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Preliminary Study: Opportunities for Utilizing Local Wisdom in Physics Learning to Enhance Scientific Argumentation

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Abstract

The era of globalization requires every individual to possess scientific argumentation skills. However, in reality, many people have yet to apply approaches that emphasize scientific argumentation. One effective way to foster scientific argumentation skills is through learning that incorporates local wisdom. Therefore, this study was conducted with the aim of obtaining an overview of whether students show a tendency toward local wisdom-based learning in physics as a means to enhance scientific argumentation skills. This research employs a quantitative descriptive method. The data collection techniques used include questionnaires supported by interviews. The instruments utilized are a questionnaire sheet and an interview sheet. The data obtained were analyzed quantitatively and descriptively using a Likert scale. The results indicate that students perceive the need for learning that is not only focused on theoretical content but also integrates local values as a medium for developing critical thinking and scientific argumentation skills. Hence, it can be concluded that students recognize the importance of local wisdom-based learning as a potential approach to support the development of scientific argumentation skills. Local wisdom provides relevant context in physics learning. Thus, local wisdom-based learning is considered a meaningful approach to strengthen scientific argumentation skills and conceptual understanding in physics.

Keywords: *local wisdom, physics learning, scientific argumentation*

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INTRODUCTION

The era of globalization is marked by rapid developments in science, technology, and communication. These advancements influence all aspects of human life. Rapid progress has created an increasingly dynamic and interconnected world (Anjarwani et al., 2022). However, this progress is accompanied by the emergence of complex problems. Such issues cannot be resolved using simple approaches. In this era, specific skills are required to face global challenges and the complexities of problems across various fields of life (Dewi et al., 2024). These skills are known as 21st-century skills. They help individuals adapt and act creatively when facing uncertain situations (Srirahmawati et al., 2023).

One of the essential 21st-century skills that every individual should possess is scientific argumentation. This skill can serve as a strategy for problem-solving (Erduran & Jiménez, 2007). Scientific argumentation involves a step-by-step process that includes reasoning, evaluation, and justification, resulting in well-structured and logical statements. It promotes responsible decision-making, as it is based on valid evidence (Simon & Maloney, 2007). In addition, scientific argumentation plays a significant role in information management. It helps individuals critically assess information, enabling society to better understand global issues and act consciously and ethically in response to emerging challenges (Muslim et al., 2024). Therefore, it is important to foster scientific argumentation within the community.

Physics learning can serve as an effective medium for fostering scientific argumentation (Mellenia & Admoko, 2022). This is because scientific argumentation is a fundamental part of scientific practice itself. Scientists use scientific argumentation to evaluate evidence, test hypotheses, and refine theories (Muslim et al., 2024). The expectation is that by applying scientific argumentation approaches in physics learning, students can be trained to think and act like scientists. This means that students are not merely passive recipients of concepts, but are actively engaged in critical thinking through making claims, constructing reasoning, and supporting arguments with relevant evidence (Dawson, 2024). Scientific argumentation can also be used to assess the extent to which students understand physics concepts. This is because students are able to construct sound arguments only when they have a solid understanding of a concept (Widhi et al., 2021).

Scientific argumentation can be fostered through contextual learning. According to Parlan et al. (2025), metacognitive learning becomes more meaningful and impactful when it is connected to real-life phenomena. One effective way to implement this approach is through local wisdom-based learning or ethnoscience (Kurniawan, 2021). In the educational context, ethnoscience refers to the integration of elements of local wisdom and traditions—encompassing knowledge, practices, and cultural values embedded within a community—into the science learning process (Idul & Fajardo, 2023). This approach helps students feel connected to the learning material rather than alienated. Instead, students perceive the content as useful and relevant to their lives (Bate et al., 2024). Moreover, local wisdom-based learning encourages scientific argumentation. This is because local wisdom often contains controversial aspects that can provoke discussion and deeper analysis, leading students to construct logical arguments (Erman & Suyatno, 2022).

Physics is an abstract science, which often makes it difficult for students to grasp various concepts (Amalissholeh et al., 2023). Physics explains how the world works, and therefore, its learning should go beyond formulas, theories, concepts, and laws. Students need to understand the real-life applications of these principles. In this context, local wisdom offers a tangible learning environment, helping physics lessons feel less abstract and theoretical (Dwikoranto et al., 2021). In scientific practice, debates often arise—especially when involving local wisdom such as indigenous knowledge. These issues open opportunities for further exploration and discussion. Such contexts are usually observable in macroscopic forms, requiring a solid understanding of scientific concepts. Ethnoscience, as an interdisciplinary field, helps reveal the scientific dimensions of local wisdom (Erman & Suyatno, 2022).

Several studies have explored the use of local wisdom in physics learning. According to Nugraha & Prabowo (2022), local wisdom can be utilized to enhance scientific literacy. When integrated into physics education, local wisdom can also improve critical thinking skills (Kurniawan, 2021). Rahman et al. (2023) found that incorporating local wisdom into STEM-based learning can enhance problem-solving abilities and creative thinking. Although the use of local wisdom in physics education has been widely researched, its specific connection to the development of scientific argumentation skills has received relatively little attention in previous studies. Therefore, this research aims to investigate the effectiveness of local wisdom-based physics learning in enhancing students' scientific argumentation skills.

METHOD

This study employs a quantitative descriptive method with a case study approach aimed at exploring students' scientific argumentation skills in local wisdom-based physics learning. The research was conducted at SMAN 22 Surabaya, involving students and physics teachers as research subjects. Data collection techniques included questionnaires supported by interviews. Questionnaires were distributed to students to understand their perceptions of local wisdom-based physics learning and the extent to which they comprehend and can develop scientific argumentation. Semi-structured interviews were conducted with students and physics teachers to gather more in-depth information and validate the questionnaire data. The instruments used in this study consisted of questionnaires and interview guides. Questionnaire data were analyzed quantitatively and descriptively by calculating the mean scores and percentages based on a Likert scale to observe students' response tendencies. Meanwhile, interview data were analyzed qualitatively using content analysis by identifying relevant themes, patterns, and categories. To ensure data validity, triangulation techniques involving multiple sources and methods were employed.

Figure 1. Research Flow Diagram

The research design is illustrated in Figure 1. The research process begins with identifying the research gap, which serves as the basis for determining the urgency and novelty of the topic under study. This is followed by a literature review to obtain theoretical foundations and relevant previous research findings. Based on the review results, the researcher develops the research instruments, which are then validated to ensure the reliability and validity of the measurement tools used. Once the instruments are validated, the next stage is data collection through questionnaires and interviews. The collected data are analyzed using Likert scale analysis for quantitative data and content analysis for qualitative data. To enhance the validity of the results, data triangulation is conducted by comparing various sources or methods. The final stage of this process is drawing conclusions and reporting the research findings, summarizing the main discoveries and their implications.

RESULTS AND DISCUSSION

Physics is a branch of natural science that studies various phenomena and the laws governing the universe and its contents. Since its inception, physics has aimed to explain how the world works through observation of natural phenomena (Siswanto et al., 2022). Every human action, whether directly or indirectly, is related to the natural laws explained by physics. Physics is also regarded as an abstract science. Some physics concepts cannot be directly observed by human senses (Amalissholeh et al., 2023). This description shows that physics learning has great potential to be taught using a contextual approach. Contextual learning is a concept that helps teachers relate the material to real-life situations, making it easier for students to understand the knowledge they acquire by applying it to everyday life (Erman & Suyatno, 2022).

One way to create contextual learning is by linking physics education with local wisdom or ethnoscience-based learning (Kurniawan, 2021). Ethnoscience represents an integration between indigenous knowledge and modern science, aiming to bridge the local community's worldview of nature with a systematic scientific approach (Erman & Suyatno, 2022). The ethnoscience-based learning process can create a highly dynamic learning. This approach allows students to express their curiosity. They become involved in creative processes of analysis and exploration to find answers and draw diverse conclusions (Atmojo et al., 2021). This is because local wisdom can generate interesting issues for students to discuss. For example, the use of the traditional game "Patil Lele" to enhance understanding of the concept of projectile motion (Rohmah et al., 2024) and the traditional game "Kekehan" to improve understanding of the concept of moment of inertia (Deta et al., 2024). Therefore, it can be said that local wisdom is closely related to physics learning as it provides real-world contexts that are familiar and relevant to students' lives.

Physics is closely related to scientific argumentation. This is because physics involves not only formulas and theories but also a systematic scientific way of thinking (Jiménez-Aleixandre & Erduran, 2007). Scientific argumentation is a core part of genuine scientific practice. In the scientific world, knowledge does not emerge as absolute truth but through a long process of proposing ideas, testing hypotheses, and engaging in critical discussions involving various perspectives (Muslim et al., 2024). In other words, scientific argumentation drives innovation by providing space for new ideas to be considered objectively. This process not only enriches understanding of a phenomenon but also serves as a mechanism to refine theories and avoid weak or biased conclusions (Widhi et al., 2024). Based on this explanation, it is clear that scientific argumentation is crucial for students to master. Therefore, scientific argumentation needs to be trained, especially through physics learning.

To support the findings of this study, questionnaires were distributed to students to gather their responses regarding the implemented learning process. The questionnaire aimed to measure several aspects, such as the integration of local wisdom and the development of scientific argumentation skills. Figure 2 is a diagram showing respondents' feedback on local wisdom.

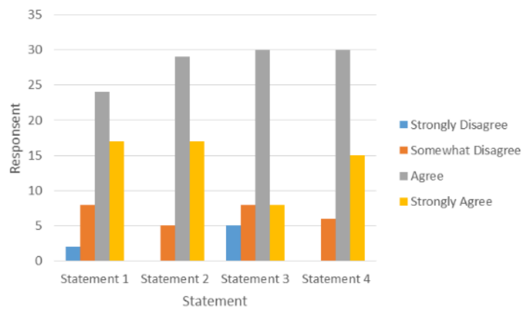

Figure 2. Respondents' Feedback on Local Wisdom-Based Learning

Based on Figure 2, it is shown that the majority of students gave positive responses to statements related to local wisdom-based learning. This is evident from the dominance of "Agree" and "Strongly Agree" choices across all statements. From this, it is clear that students feel a need for physics learning that incorporates cultural values and local wisdom. Although they may not have fully experienced such learning, these results reflect their awareness of the importance of education that is closely connected to daily life, the surrounding environment, and the cultural values they know. This is also supported by an interview result where a student expressed a desire and hope that learning would not solely focus on textbooks and global theories but also pay attention to local contexts that are more relevant and meaningful to them. This tendency indicates that developing learning that integrates local wisdom is not only relevant but also highly needed by students to make the learning process more engaging and grounded. These questionnaire results are also consistent with the research by Nugraha & Prabowo (2022), which states that students are more interested when physics material is taught through local wisdom.

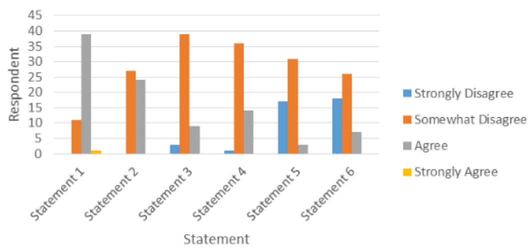

Figure 3. Respondents' Feedback on Scientific Argumentation Skills

Figure 3 illustrates respondents' feedback on six statements related to scientific argumentation skills in learning. Based on the results for Statement 1, most respondents expressed agreement, indicated by the dominance of the gray bars (Agree), suggesting that they generally accept or recognize the importance of the mentioned scientific argumentation aspect. However, for Statements 2 and 3, the majority of respondents responded with Somewhat Disagree, indicating that they have not fully experienced the benefits or received sufficient training in constructing scientific arguments. For Statement 4, there is a slight shift toward positive responses, with an increasing number of respondents agreeing. Meanwhile, for Statements 5 and 6, responses tend to be more varied but are still dominated by disagree and somewhat disagree categories. Overall, this data indicates that students' scientific argumentation skills have not yet developed optimally. Many students feel they have not had enough experience or training to formulate strong scientific arguments, such as making claims, including supporting data, and providing appropriate rebuttals. These results can serve as an important basis for teachers and curriculum developers to emphasize the integration of scientific argumentation skills in the learning process, enabling students to think critically, logically, and based on evidence in line with 21st-century learning demands.

These findings are supported by interview results from a student who stated that classroom learning is often labeled as "active" simply because the teacher poses basic questions. The student also added that teachers rarely provide opportunities to analyze issues, connect statements with evidence, or present counterarguments. Therefore, it can be concluded that students can develop scientific argumentation skills when given opportunities to engage in argumentation. This aligns with the study by Wulandari (2023), which emphasized that teachers' creativity in designing both content and learning techniques plays a crucial role in the success of instruction. Teachers must also be able to integrate practical approaches to support experience-based learning (Edelweiss et al., 2024). To train scientific argumentation skills, learning designs must offer students frequent opportunities to construct and critique arguments, make claims, and use evidence in reasoning processes through inquiry-based activities (Mikesha & Howel, 2020).

Based on the explanation above, it shows the importance of training scientific argumentation skills in learning, supported by a contextual and meaningful approach for students. One effective approach is learning based on local wisdom. The students' responses indicate a strong need for a learning model rooted in their culture and surrounding environment. Local wisdom provides a familiar real-world context, making it easier for students to understand scientific concepts, develop ideas, and practice logical and critical argumentation skills (Erman & Suyatno, 2022). Thus, the use of local wisdom not only strengthens cultural identity but also serves as a strategic bridge to enhance students' scientific competence, particularly in constructing and delivering coherent, evidence-based arguments. According to Novanda et al. (2024), learning based on local wisdom can effectively train students' scientific argumentation skills.

This study still has limitations that need to be considered. The research only describes students' perceptions of the need for learning based on local wisdom without exploring in depth its implementation in real learning contexts, especially in training scientific argumentation skills. Therefore, it is recommended that future research conduct a more thorough study on the implementation of local wisdom-based learning in the context of developing scientific argumentation skills. It is hoped that future studies can directly test the effectiveness of this learning model through qualitative or experimental approaches. The goal is to obtain a more comprehensive understanding of how local elements can be optimally utilized to build students' critical thinking and argumentative skills.

CONCLUSION

The study indicates that students perceive a need for learning based on local wisdom as an approach that can assist them in developing scientific argumentation skills. The predominant positive responses to the statements in the questionnaire suggest that students desire a more contextual and culturally relevant learning experience. Local wisdom, with its values and experiences close to everyday life, is believed to be an effective medium for building scientific understanding and the ability to present arguments logically and systematically. Therefore, local wisdom-based learning holds great potential to be developed as a strategy to enhance students' critical thinking and argumentative competencies. As a recommendation, future research is expected to explore more deeply the actual implementation of local wisdom-based learning in training scientific argumentation through qualitative or experimental approaches.

AUTHOR CONTRIBUTIONS

Nur Afni Agustinaningrum: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, and Writing - Original Draft; **Diah Krisdiyanti**: Resources and Validation; **Suliyanah**: Validation, Writing - Review & Editing, and Supervison; and **Nina Fajriyah Citra**: Validation and Supervison.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCCESS

The authors declare that Generative Artificial Intelligence and other assistive technologies were not excessively used in the research and writing process of this manuscript. Specifically, ChatGPT was utilized for brainstorming ideas, and Grammarly was employed for grammar and style correction, paraphrasing, and improving language clarity and coherence. All AI-generated content has been thoroughly reviewed and edited by the authors to ensure accuracy, completeness, and adherence to ethical and scientific standards. The authors take full responsibility for the final version of the manuscript.

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