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Indigenous Technology-Based Physics Learning to Support Global Scientific Literacy among Prospective Physics Teachers

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ABSTRACT

This study investigates indigenous technology-based physics learning as a culturally responsive approach to support global scientific literacy among prospective physics teachers. The study addresses the need to connect physics concepts with local cultural knowledge while providing more inclusive learning experiences for male and female students. A mixed methods design was employed through two phases: an exploratory phase and an implementation phase. In the exploratory phase, indigenous technologies from West Kalimantan were examined through field observations, cultural document analysis, and expert consultation. Sape' and Senggayung were selected and reconstructed as physics learning media representing standing waves, harmonics, frequency relationships, air-column vibration, and acoustic resonance. In the implementation phase, the learning media were used in a basic physics course involving 21 prospective physics teachers selected through purposive sampling. Students' global scientific literacy was measured using the Global Scientific Literacy Questionnaire before and after instruction, and the results were analyzed descriptively using normalized gain. The findings showed an increase in students' global scientific literacy from a mean score of 3.20 to 3.98, with an n-gain of 0.43 in the moderate category. Improvements were observed across male and female students, with a preliminary tendency toward a smaller gender gap in the dimension of science as a human endeavor. This study concludes that indigenous technology-based physics learning has potential to strengthen global scientific literacy through culturally meaningful experimentation, although further studies with larger and more balanced samples are needed.

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1. INTRODUCTION

Humanist education strives to realize learning that respects students' interests, talents, and cultural backgrounds. The concepts students acquire when learning physics will be better understood if they are preceded by providing basic experiences through experimental activities and connecting them to everyday life contexts (Sarjono et al., 2018). Globally, scientific literacy is the main standard of educational success, as emphasized by PISA. Its benefits lead to students' lives as adults, and in the 21st century, this is in line with scientific literacy, which is the focus of attention of the Program for International Student Assessment (PISA) (Naganuma, 2017; Tsai, 2015).

There is a gap between the demands of global scientific literacy and the reality of education at the local level, particularly in West Kalimantan. Various studies have revealed that students in West Kalimantan have not succeeded in measuring PISA related to scientific literacy (Sari et al., 2017). The results of research in Pontianak, West Kalimantan using the Global Scientific Literacy Questionnaire (GSLQ) revealed that the dimensions of habits of mind and the dimensions of character and values were not (Pramuda et al., 2019). More specifically, the dimensions of habits of mind and character and values were in the unsatisfactory category (Pramuda et al., 2019). This indicates that physics learning has not been able to bridge theoretical understanding with concern for local issues that have global impacts.

This gap is rooted in the lack of concrete learning resources that are capable of integrating traditional technology with the substance of physics material. In fact, local technology has great potential as a foundation for developing scientific literacy (Sjøberg, 2015). This dimension is closely related to problem-solving through a scientific approach and a concern for global issues.

The use of local wisdom-based science e-books is practically applied (79.64%) to support students in the learning process by utilizing technology (Rahayu et al., 2025). Physics learning modules based on traditional technology are suitable for improving students' understanding of physics concepts, with a feasibility of 85.99% for the material aspect (Panis et al., 2023). Integration of traditional technology can be used as contextual physics learning for meaningful learning (Putra et al., 2023). Local wisdom in learning improves students' thinking skills with a Cohen's d effect = 2.66 large category (Fajrun et al., 2025). Traditional technology is the result of human efforts and learning processes, so that various values preserved in the past have the potential to form a better global society (Mungmachon, 2012). In addition, various traditional technologies that are still relatively simple in form can still be studied in relation to current scientific concepts. This is mainly supported by technological advances to create experimental prototypes of various physical phenomena, making them more practical (Pramuda et al., 2019). This dimension is closely related to problem-solving through a scientific approach and a concern for global issues.

The learning processes experienced by people in the past may differ from those experienced in modern society, and the resulting technological complexity may also differ (Baquete et al., 2016). Furthermore, various traditional technologies, even relatively simple in form, can still be studied in relation to existing scientific concepts. The inclusion of traditional technology in basic physics learning media based on local technology prototypes will open up the possibility that learning will be more directed towards preserving local wisdom values and beneficial for the development of global scientific literacy.

Physics learning has often been associated with differences in participation and achievement across genders, despite students having comparable initial abilities (Blue et al., 2019; Pinson et al., 2020; Vilia & Candeias, 2020; Whitcomb & Singh, 2020). Consequently, examining learning approaches that provide meaningful opportunities for all students to engage in physics learning remains an important issue in science education. Previous studies suggest that collaborative and technology-supported learning environments can promote more inclusive participation and broaden access to learning experiences in physics (Carreño et al., 2022; Corrigan et al., 2024; Pollard-Larkin et al., 2018). In this context, the integration of indigenous technology into physics learning offers a culturally relevant approach that connects local knowledge with scientific concepts while encouraging active engagement among prospective physics teachers. In the long term, this approach may contribute to the development of physics learning resources that reflect the local potential of West Kalimantan and support the implementation of more inclusive and contextual physics education.

Based on these conditions, there is an urgent need to develop physics learning media based on prototypes of local West Kalimantan technology designed with a gender-responsive perspective. This research aims to develop traditional technology-based learning media and its improvement on students' scientific literacy, while also analyzing its impact on equal participation between male and female students. Integration of local technology supported by inclusive learning design can significantly improve students' scientific literacy dimensions and reduce gender-based achievement gaps in physics education in West Kalimantan.

2. METHODS

This research is mixed method with exploratory and implementation phases (Creswell & Poth, 2017). In the initial research phase, an exploration of the phenomenon was conducted, including the physical concept of the artifact model and the cultural background of traditional West Kalimantan technology. The exploratory approach associated with this research tends toward ethnography, as it involved direct field observations and in-depth research, as well as describing the physical principles manifested in indigenous community practices (Domingo & Miña, 2021). Referring to the qualitative results, basic physics learning media based on traditional technology prototypes were designed to improve students' global scientific literacy in West Kalimantan.

Qualitative research was conducted in several locations, namely the Center for the Study of History of West Kalimantan, the Institute of Dayakology in West Kalimantan, and the Museum of the Province of West Kalimantan. The exploration stage involved two categories of cultural informants: one researcher from the Institute of Dayakology and one of the history lecturers who is an expert on traditional Dayak culture. Field observations were conducted on four occasions between May and July 2021. The researchers examined cultural documents, ethnographic reports, museum collections, and traditional musical instruments, particularly Sape' and Senggayung. These artefacts were selected because they remain actively used in local communities, possess clear physical mechanisms related to sound production, and can be reconstructed into educational physics experiments.

The reconstruction of physics concepts was conducted through an iterative analysis linking cultural practices with scientific principles. The Sape' instrument was reconstructed to represent standing waves, frequency relationships, harmonics, and string interference. Senggayung was reconstructed as an open-pipe resonance model to illustrate air-column vibration and acoustic resonance. Cultural validity was established through member checking with cultural experts and practitioners, while conceptual validity was evaluated by two physics education experts who reviewed the alignment between indigenous technologies and the targeted physics concepts. Prototyping of traditional West Kalimantan production equipment along with concept verification and testing was carried out at the Pontianak IKIP-PGRI Laboratory. Quantitative research, namely implementation to determine students' global scientific literacy on experimental tools based on traditional West Kalimantan production equipment by purposive sampling on prospective physics teacher or undergraduate students at IKIP PGRI Pontianak in the 2nd introduction Physics course, consisting of 21 students (16 female and 5 male). The implementation of local West Kalimantan technology prototype media in basic physics learning was carried out in 4 sessions with 100 minutes each session. This research was conducted in strict adherence to research ethics standards. First, the principle of informed consent was implemented by providing a thorough explanation of the study's purpose and the participant's right to withdraw at any time. Second, to ensure confidentiality, participants' real identities were replaced with pseudonyms in all transcripts and the final report.

The instrument for exploration (qualitative) with a focus on traditional technology in West Kalimantan is the Human instrument. The tools used in this research are Log Book, image and video capture tools, and sensor-based instrumentation. The main instrument (quantitative) in this study adopted GSLQ, with four dimensions: content knowledge, habits of mind, character and values, and science as human endeavor (Mun et al., 2015). GSLQ has been tested for validity and reliability.

Qualitative data analysis in this study follows data analysis with an interactive model referring to Miles et al (2019). Whether there is an increase in global scientific literacy is known from the increase in the mean score in descriptive statistics and n gain. Descriptive analysis is very important to identify patterns and trends in the data, have an important position in building a solid foundation for study analysis (Harbison & Simmons, 2024).

3. FINDINGS AND DISCUSSION

Indigenous technology-based physics learning in this study was implemented through seven stages: formulating goals, analyzing material structures, identifying attributes and generating hypotheses, strengthening cognitive organization, defining concepts, confirming concepts and designing investigations, and analyzing thinking strategies. These stages were embedded in a learning module designed according to andragogical principles to provide a holistic understanding of physics concepts and their mathematical relationships (Astalin et al., 2021; Carreño et al., 2022).

The module incorporated learning activities based on the scientific reconstruction of two indigenous technologies from West Kalimantan, namely Sape' and Senggayung. Sape', a traditional Dayak string instrument, was selected to explore standing waves, harmonics, frequency relationships, and wave interference through the manipulation of movable frets (Yan et al., 2013). Meanwhile, Senggayung, a bamboo musical instrument, was reconstructed as a model of an open air column to investigate resonance and sound-wave behavior. To support data collection and analysis, students used smartphone-based applications such as Audacity, Spectroid, and Physics Suite to measure frequencies and visualize sound spectra.

Through these activities, students connected indigenous technological practices with scientific concepts, including wave classification, sound propagation, resonance, and harmonic relationships. This reconstruction demonstrates the relevance of indigenous technology as a meaningful context for learning physics concepts (Domingo & Miña, 2021). Furthermore, the learning stages were aligned with the dimensions and items of the Global Scientific Literacy Questionnaire (GSLQ), as reflected in the improvement of students' scientific literacy scores presented in Figure 1.

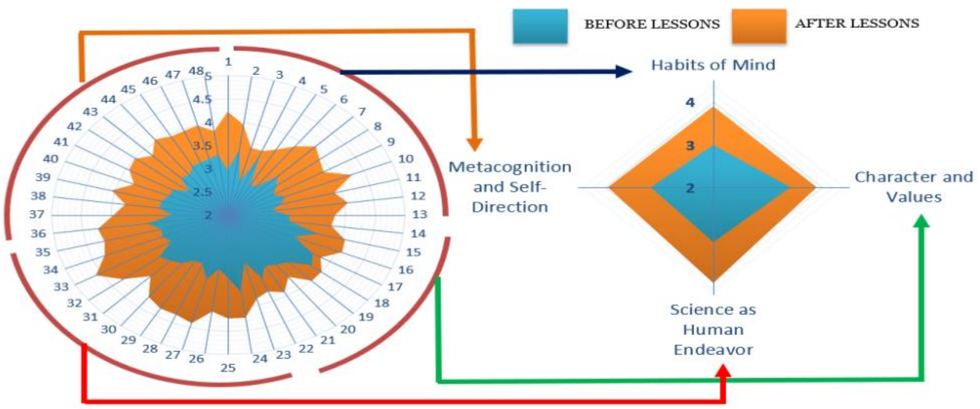

Figure 1. The Average Score of Students' Global Scientific Literacy Before and After Lessons from the Dimensions and Items in GSLQ.

Indigenous technology-based physics can improve all dimensions of GSLQ, both male and female physics educator students, known from mean of students' scientific literacy before 3.20 and after 3.98 with n-gain 0.43 (moderate category). There is an improvement in the dimensions of habits of mind and science as human endeavor which is consistent with Pramuda et al. (2019). Each stage of the learning process leads students to improve their scientific literacy. In the goal-formulating stage, they develop sensitivity to global issues, knowledge of various socio-scientific issues, and critical issues. In the material structure-analyzing stage, students think systematically, develop an individual understanding of overall physics concepts, and develop conceptual models. In the attribute-identifying and hypothesis-forming stage, students are confronted with unusual events using traditional technology prototypes. This stage builds students' knowledge to understand how they should work when facing incidental problems. Prospective teachers in the cognitive organization-strengthening stage conduct experiments using traditional technology prototypes. In the concept-defining stage, prospective teachers listen and interpret information while communicating and collaborating with others from diverse backgrounds to build shared understanding. In the concept-confirming and investigative design stage, students determine what to do to solve the problem. Prospective teachers in the thinking strategy-analyzing stage review their work processes and evaluate their decisions and problem-solving skills for appropriateness. All these stages provide meaningful learning for students. This is in line with several research findings which show that local wisdom and culture integrated into science make learning meaningful and help improve scientific literacy (Aziz & Johari, 2023; González & Fontalvo, 2026; Lantik & Kuswanto, 2024; Nasution & Nasution, 2026; Pertiwi & Firdausi, 2019).

The findings suggest that indigenous technology can serve as a meaningful context for strengthening global scientific literacy. Kumar et al. (2024) emphasized that socio-scientific and socio-cultural issues provide opportunities for students to understand the interrelationships among science, technology, society, and ethical decision-making. In this study, the investigation of Sape' and Senggayung enabled prospective physics teachers to connect scientific concepts with cultural practices and broader societal issues. This finding is consistent with Quiroz-Martinez & Rushton, (2025), who argued that contextual learning experiences can support the development of responsible scientific literacy by linking scientific knowledge to real-world contexts. Figure 2 presents the average scores of male students' global scientific literacy before and after instruction across the dimensions and items of the GSLQ. Figure 3 presents the average score of female students' global scientific literacy before and after lessons from the dimensions and items in GSLQ.

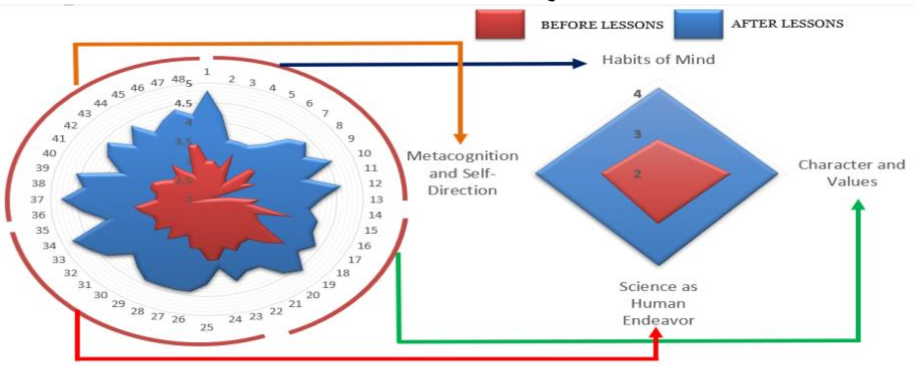

Figure 2. The Average Score of Male Students' Global Scientific Literacy Before and After Lessons from the Dimensions and Items in GSLQ.

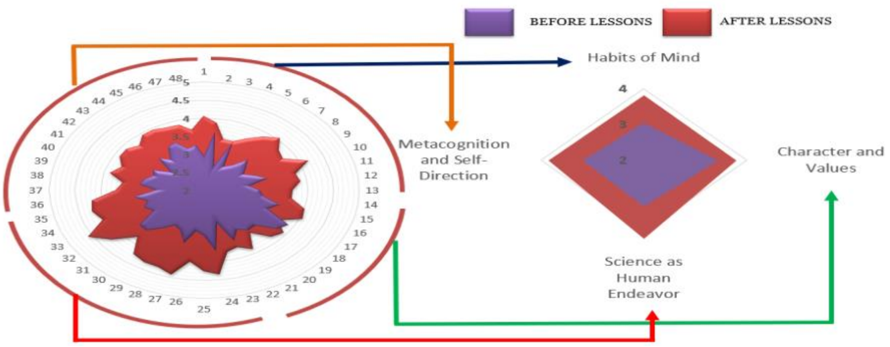

Figure 3. The Average Score of Female Students' Global Scientific Literacy Before and After Lessons from the Dimensions and Items in GSLQ.

There was an increase in scientific literacy among both male and female students following the implementation of indigenous technology-based physics learning. This improvement was likely supported by experimental activities that combined indigenous technology with digital tools, enabling students to investigate physics concepts through authentic and culturally meaningful contexts. Previous studies have shown that technology-enhanced and contextual physics learning can improve students' engagement and conceptual understanding (Balta & Asikainen, 2019; Carreño et al., 2022; Damayanti & Kuswanto, 2021). In the present study, smartphone applications were used as supporting tools for data collection and analysis, whereas indigenous technology served as the primary learning context through which students explored wave phenomena, resonance, and scientific inquiry**.**

The use of indigenous technology enabled students to identify physical quantities and concepts more easily through direct observation and experimentation. The reconstruction of Sape' and

Senggayung provided a tangible context for understanding wave phenomena, resonance, and harmonic relationships, while also demonstrating the connections among science, technology, and society (Sagala et al., 2019; Samsudin et al., 2018). Such contextual learning experiences are increasingly emphasized in indigenous STEM research because they facilitate the application of scientific knowledge to authentic cultural settings (Budiman & Suwarma, 2025).

The findings further suggest that indigenous technology-based physics learning has the potential to promote more inclusive participation among prospective physics teachers. The learning activities encouraged collaboration, investigation, and evidence-based reasoning, creating opportunities for both male and female students to engage actively in scientific inquiry. Motivation and self-confidence are important factors influencing learning achievement (Elejere, 2018; Ugwuanyi et al., 2020), and the integration of traditional technology with experimental activities provided meaningful learning experiences that can be adapted to future classroom practice (Okeke & Ukoh, 2020).

Furthermore, the stages of identifying attributes, generating hypotheses, confirming concepts, designing investigations, and analyzing thinking strategies supported evidence-based and inquiry-oriented learning. These stages provided opportunities for students to refine their understanding through experimentation and reflection, which are important processes in reducing disparities in learning outcomes and broadening participation in physics education (Akinbobola, 2018; Karim et al., 2018; Malik et al., 2019). This finding is particularly relevant because students may demonstrate different approaches to creative thinking and problem solving during physics learning (Amalia et al., 2020).

Figure 4 presents the average score of male and female students' global scientific literacy before and after lessons from the dimensions in GSLQ. The average GSLQ scores of male and female teacher candidates had relatively the same trend of answers. The average score before Indigenous technology-based physics learning for physics education students with male gender is slightly lower than physics education students with female gender.

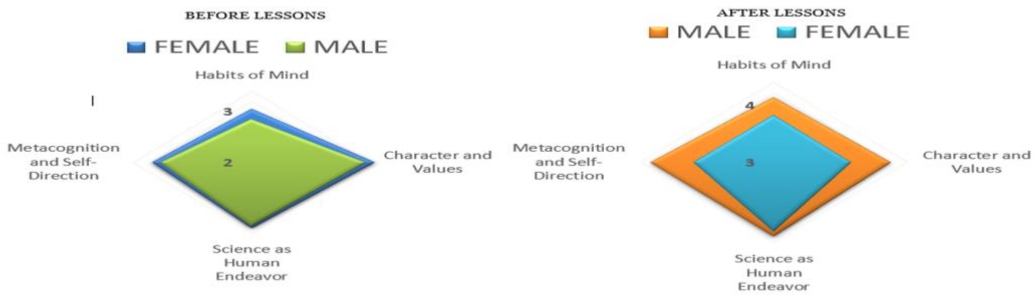

Figure 4. The Average Score of Male and Female Students' Global Scientific Literacy Before and After Lessons from the Dimensions in GSLQ

Following the implementation of indigenous technology-based physics learning, improvements were observed across all dimensions of global scientific literacy for both male and female students. Although differences remained in the dimensions of habits of mind, character and values, and metacognition and self-direction, the overall pattern of improvement was comparable across genders. This finding suggests that the learning approach provided meaningful opportunities for students with diverse backgrounds to engage in scientific inquiry and conceptual understanding. Previous studies have reported that differences in learning outcomes among physics education students may be influenced by variations in personal epistemology, motivation, technology use, and reasoning approaches (Manurung & Panggabean, 2018; Mustafa Alpaslan, 2019; Pramuda et al., 2019; Suana, 2018). Nevertheless, the consistent improvement observed across genders in this study indicates that indigenous technology-based learning has the potential to support more inclusive participation while strengthening global scientific literacy.

Notably, the gap between male and female students became smaller in the dimension of science as a human endeavor. This finding is consistent with Tunjungbiru et al. (2025) , who reported that technology-supported learning environments can help reduce gender disparities by promoting active engagement and participation. In the present study, the integration of indigenous technology, experimental investigation, and collaborative learning provided opportunities for all students to engage with scientific concepts in meaningful contexts. As a result, students developed a stronger understanding of science as a socially embedded human activity and of the interrelationships among science, technology, and society. These findings suggest that indigenous technology-based physics learning has the potential to support more inclusive participation while strengthening global scientific literacy among prospective physics teachers.

4. CONCLUSION

This study demonstrates that indigenous technology-based physics learning can moderately improve prospective physics teachers' global scientific literacy. The reconstruction of Sape' and Senggayung as physics learning media successfully connected local cultural knowledge with scientific concepts, enabling students to develop a deeper understanding of waves, resonance, and sound phenomena through authentic learning experiences. These findings demonstrate that indigenous technology can be transformed into scientifically valid learning resources while preserving cultural knowledge and practices. The findings further indicate that indigenous technology provides a meaningful context for strengthening global scientific literacy by linking scientific understanding with cultural and societal perspectives. In addition, the learning approach showed potential for promoting more inclusive participation, as both male and female students benefited from the learning activities and demonstrated similar patterns of improvement. Nevertheless, the findings should be interpreted cautiously because the implementation phase involved a relatively small sample from a single institution. Future studies involving larger and more diverse samples are recommended to further examine the effectiveness of indigenous technology-based learning across different educational contexts and scientific domains.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

Akinbobola, A. O. (2018). Teaching techniques, study habits, school environment, and gender factors as determinants of cognitive achievement of physics students in Nigerian senior secondary schools. *Journal of Global Research in Education and Social Science*, 43–55.

Amalia, Y., Sukarmin, & Suharno. (2020). Gender analysis in learning physics in terms of student SEPs skills and creative thinking. *Journal of Global Research in Education and Social Science, 57*(8), 394–401.

Astalin, A., Darmaji, D., Kurniawan, D. A., & Wulandari, M. (2021). Male or female, who is better? Students' perceptions of mathematics physics e-module based on gender. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, 207–224. https://doi.org/10.23917/ijolae.v3i3.14830

Aziz, A. A., & Johari, M. (2023). The effect of argumentation about socio-scientific issues on secondary students' reasoning pattern and quality. *Research in Science Education, 53*(4), 771–789. https://doi.org/10.1007/s11165-023-10099-5

Balta, N., & Asikainen, M. (2019). Introductory students' attitudes and approaches to physics problem solving: Major, achievement level, and gender differences. *Journal of Technology and Science Education, 9*(3), 378. https://doi.org/10.3926/jotse.666

Baquete, A. M., Grayson, D., & Mutimucuio, I. V. (2016). An exploration of indigenous knowledge related to physics concepts held by senior citizens in Chókwé, Mozambique. *International Journal of Science Education, 38*(1), 1–16. https://doi.org/10.1080/09500693.2015.1115137

Blue, J., Traxler, A., & Cochran, G. (2019). Resource letter: GP-1: Gender and physics. *American Journal of Physics, 87*(8), 616–626. https://doi.org/10.1119/1.5114628

Budiman, & Suwarma, I. R. (2025). Global research trends of indigenous STEM in science education: A bibliometric analysis. Article 080024. https://doi.org/10.1063/5.0259698

Carreño, M. J., Castro-Alonso, J. C., & Gallardo, M. J. (2022). Interest in physics after experimental activities with a mobile application: Gender differences. *International Journal of Science and Mathematics Education, 20*(8), 1841–1857. https://doi.org/10.1007/s10763-021-10228-4

Corrigan, E., Williams, M., & Wells, M. A. (2024). Beyond gender: The intersectional impact of community demographics on the continuation rates of male and female students into high school physics. *Canadian Journal of Physics, 102*(11), 577–589. https://doi.org/10.1139/cjp-2023-0319

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Damayanti, A. E., & Kuswanto, H. (2021). The effect of the use of indigenous knowledge-based physics comics of Android-based marbles games on verbal representation and critical thinking abilities in physics teaching. *Journal of Technology and Science Education, 11*(2), 581. https://doi.org/10.3926/jotse.1142

Domingo, A. L., & Miña, L. (2021). Physics principles gleaned from the indigenous fishing practices of fisherfolks in Santo Domingo, Albay, Philippines. *Bicol University R & D Journal, 24*(2).

Elejere, U. C. (2018). Gender-based relationship: Students' performance in mathematics and physics in the West African Senior Certificate Examination (WASSCE). *Journal of Pristine, 14*(1).

Fajrun, F., Suharti, S., & Ramdhani, L. (2025). The influence of digital literacy based on Bima's local wisdom on the critical thinking ability of classroom students VIII 10 at SMPN 1 Woha. *Jurnal Ilmiah Mandala Education, 11*(4), 1016. https://doi.org/10.58258/jime.v11i4.9444

González, J. R. G., & Fontalvo, L. M. V. (2026). Physics teaching in basic and secondary education from an ethnoeducational perspective in Colombia. *Multidisciplinary Reviews, 9*(8), Article 2026342. https://doi.org/10.31893/multirev.2026342

Harbison, L., & Simmons, K. (2024). Fundamentals of descriptive statistics. *Journal of Dental Hygiene: JDH, 98*(5), 51–54.

Karim, N. I., Maries, A., & Singh, C. (2018). Do evidence-based active-engagement courses reduce the gender gap in introductory physics? *European Journal of Physics, 39*(2), Article 025701. https://doi.org/10.1088/1361-6404/aa9689

Kumar, V., Choudhary, S. K., & Singh, R. (2024). Environmental socio-scientific issues as contexts in developing scientific literacy in science education: A systematic literature review. *Social Sciences & Humanities Open, 9*, Article 100765. https://doi.org/10.1016/j.ssaho.2023.100765

Lantik, V., & Kuswanto, H. (2024). Meta-analysis of research: Indigenous knowledge in physics teaching and learning. *Journal of Research in Science and Engineering, 6*(6), 44–50. https://doi.org/10.53469/jrse.2024.06(06).11

Malik, U., Angstmann, E. J., & Wilson, K. (2019). Learning and conceptual change in thermal physics concepts: An examination by gender. *International Journal of Innovation in Science and Mathematics Education, 27*(1). https://doi.org/10.30722/IJISME.27.01.003

Manurung, S. R., & Panggabean, D. D. (2018). The identification of logical thinking ability based on gender in physics teachers prospective students. *Journal of Community Research and Service, 2*(1), 192. https://doi.org/10.24114/jcrs.v2i1.10471

Miles, M. B., Huberman, M., & Saldaña, J. (2019). *Qualitative data analysis: A methods sourcebook*. SAGE Publications.

Mun, K., Shin, N., Lee, H., Kim, S.-W., Choi, K., Choi, S.-Y., & Krajcik, J. S. (2015). Korean secondary students' perception of scientific literacy as global citizens: Using the Global Scientific Literacy Questionnaire. *International Journal of Science Education, 37*(11), 1739–1766. https://doi.org/10.1080/09500693.2015.1045956

Mungmachon, M. R. (2012). Knowledge and local wisdom: Community treasure. *International Journal of Humanities and Social Science, 2*(13).

Mustafa Alpaslan, M. (2019). Examining relations between physics-related personal epistemology and motivation in terms of gender. *The Journal of Educational Research, 112*(3), 397–410. https://doi.org/10.1080/00220671.2018.1540966

Naganuma, S. (2017). An assessment of civic scientific literacy in Japan: Development of a more authentic assessment task and scoring rubric. *International Journal of Science Education, Part B, 7*(4), 301–322. https://doi.org/10.1080/21548455.2017.1323131

Nasution, N. H., & Nasution, I. W. (2026). Efforts to improve scientific literacy through ethnoscience-based learning in science learning. *Jurnal Pendidikan Indonesia: Teori, Penelitian dan Inovasi, 6*(1).

Okeke, U., & Ukoh, E. (2020). The influence of locus of control, study habits, and gender on the academic achievement of senior secondary school physics students in Ibadan Metropolis. *African Journal of Teacher Education, 9*, 21–48. https://doi.org/10.21083/ajote.v9i0.5815

Panis, I. C., Mukin, M. U. J., & Uran, Y. L. (2023). Pengembangan modul pembelajaran fisika berbasis kearifan lokal pada alat musik tradisional untuk meningkatan pemahaman konsep. *JKTP: Jurnal Kajian Teknologi Pendidikan, 6*(1), 050. https://doi.org/10.17977/um038v6i12023p050

Pertiwi, U. D., & Firdausi, U. Y. R. (2019). Upaya meningkatkan literasi sains melalui pembelajaran berbasis etnosains. *Indonesian Journal of Natural Science Education (IJNSE), 2*(2).

Pinson, H., Feniger, Y., & Barak, Y. (2020). Explaining a reverse gender gap in advanced physics and computer science course-taking: An exploratory case study comparing Hebrew-speaking and Arabic-speaking high schools in Israel. *Journal of Research in Science Teaching, 57*(8), 1177–1198. https://doi.org/10.1002/tea.21622

Pollard-Larkin, J. M., Paradis, K. C., Moran, J. M., Martel, M. K., & Rong, Y. (2018). Voices for gender equity in medical physics. *Journal of Applied Clinical Medical Physics, 19*(6), 6–10. https://doi.org/10.1002/acm2.12487

Pramuda, A., Mundilarto, M., Kuswanto, H., & Hadiati, S. (2019). Effect of real-time physics organizer-based smartphone and indigenous technology on students' scientific literacy viewed from gender differences. *International Journal of Instruction, 12*(3), 253–270. https://doi.org/10.29333/iji.2019.12316a

Putra, A. M. S., Putri, A. N. L., Angelina, O. P., Lutfi, T., Handayani, R. D., & Prihandono, T. (2023). Analysis of the physics concepts of center of mass and equilibrium in the traditional Tari Piring dance of West Sumatra. Article 050069. https://doi.org/10.1063/5.0125929

Quiroz-Martinez, D., & Rushton, E. A. C. (2025). Teaching high school chemistry through education for sustainability: A collaborative case study from Chile. *Environmental Education Research*, 1–18. https://doi.org/10.1080/13504622.2025.2573145

Rahayu, S., Muntari, M., Harjono, A., Makhrus, M., Kurniadin, M. Z., Sarwanto, S., & Mohtar, S. H. (2025). Development of science e-books based on local wisdom to improve digital literacy and students' critical thinking skills as an innovation to improve Education Sustainable Development Goals (ESDG). *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran, 11*(1), 100. https://doi.org/10.33394/jk.v11i1.14723

Sagala, R., Umam, R., Thahir, A., Saregar, A., & Wardani, I. (2019). The effectiveness of STEM based on gender differences: The impact on physics concept understanding. *European Journal of Educational Research, 8*(3), 753–761. https://doi.org/10.12973/eu-jer.8.3.753

Samsudin, M. A., Zain, A. N. M., Jamali, S. M., & Ebrahim, N. A. (2018). Physics achievement in STEM PjBL: A gender study. *The Asia Pacific Journal of Educators and Education, 32*, 21–28.

Sari, D. N. A., Rusilowati, A., & Nuswowati, M. (2017). Pengaruh pembelajaran berbasis proyek terhadap kemampuan literasi sains siswa. *PSEJ (Pancasakti Science Education Journal), 2*(2), 114. https://doi.org/10.24905/psej.v2i2.741

Sarjono, S., Mardapi, D., & Mundilarto, M. (2018). Development of physics lab assessment instrument for senior high school level. *International Journal of Instruction, 11*(4), 17–28. https://doi.org/10.12973/iji.2018.1142a

Sjøberg, S. (2015). PISA and global educational governance—A critique of the project, its uses, and implications. *EURASIA Journal of Mathematics, Science and Technology Education, 11*(1). https://doi.org/10.12973/eurasia.2015.1310a

Suana, W. (2018). Students' internet access, internet self-efficacy, and internet for learning physics: Gender and grade differences. *Journal of Technology and Science Education, 8*(4), 281. https://doi.org/10.3926/jotse.399

Tsai, C.-Y. (2015). Improving students' PISA scientific competencies through online argumentation. *International Journal of Science Education, 37*(2), 321–339. https://doi.org/10.1080/09500693.2014.987712

Tunjungbiru, A. D., Pranggono, B., Sari, R. F., Sanchez-Velazquez, E., Purnamasari, P. D., Liliana, D. Y., & Andryani, N. A. C. (2025). AI literacy and gender bias: Comparative perspectives from the UK and Indonesia. *Education Sciences, 15*(9), Article 1143. https://doi.org/10.3390/educsci15091143

Ugwuanyi, C. S., Okeke, C. I. O., & Ageda, T. A. (2020). Psychological predictors of physics learners' achievement: The moderating influence of gender. *Cypriot Journal of Educational Sciences, 15*(4), 834–842. https://doi.org/10.18844/cjes.v15i4.4635

Vilia, P., & Candeias, A. A. (2020). Attitude towards the discipline of physics-chemistry and school achievement: Revisiting factor structure to assess gender differences in Portuguese high school students. *International Journal of Science Education, 42*(1), 133–150. https://doi.org/10.1080/09500693.2019.1706012

Whitcomb, K. M., & Singh, C. (2020). For physics majors, gender differences in introductory physics do not inform future physics performance. *European Journal of Physics, 41*(6), Article 065701. https://doi.org/10.1088/1361-6404/ab9f1d

Yan, Y., Chai, K., Liang, H., & Kong, L. (2013). Physics involvement in ancient Chinese chime bells. 43–48. https://doi.org/10.1063/1.4794219