both. Since the significance values exceeded the threshold of 0.05, it was confirmed that the data met the assumption of normality, allowing further statistical analysis using parametric tests. Since the data followed a normal distribution, it was subsequently analyzed using the t-test, effect size, and N-gain test.

The statistical analysis results illustrate the improvement in students' argumentation abilities after implementing the ALIVP model in learning temperature and heat. The mean pretest score was lower than the posttest score, indicating a significant increase. The significance value (2-tailed) confirmed that the difference was statistically meaningful. Additionally, the effect size demonstrated a substantial impact of the ALIVP model, while the N-gain score suggested a high level of improvement in students' argumentation abilities. The detailed statistical results are presented in Table 2.

Table 2. Descriptive statistical findings on students' argumentation abilities

Statistical Indicator	Calculation
Mean pretest	1.4269
Mean posttest	2.5772
Sig (2-tailed)	0.000
effect size	3.87
N-gain	0.72

This finding highlights students' argumentation abilities as an impact of the effectiveness of the ALIVP instructional model within the context of physics learning in *pesantren*. A comparison of students' argumentation abilities before and after the implementation of the ALIVP model is presented in Table 2. The analysis revealed that the average pretest score was 1.43, while the posttest score increased to 2.58. The results of the paired sample t-test results indicated a significance value of 0.000., which was lower than 0.05. These findings indicated a statistically significant difference in students' argumentation abilities before and after engaging in learning activities using the ALIVP model.

The results of this study indicated that the ALIVP model, which emphasizes problem-solving and argumentation, had a substantial positive effect on students' argumentation abilities. This was reflected in the significant difference observed between pretest and posttest scores following the implementation of the ALIVP model. The structured stages within ALIVP provided systematic scaffolding that supported the development of students' argumentation abilities. These findings were consistent with previous studies demonstrating the effectiveness of PBL-based learning (Eldy et al., 2023; Prifes & Okmarisa, 2024). Similarly, the integration of the ADI learning model with PhET simulations proved highly effective in enhancing students' argumentation skills (Fakhruddin et al., 2023). Additionally, the modified argument-driven inquiry (MADI) approach in practical science significantly enhanced students' argumentation skills (Ping et al., 2020). The strength of the ALIVP model in fostering argumentation skills lies in its structured learning phases, which guide students through claim-making, negotiation, and argument construction. Specifically, several key phases contribute to the development of students' argumentation abilities in the *pesantren* context.

Instruction through the ALIVP model produced an effect size of 3.87, as presented in Table 3. This finding indicated that the ALIVP model had a significantly large impact on students' ability to construct well-supported arguments. at the Negotiation & Scientific Experience stage in the ALIVP model is designed to encourage students to engage in scientific discussions through group investigations, experiments, and literature reviews. The process of negotiating different perspectives and backing of claims with evidence enhances their reasoning and critical thinking skills. Negotiating in group discussions facilitate the development of argumentation skills by encouraging students to rationalize their claims with supporting evidence (Governor et al., 2021; Jang & Nam, 2016). This process involves evaluating the relationship between evidence and explanatory models, leading to more robust and defensible claims. Similarly, group discussions in science activities led to significant improvements in both claim and evidence scores (Jo & Choi, 2015). The results of the N-gain analysis, as presented in Table 3, indicated that students' argumentation abilities increased to a high category when comparing their performance before and after learning with the ALIVP model. The N-gain analysis results revealed an average value of 0.72, categorizing the improvement as high. These findings suggested that the ALIVP model yielded better outcomes compared to previous studies. For instance, ADI with STEM learning on wave material only resulted in a low n-gain score of 0.18 (Suganda et al., 2023). Similarly, the implementation of Authentic Problem-Based Learning (aPBL) with STEM, alongside formative assessment, was only able to enhance students' argumentation abilities to the medium category, with an N-gain score of 0.51 (Jewaru et al., 2023).

3.2. Enhancement Based on Indicators of Argumentation Abilities

Table 3 presented the extent of improvement in students' argumentation abilities for each indicator. These indicators were adapted from a framework established by Muslims, which included the accuracy of claims, completeness of data, credibility of data, strength of reasoning, and strength of evidence.

Table 3. Variations in N-Gain across different indicators of students' argumentation abilities

Indicator	N-gain Score	Category
accuracy of claims	0.96	High
completeness of data	0.86	High
credibility of data	0.82	High
strength of backing	0.69	Medium
strength of evidence	0.52	Medium

The data presented in Table 3 indicates that the most significant improvement in students' argumentation abilities occurred in the claim accuracy indicator, with an N-gain value of 0.96, classified as high. Prior to the learning process, students struggled to formulate claims aligned with the physics concepts being addressed. They often relied on personal experiences from the *pesantren* or made claims without considering the available data. However, after participating in the ALIVP learning model, students demonstrated a more structured approach to argumentation. During the post-test, they formulated claims based on the data provided in the questions and presented their arguments more comprehensively and accurately. The accuracy of claims indicators was reinforced throughout four key phases of the learning model, namely the opening, integrating, orienting, and claiming phases. The structured nature of these phases systematically guided students in refining their argumentation skills. The most crucial reinforcement occurred in the claiming phase, where students received explicit support in constructing complete and precise claims. This structured facilitation played a vital role in strengthening their ability to articulate well-founded arguments, ultimately enhancing their overall argumentation skills in the context of physics learning.

Instructional approaches that support the development of scientific argumentation, particularly in constructing claims, have a significant influence on the quality of claims within the argumentation process. Such approaches enhance coherence and promote reasoning based on evidence (Cope et al., 2013). Changes observed in students' claims and justifications suggest that instructional strategies designed to facilitate claim construction play a crucial role in improving the quality of argumentation (Walker et al., 2019). Additionally, the learning strategies implemented through several stages have been proven to enhance students' ability to make accurate claims, demonstrating that a stepwise approach contributed to improved learning outcomes (Tristanti & Nusantara, 2021). Furthermore, learning through claim revisions provides valuable insights into generalizable indicators, enabling students to assess and refine their arguments more effectively (Skitalinskaya et al., 2021).

The next indicators of argumentation abilities, as presented in Table 3, were completeness of data and credibility of data. Both indicators showed an increase classified as high; however, despite being in the same category as claim accuracy, their N-gain values were lower. Students who were able to present data also tended to analyze it effectively. The implementation of the ALIVP model supported the development of data completeness and credibility through the orientating, negotiating & scientific experiencing, and argumentating phases. These three phases provided structured training, particularly in group settings, through discussions and practical activities. As a result, students were able to present sufficient data and refine it into high-quality data. During the argumentation phase, any incorrect data presented by a group was corrected through peer review from other groups, allowing for revisions that enhanced the quality of the analyzed data. Learning that emphasized hands-on physics activities contributed to students' ability to gather precise data and support their scientific arguments with well-founded evidence (Pols et al., 2023). Engaging in practical activities within physics learning improved students' research skills, facilitated connections between theoretical concepts and real-world applications, enabled more accurate data analysis, and strengthened their ability to construct arguments based on high-quality evidence (Voitkiv & Lishchynskyy, 2022). Additionally, the use of data to support arguments had been facilitated through physics experimental activities, which provided hands-on experience, encouraged critical thinking, and enhanced students' conceptual understanding (Junior et al., 2024).

Students demonstrated an improvement in their ability to strength of backing based on the available data, with a gain of 0.69, which fell into the moderate category. This progress indicated an enhancement in the strength of their supporting arguments. This moderate increase was due to the fact that, during the pretest, none of the students were able to provide justifications. However, after engaging in the ALIVP learning model, students were able to justify their claims, albeit not entirely correctly. Facilitation the strength of backing within ALIVP learning was primarily provided during the negotiating and scientific experiencing phases. In the post-practical learning stage, students were guided to connect the results of their data analysis with the claims they formulated. Critical argumentation in science learning played a crucial role in distinguishing between valid knowledge and unfounded claims, as it required a justification process to support the arguments presented (García-Pérez et al., 2024; Zlatkin-Troitschanskaia et al., 2020). Furthermore, including counterarguments and refutations strengthens the argument by addressing potential objections and demonstrating a comprehensive understanding of the topic (Xiao & Kuhn, 2024). Strengthening connections between data analysis and written claims enhanced students' backing skills in physics learning (Odden & Burk, 2020).

The final indicator of argumentation abilities, which showed the lowest improvement, was the strength of evidence. The N-gain value for this indicator was 0.52, which, although categorized as moderate like the strength of evidence indicator, remained the lowest among all indicators. An analysis of students' responses revealed that, during the pretest, none of the students attempted to connect or provide support based on data analysis results to substantiate their claims. However, in the posttest, nearly all students demonstrated the ability to relate data analysis to their claims as a form of support, though their justifications were not entirely accurate. In the ALIVP learning model, the strength of backing was primarily facilitated during the negotiating and scientific experiencing phases. In the post-practical activity phase, students were encouraged to link the results of their data analysis to the claims they formulated while also incorporating theoretical foundations as supporting evidence. Despite this, not all students included theoretical support in their responses, as many tended to disregard existing theories when justifying their claims (Admoko et al., 2021; Dwikoranto, 2023). Several studies have addressed challenges related to low support in argumentation within physics learning. A hybrid learning model that integrates computer-supported collaborative argumentation was found to enhance students' argumentation abilities, particularly in addressing weaknesses in providing supporting evidence (Murdani et al., 2023). Additionally, the ADI model in physics instruction significantly improved students' ability to construct arguments, including their ability to provide appropriate support, thus helping to overcome deficiencies in argumentation skills (Admoko et al., 2022). Furthermore, students' argumentation abilities in thermodynamics were significantly improved through the APBL-STEM approach with formative assessment, despite their initial difficulties in incorporating theoretical support into their arguments (Jewaru et al., 2023).

The limitations of this study included its focus on a single physics topic, namely temperature and heat, which may restrict the generalizability of the findings to other physics concepts. Additionally, the research was conducted in only one *pesantren*-based school, limiting the diversity of student backgrounds and learning environments. The study also relied on a specific argumentation framework, which may not fully capture other dimensions of students' reasoning abilities. Furthermore, the intervention period was relatively short, potentially affecting the depth of conceptual change observed. These limitations should be considered when interpreting the results and designing future research.

4. Conclusion

The findings of this research demonstrated a significant enhancement in the argumentation abilities of MA *pesantren* students on the topic of temperature and heat following the implementation of the ALIVP model. The results of the statistical analysis indicated a notable disparity in students' argumentation abilities before and after the intervention, with a significance value of 0.000. The ALIVP model exhibited a substantial impact on students' argumentation skills, as reflected by an effect size of 3.87, and significantly enhanced their abilities, with an N-gain score of 0.72, which fell into the high category. These findings indicated that *pesantren* students successfully formulated claims with accuracy, incorporated relevant data, conducted comprehensive analyses, and provided backing to support their arguments, although some still faced challenges in offering sufficient backing for certain claims. The findings of this study implied that integrating Islamic values into argumentation-based learning could enhance students' reasoning skills in *pesantren* by making scientific discussions more contextual and meaningful in the *pesantren* environment. The structured phases of the ALIVP model, particularly the Claiming, Negotiating & Scientific Experiencing, and Argumentating phases, played a key role in fostering critical thinking and reasoning. In practice, the ALIVP model could serve as an alternative learning approach to improve students' scientific argumentation abilities in *pesantren*, particularly in physics learning. Future research needs to examine its applicability to other physics topics and compare its effectiveness with other argumentation-based models to further refine its implementation in *pesantren*-based education.

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All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

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