Schrödinger: Journal of Physics Education
Vol. 5, No. 3, September 2024, pp. 117~123
ISSN: 2716-1587, DOI: 10.37251/sjpe.v5i3.1109

Integrating Local Craftsmanship into Physics Education: The Role of Kasongan Pottery in Developing Lateral Thinking Skills

Ani Setyaningsih[1], Turgut Fakıoglu[2], Dwi Karyanti[3], Harini Wigya Hantari[4]
[1,3,4]State Junior High School 16 Yogyakarta, Yogykarta, Indonesia
[2]Physics Department, Middle East Technical University, Ankara, Turkey

Article Info

Article history:

Received Aug 14, 2024
Revised Sep 14, 2024
Accepted Sep 16, 2024
Online First Sep 20, 2024

Keywords:

Kasongan Pottery
Lateral Thinking Skills
Local Crafts
Physics Learning
Scientific Knowledge

ABSTRACT

Purpose of the study: This study aims to explore scientific knowledge about the process of making Kasongan pottery and its potential to improve the lateral thinking skills of junior high school students through the integration of local crafts in physics learning.

Methodology: This study uses a descriptive qualitative approach with semi-structured interviews, observation, and documentation. It also uses a purposeful sampling technique with 38 craftsmen and analyzes the data using Miles and Huberman's interactive model.

Main Findings: Scientific knowledge involved in making pottery includes concepts of physics, chemistry, and biology. Applying practical problems and solutions can improve students' lateral thinking skills.

Novelty/Originality of this study: This study introduces the integration of local crafts, especially Kasongan pottery, in physics education to improve lateral thinking skills. This approach connects scientific concepts with traditional practices, offering a new learning method and preserving culture.

Corresponding Author:
Dwi Karyanti,
State Junior High School 16 Yogyakarta,
Jl. Nagan Lor No.8, Patehan, Kraton, Yogyakarta, 55133, Indonesia
Email: dwikaryanti0101@gmail.com

1. INTRODUCTION

The ability to think creatively and innovatively is a very important competency in facing the challenges of the 21st century, especially in solving various complex problems faced in everyday life. Lateral thinking ability is one type of creative problem solving [1]-[3]. It allows people to see problems from different perspectives and find unusual solutions. Education in the 21st century, especially in the field of science, requires students to acquire knowledge and critical and creative thinking skills [3]-[5]. Both of these skills can help students in overcoming various challenges that arise.

Incorporating local wisdom is one way to make science learning contextual and meaningful for students. Kasongan pottery from Bantul, Yogyakarta, is a very educational type of local wisdom [6]. Kasongan pottery is not only a craft product; it also contains a lot of scientific knowledge that can be used as science learning materials [6], [7]. Students can relate the physics concepts they learn in class to everyday life by understanding the process of making this pottery [8], [9].

The making of Kasongan pottery uses many important physics concepts, including the centripetal force that occurs when the pottery wheel rotates, the plasticity of clay that allows for the formation of various shapes, and the concept of surface tension that ensures that the shape of the pottery remains stable before being fired. In addition, the physics concepts taught in schools are closely related to other physics phenomena, such as water

evaporating from clay, the amount of material decreasing during drying, and the effects of high temperatures on firing.

In addition, the process of making Kasongan pottery offers students an opportunity to learn the law of conservation of energy because the heat energy used in firing is transferred to the clay, increasing the strength and resilience of the molecular structure [10], [11]. Students gain a better understanding of these concepts and how the theories learned can be applied in real-world situations [12], [13].

Learning that integrates local wisdom, such as Kasongan pottery, has great potential to encourage students' lateral thinking skills. Students can be invited to identify problems that craftsmen might face during the pottery-making process, such as ensuring that the shape and quality of the product remain consistent and find creative solutions to these problems. Therefore, physics lessons do not only focus on theory but also on the ability to solve problems creatively and practically.

Abroad, such as in Turkey, especially in the Cappadocia and Iznik regions, ceramic and pottery making has become an integral part of cultural heritage. The traditional techniques, including coloring and glazing, are similar to the processes carried out in Kasongan. In Turkey, Avanos is famous for its centuries-old ceramic-making tradition. The pottery-making process in Avanos uses clay from the Kızılırmak River and involves traditional techniques passed down from generation to generation, similar to the process in Kasongan.

The results of previous studies have shown that integrating local science into science learning can benefit students and preserve local culture. This study explores various cultural activities of the community in Nagekeo, East Nusa Tenggara, and finds several science concepts that can be integrated into science learning, such as the system of units and measurements, Newton's laws, and others [14]. The identified GAP between the two studies is the difference in approach and focus of integrating local culture into learning. Previous studies emphasized identifying local science elements in various cultural activities and how they can be applied to science learning. Meanwhile, the current study focuses on using a specific local craft, namely Kasongan pottery, to develop students' lateral thinking skills in the context of physics learning. Both studies have similar goals in integrating local culture with science education but with different approaches and focus [15]-[17].

This study offers an innovative approach by integrating local wisdom, especially the process of making Kasongan pottery, into science learning as a medium to train students' lateral thinking skills, which have yet to be widely explored. This has important implications for developing a more contextual and meaningful curriculum and strengthening students' critical and creative thinking skills, which are greatly needed in the 21st century. With the urgency of improving the quality of science learning that focuses not only on material but also on high-level thinking skills, this study also contributes to preserving local culture while strengthening students' cultural identity in the era of globalization. This study aims to identify and integrate scientific concepts contained in the process of making Kasongan pottery into science learning.

2. RESEARCH METHOD

This study uses a qualitative approach with a descriptive method. The descriptive method is used to describe existing phenomena systematically, factually, and accurately [18]-[20]. This study aims to explore and understand in depth the scientific knowledge of natural science contained in the process of making Kasongan pottery and its potential to support the lateral thinking skills of junior high school students.

This study's population was all pottery craftsmen in Kasongan Village, Bantul, Yogyakarta. The sampling technique used was purposive sampling, namely selecting samples based on specific criteria relevant to the research objectives. The sample taken in this study amounted to 38 pottery artisans who were considered to have in-depth knowledge of the Kasongan pottery making process.

The main instrument used in this study was the researcher himself (human instrument), who functioned as a data collector through interviews, observations, and documentation. In addition, a semi-structured interview guide was also used to ensure that the information obtained followed the research objectives. This instrument was designed to reveal the concepts of science in making Kasongan pottery and how the process can train lateral thinking skills.

The data in this study were collected through three main techniques: semi-structured interviews and interviews with 38 pottery artisans to gain information about the scientific knowledge of science they use in the pottery-making process. Observations were conducted directly during the pottery-making process in Kasongan to see and record the physical, chemical, and biological phenomena that occurred during the process. Documentation in photos, videos, and notes of the pottery making process were used to support the data obtained from interviews and observations.

Data analysis in this study was conducted using the Miles and Huberman interactive analysis model, which involves several stages [21]-[23]:

Data Reduction: The process of selecting, focusing on, and simplifying data obtained from the field.

Data Presentation: The reduced data is presented as descriptive narratives, matrices, or graphs to facilitate understanding.

Conclusion Drawing and Verification: After the data is presented, the researcher concludes the analyzed data and verifies them through the triangulation of sources and methods to ensure data validity.

This research procedure was carried out in several stages as follows:

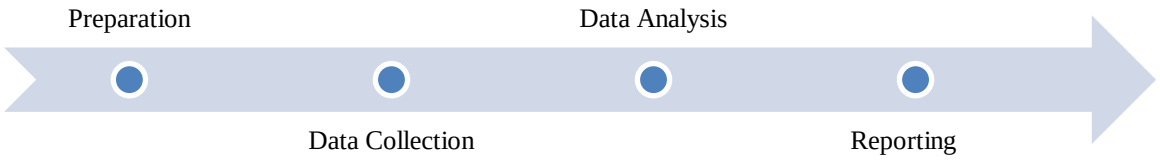

Figure 1. Research Procedure

3. RESULTS AND DISCUSSION

Semi-structured interview result table from research on scientific knowledge of natural science in making Kasongan pottery. This table presents information based on the results of interviews with Kasongan pottery artisans, including the concept of natural science related to each stage of the pottery making process.

Table 1. Results of Semi-Structured Interviews with Kasongan Pottery Craftsmen

No.	Process Stages	Science Concept	Description from the Crafter	Problems Encountered	Problems Encountered	Proposed Solutions
1	Clay Collection	Physical Properties of Clay	Clay is collected from specific locations and selected based on quality and moisture.	Clay sometimes contains gravel or dirt.	Clay sometimes contains gravel or dirt.	Screening and processing of clay to remove impurities.
2	Forming	Centripetal Force, Plasticity	The clay is shaped like a potter's wheel. Centripetal force helps shape the clay into the desired shape.	The pottery shape is only sometimes consistent.	The pottery shape is only sometimes consistent.	Use of more precise shaping techniques and experience.
3	Drying	Evaporation, Shrinkage	The shaped pottery is left to dry. The evaporation process causes the clay to shrink.	Pottery cracks during drying.	Pottery cracks during drying.	Optimal control of humidity and drying conditions.
4	Firing	Law of Conservation of Energy, Reduction	The pottery is fired in an oven. The heat energy changes the structure of the clay and affects its strength.	Pottery color or strength needs to be more consistent.	Pottery color or strength needs to be more consistent.	More precise control of firing temperature and time.
5	Finishing	Texture and Quality	After firing, the pottery is decorated or painted. The finishing technique determines the finishing technique	detere to the finishing layer.	Damage to the finishing layer.	Use of better finishing techniques and protective materials.
6	Environmental Impact	Air Pollution, Use of Ash	The firing process can cause air pollution. Ash from the firing is used as fertilizer.	Air pollution from combustion smoke.	Air pollution from combustion smoke.	Use of ventilation systems and management of firing waste.

Interviews with 38 Kasongan pottery artisans revealed that the pottery-making process involves various science concepts, especially in physics, chemistry, and biology. Artisans explained the various stages of pottery making, from clay selection to firing, and their challenges.

Direct observation of the Kasongan pottery-making process showed significant physical and chemical phenomena:

Centripetal Force: This is seen when the pottery wheel rotates, causing the clay to form the desired circular pattern.
Clay Plasticity: Clay can be molded into various shapes without breaking during forming.
Surface Tension: The surface of the clay remains stable before firing, which is important for maintaining the shape of the pottery.
Evaporation and Shrinkage: Drying the clay causes shrinkage, which needs to be controlled to avoid cracking. High temperatures during firing affect the final pottery outcome.
Reduction and Oxidation Firing: Affects the color and strength of the pottery.

Documentation in the form of photos and videos shows various stages of the pottery making process, including the use of traditional tools and techniques used by the artisans. This documentation supports information obtained from interviews and observations. The following is a table that describes the scientific knowledge of science contained in the Kasongan pottery making process and its potential for empowering the lateral thinking abilities of junior high school students:

Table 2. Scientific Knowledge of Science in the Process of Making Kasongan Pottery

Scientific Aspects	Science Concept	Description	Potential for Lateral Thinking Development
Physics	Centripetal Force	The forces acting on the clay as the pottery wheel rotates allow the desired shape to be formed.	They identify ways to maintain shape during the pottery-making process.
	Clay Plasticity Properties	The ability of the clay to be shaped into various shapes without breaking.	We are finding new techniques to manipulate clay into more complex shapes.
	Surface Tension	The forces that keep the clay surface stable before firing.	We are solving problems related to shape stability and preventing cracking in pottery.
	Evaporation	Water evaporating from the clay during the drying process affects the strength of the material.	We are finding solutions to accelerate drying without affecting quality.
	Shrinkage of Objects and Temperature	The decrease in volume of the clay as it dries and the temperature changes during firing affect the size and strength of the pottery.	We are finding methods to control shrinkage and pottery quality during firing.
	Law of Conservation of Energy	The heat energy transferred to the clay during firing increases the strength and resilience of the molecular structure.	We are developing strategies to maximize energy efficiency during firing.
Chemistry	Combustion Reduction and Oxidation	The chemical processes that occur during firing affect the color and strength of the pottery.	We are identifying ways to control chemical processes for consistent results.
Biology	Air Pollution	The impact of the firing process on air quality.	We are developing solutions to reduce air pollution during pottery making.
	Straw Ash as Soil Fertilizer	Using straw ash as a fertilizer increases soil fertility for agriculture.	They are finding innovative ways to utilize waste in the pottery making process.
	Respiratory Disorders	Health problems faced by artisans due to dust and smoke from the pottery making process.	We are finding methods to protect the health of artisans during the making process.

The process of making Kasongan pottery involves various science concepts that can be linked to the science curriculum in schools. In physics, centripetal force, clay plasticity, and surface tension are integral to pottery-making. Centripetal force is essential for shaping clay on the pottery wheel, while plasticity and surface tension affect the quality and stability of the pottery shape. The processes of evaporation and shrinkage are also important for understanding the physical changes in clay during manufacture. Then, in chemistry, the firing process involves reduction and oxidation reactions that affect the color and strength of the pottery. Understanding these chemical processes can help students learn about changes in matter and the results of chemical processes. In biology, the pottery making process's impact on artisans' environment and health shows relevance to biological concepts, such as air pollution and the use of straw ash as fertilizer. Integrating scientific knowledge from the Kasongan pottery making process into science learning can encourage the development of students' lateral thinking skills. By understanding artisans' challenges, students can be invited to identify problems that may arise, such as cracks in the pottery due to shrinkage or color changes due to firing [24]. Then, creative solutions to the problem can be found by developing new techniques to control shrinkage or modifying the firing process for more consistent results.

Integrating local wisdom, such as making Kasongan pottery, in science learning provides a real context for students to understand scientific concepts. This contextual and relevant learning improves students' understanding of scientific theories and trains them to think creatively and solve problems practically [25]-[27]. This is in line with the needs of the 21st century to have critical and creative thinking skills.

The results of previous studies show that this module is very feasible to use in learning, with proven effectiveness through t-tests and significant improvements in students' physics learning [28]. The identified GAP between previous and current studies is the shift in focus from the use of e-learning technology in physics learning to the direct integration of local wisdom and traditional crafts as educational media. Previous studies emphasized the validation and effectiveness of e-learning modules, while the current study focuses on improving lateral thinking skills through practical and contextual approaches. Both studies offer different approaches in combining local wisdom with science education, but with the same goal of improving the quality of physics learning [29]-[31].

This study significantly contributes to the development of a more contextual curriculum by incorporating local wisdom as a learning medium. It also supports the preservation of local culture while strengthening students' cultural identities in the era of globalization. This integration can be a model for other efforts in science education to bridge theory with real-world practice.

The novelty of this study introduces a new approach by integrating local crafts, especially Kasongan pottery, into physics learning to improve students' lateral thinking skills. By linking traditional pottery-making techniques with scientific concepts such as centripetal force, plasticity, and heat energy, this study provides a unique context for understanding complex physics principles. These findings suggest that local crafts can contextualize and engage science learning. However, the generalizability of these results may be limited to similar local craft contexts and may not be directly applicable to all types of traditional crafts or other educational settings. In addition, this study is limited by its focus on a specific location and sample size, which may affect the broader applicability of the conclusions. Further research is needed to explore the effectiveness of this approach in different settings and with different types of local knowledge.

4. CONCLUSION

This study shows that making Kasongan pottery is rich in scientific knowledge relevant to science learning. Using this local wisdom in science learning has great potential to develop students' lateral thinking skills and improve the quality of learning that is more contextual and meaningful. For further research, it is recommended that further studies be conducted by expanding the scope to other local crafts and various educational settings to test the generalizability of these findings. Research can also involve larger and more diverse samples to increase the validity of the results. In addition, a deeper exploration of integrating local crafts into the educational curriculum and its impact on student's critical thinking skills and creativity can provide more comprehensive insights.

ACKNOWLEDGEMENTS

We want to thank the Kasongan Pottery artisans in Kasongan Village for their cooperation and valuable information. We also appreciate the support of family and friends, who have motivated us during this research.

REFERENCES

[1] W. Srikongchan, S. Kaewkuekool, and S. Mejaleurn, "Backward instructional design based learning activities to developing students' creative thinking with lateral thinking technique," *Int. J. Instr.*, vol. 14, no. 2, pp. 233–252, 2021, doi: 10.29333/iji.2021.14214a.

[2] R. F. Mustofa and Y. R. Hidayah, "The effect of problem-based learning on lateral thinking skills," *Int. J. Instr.*, vol. 13,

no. 1, pp. 463–474, 2020, doi: 10.29333/iji.2020.13130a.
[3] S. Isparta *et al*., "The relationship between problem-solving ability and laterality in cats," *Behav. Brain Res.*, vol. 391, no. November 2019, p. 112691, 2020, doi: 10.1016/j.bbr.2020.112691.
[4] E. Haryani, W. W. Cobern, B. A. S. Pleasants, and M. K. Fetters, "Analysis of teachers' resources for integrating the skills of creativity and innovation, critical thinking and problem solving, collaboration, and communication in science classroom," *J. Pendidik. IPA Indones.*, vol. 10, no. 1, pp. 92–102, 2021, doi: 10.15294/jpii.v10i1.27084.
[5] A. Ghafar, "Convergence between 21 st century skills and entrepreneurship education in higher education institutes," *Int. J. High. Educ.*, vol. 9, no. 1, pp. 218–229, 2020, doi: 10.5430/ijhe.v9n1p218.
[6] K. Ismail, S. Dian, and W. Prajanti, "Strategy for empowerment of pottery craftsmen in kasongan tourism village , bantul regency," in *3rd International Conference on Innovative Research Across Disciplines (ICIRAD 2019) Strategy*, 2020, pp. 81–86. doi: 10.2991/assehr.k.200115.014.
[7] S. A. Syahrin, E. Sriyono, and M. A. Hapsari, "Valuing local heritage : Issue and challenges of geographical indication protection for local artisans in Indonesia Kasongan village heritage," *J. World Intellect. Prop.*, no. March 2021, pp. 71–85, 2022, doi: 10.1111/jwip.12206.
[8] J. Guan, K. Jin, and G. Hwang, "Effects of a virtual reality-based pottery making approach on junior high school students ' creativity and learning engagement," *Interact. Learn. Environ.*, vol. 0, no. 0, pp. 1–17, 2022, doi: 10.1080/10494820.2021.1871631.
[9] F. La Braca and C. S. Kalman, "Comparison of labatorials and traditional labs : The impacts of instructional scaffolding on the student experience and conceptual understanding," *Phys. Rev. Phys. Educ. Res.*, vol. 17, no. 1, p. 10131, 2021, doi: 10.1103/PhysRevPhysEducRes.17.010131.
[10] T. K. Bahar, M. H. Rauf, and M. L. Hidayatullah, "Identification of actor roles in endogenous development of rural areas : Kasongan village study case," *J. Tata Kota Dan Drh.*, vol. 15, no. 2, pp. 119–128, 2023, doi: 10.21776/ub.takoda.2023.015.02.3.
[11] S. W. Oktavia, N. N. Qoidah, I. Giorgadze, and C. Gasparin, "Exploring local wisdom : Improving basic skills in heat transfer material through developing a physics module based on smoked fish," vol. 4, no. 4, pp. 125–131, 2023, doi: 10.37251/sjpe.v4i4.921.
[12] E. A. Dare, K. Keratithamkul, B. M. Hiwatig, and F. Li, "Beyond Content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated STEM Education," *Educ. Sci.*, vol. 11, no. 737, pp. 1–22, 2021, doi: 10.3390/ educsci11110737.
[13] S. Cai, C. Liu, T. Wang, E. Liu, and J. Liang, "Effects of learning physics using augmented reality on students' self-efficacy and conceptions of learning," *Br. J. Educ. Technol.*, vol. 52, no. 1, pp. 235–251, 2021, doi: 10.1111/bjet.13020.
[14] Y. F. Kasi *et al*., "Integrating local science and school science: The benefits for preserving local wisdom and promoting students' learning," *Paedagogia*, vol. 27, no. 1, p. 24, 2024, doi: 10.20961/paedagogia.v27i1.83925.
[15] R. Zidny, J. Sjöström, and I. Eilks, "A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability," *Sci. Educ.*, vol. 29, no. 1, pp. 145–185, 2020, doi: 10.1007/s11191-019-00100-x.
[16] P. Sund and N. Gericke, "Teaching contributions from secondary school subject areas to education for sustainable development–a comparative study of science, social science and language teachers," *Environ. Educ. Res.*, vol. 26, no. 6, pp. 772–794, 2020, doi: 10.1080/13504622.2020.1754341.
[17] N. Suprapto, B. K. Prahani, and T. H. Cheng., "Indonesian curriculum reform in policy and local wisdom: Perspectives from science education," *J. Pendidik. IPA Indones.*, vol. 10, no. 1, pp. 69–80, 2021, doi: 10.15294/jpii.v10i1.28438.
[18] R. Mõttus *et al*., "Descriptive , Predictive and explanatory personality research : Different goals , different approaches , but a shared need to move beyond the big few traits," *Eur. J. Pers.*, vol. 34, pp. 1175–1201, 2020, doi: 10.1002/per.2311.
[19] M. Alvesson and J. Sandberg, "The art of phenomena construction : A framework for coming up with research phenomena beyond ' the usual suspects ,'" *J. Manag. Stud.*, vol. 61, no. July, 2024, doi: 10.1111/joms.12969.
[20] J. Jusmaniar, I. Riani, E. C. Anderson, M. C. Lee, and S. W. Oktavia, "Gasing game: Ethnoscientific exploration of circular motion in physics learning on the coast of east sumatra to build the character of perseverance," *Schrödinger J. Phys. Educ.*, vol. 5, no. 1, pp. 1–9, 2024, doi: 10.37251/sjpe.v5i1.902.
[21] J. Jana, H. Hammidah, R. Chand, and J. Haselkorn, "Community spirit and local wisdom: Strengthening character education through the ngarot tradition in social studies learning," *J. Soc. Knowl. Educ.*, vol. 5, no. 1, pp. 9–20, 2024, doi: 10.37251/jske.v5i1.888.
[22] A. Van Den Beemt *et al*., "Interdisciplinary engineering education : A review of vision , teaching , and support," *J. ofEngineering Educ.*, vol. 109, no. December 2019, pp. 508–555, 2020, doi: 10.1002/jee.20347.
[23] R. Uspayanti, R. Butarbutar, Fredy, H. J. Hiskya, Sajriawati, and A. F. Ainani, "Local wisdom and its implication for nature conservation," *Rev. Int. Geogr. Educ. Online*, vol. 11, no. 5, pp. 292–302, 2021, doi: 10.48047/rigeo.11/5/30.
[24] A. N. Fauziyah, M. Ramadan, P. R. Gumede, and I. N. Udosen, "Development of digital book bilingual physics learning media using kvisoft flipbook for high school class X semester 1 subject of newton's law," *J. Educ. Technol. Learn. Creat.*, vol. 1, no. 1, pp. 7–15, 2023, doi: 10.37251/jetlc.v1i1.618.
[25] R. Sidek, L. Halim, N. A. Buang, and N. M. Arsad, "Fostering scientific creativity in teaching and learning science in schools : A systematic review," *J. Penelit. dan Pembelajaran IPA*, vol. 6, no. 1, pp. 13–35, 2020, doi: 10.30870/jppi.v6i1.7149.
[26] I. H. Wenno, Jamaludin, and J. R. Batlolona, "The effect of problem based learning model on creative and critical thinking skills in static fluid topics," *J. Pendidik. Sains Indones.*, vol. 9, no. 3, pp. 498–511, 2021, doi: 10.24815/jpsi.v9i5.20829.
[27] K. Septaria and R. Rismayanti, "The effect of scientific approach on junior high school students ' scientific creativity and cognitive learning outcomes," *J. Penelit. dan Pengkaj. Ilmu Pendidik. e-Saintika*, vol. 6, no. 3, pp. 173–189, 2022.
[28] Matsun, V. S. Andrini, T. W. Maduretno, and A. C. Yusro, "Development of physics learning e-module based on local culture wisdom in Pontianak,West Kalimantan," *J. Phys. Conf. Ser.*, vol. 1381, no. 1, 2019, doi: 10.1088/1742-

6596/1381/1/012045.

[29] R. A. Mashami, B. M. Harisanti, and Y. Khery, "Identification of local wisdom of the sasak tribe in chemistry learning as an effort to strengthen student character," *J. Penelit. Pendidik. IPA*, vol. 9, no. 1, pp. 337–345, 2023, doi: 10.29303/jppipa.v9i1.2434.

[30] Usmeldi and R. Amin, "The effect of integrated science learning based on local wisdom to increase the students competency The effect of integrated science learning based on local wisdom to increase the students competency," in *Journal of Physics: Conf. Series*, 2020. doi: 10.1088/1742-6596/1470/1/012028.

[31] A. Ramdani, A. W. Jufri, Gunawan, M. Fahrurrozi, and M. Yustiqvar, "Analysis of students' critical thinking skills in terms of gender using science teaching materials based on the 5E learning cycle integrated with local wisdom," *J. Pendidik. IPA Indones.*, vol. 10, no. 2, pp. 187–199, 2021, doi: 10.15294/jpii.v10i2.29956.