Studies in Philosophy of Science and Education
Homepage: https://scie-journal.com/index.php/SiPoSE
Email: sipose@scie-journal.com

p-ISSN: 2722-3523; e-ISSN: 2721-9267
SiPoSE, Vol. 6, No. 3, November 2025: 196-207

E-LKPD Based on Ethnophysics "*Siwalan* Dawet Ice Making Process" to Improve High School Students' Learning Motivation

A Rusmaya[1], *N Suprapto[1], B K Prahani[1], E Hariyono[1], H V Saphira[2]
[1]Department of Physics, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya, Surabaya 60231, Indonesia
[2]Departement of Digital Technologies for Learning, Faculty of the Arts, Social Sciences and Humanities, University of Wollongong, Wollongong NSW 2500, Australia

Article Info

Article history:

Received June 24, 2025
Revised July 4, 2025
Accepted July 6, 2025
Available Online 30 November 2025

Keywords:

E-LKPD;
Edutainment;
Ethnophysics;
Learning motivation;
Static fluid;

ABSTRACT

Physics education often struggles to convey abstract concepts like static fluids, leading to low student interest and achievement. This study aims to develop an ethnophysics-based E-LKPD (Electronic Student Worksheet) that integrates physics with local culture, specifically the traditional process of making *Siwalan* dawet ice from Lamongan. The E-LKPD is designed to enhance learning motivation through an engaging, interactive edutainment approach. Using the ADDIE development model, only the Analyze, Design, and Development stages were conducted. This was due not only to time constraints but also because the research focused on product design and expert validation. Classroom implementation and evaluation were beyond the current research scope and are planned for future studies. Validation involved three expert lecturers who assessed presentation, content, and language using a Likert scale. Results indicated a very valid product, with an overall average score of 95.75% (presentation 91.75%, content 98.06%, language 97.22%). The E-LKPD was developed using the Liveworksheets platform, offering features like ElsQuiz, ElsAct, ElsLink, and ElsFo to promote interactivity and accessibility. Findings suggest that integrating ethnophysics and local culture into digital worksheets effectively improves student motivation in learning static fluid concepts.

https://doi.org/10.46627/sipose

INTRODUCTION

Physics is among the disciplines in education that face significant challenges, particularly in responding to technological advancements and shifts in modern society. These challenges arise from the increasing need to grasp physics concepts in order to keep up with current developments. In today's era, where technology plays a dominant role, mastering physics is essential for understanding new technologies and their practical applications in everyday life (Smaragdis et al., 2020). A major issue in physics education lies in the difficulty students often have in comprehending abstract ideas. These abstract concepts are not easily grasped, particularly when presented through static visuals, which can result in reduced interest and lower achievement in physics.

Moreover, rapid technological progress requires that physics education continuously adapt by incorporating updated learning strategies. The integration of technology in physics instruction is growing in order to improve teaching effectiveness and enrich students' learning experiences (Kim & Lee, 2020; Sari et al., 2021; Suprapto et al., 2024). Research by Enda (2023) highlights that successful learning heavily relies on students' learning motivation. The study found that students with strong motivation are more capable of grasping concepts and completing tasks effectively (Janifa & Gokula Krishnan, 2015).

One approach that can enhance learning motivation is the use of edutainment-based learning, which merges entertainment with educational content. This strategy aims to make learning more enjoyable and engaging, thereby increasing students' interest in the subject. According to Johnson (2021) and Thuan (2025), edutainment has been shown to significantly boost students' motivation and active participation in learning.

Edutainment-based learning utilizes a variety of media formats, including videos, games, educational animations, simulations, and even virtual or augmented reality technologies (Safitri et al., 2023; Halim & Yusriati, 2022; Janifa et al., 2024; Yanto et al., 2024; Candra et al., 2024). For instance, the use of physics vlogs or educational videos has been found to boost student engagement and conceptual understanding (Leshty et al., 2024; Kozub et al., 2023). This method blends entertainment with academic tasks, creating a more dynamic and enjoyable learning environment. Additionally, it allows instruction to be tailored to students' individual learning styles, whether they are visual or auditory learners. Thompson (2023) found that students exposed to edutainment methods experienced significant improvements in both motivation and learning outcomes.

Another strategy to support student motivation is through the use of Electronic Student Worksheets (E-LKPD). These tools have demonstrated positive effects in improving student performance across different levels and academic subjects (Fitriyah et al., 2024; Maharani & Hidayah, 2024; Alexon & Handayani, 2024; Deni & Masduki, 2023; Pratama & Widowati, 2022; Susanti & Widowati, 2022). E-LKPDs often include interactive features and digital resources, enabling students to access assignments and learning materials via electronic devices like laptops, tablets, or smartphones. A key benefit of E-LKPDs is their flexibility, allowing students to study anywhere and anytime (Yanto et al., 2024; Haryanto et al., 2020; Rahman et al., 2025; Sytynkova et al., 2025). These digital worksheets can also be adapted to meet diverse learning preferences and levels of difficulty.

The development of E-LKPDs is increasingly important in modern physics education. As highlighted by Setyawan et al. (2024), incorporating local potential into instructional materials helps make learning more relevant. The ethnophysics approach, for instance, offers a meaningful strategy by blending physics with local wisdom and cultural practices. Several studies have confirmed that such a contextual approach can enhance students' scientific literacy and engagement (Nuryatin et al., 2024; Alexon et al., 2025; Rizki et al., 2025; Misbah et al., 2021). Through this lens, students can better relate physics to their everyday experiences by connecting it to familiar cultural contexts (Syahda & Deta, 2023; Aziziha et al., 2022; Saputri et al., 2024; Zateri et al., 2024).

The abstract and complex static fluid material in physics is relevant for the development of ethnophysics-based E-LKPD. By integrating physics concepts with local cultural contexts, E-LKPD can make it easier for students to understand physics concepts related to everyday phenomena and appreciate local wisdom in their culture (Winarto et al., 2025). The development of ethnophysics-based E-LKPD also aims to promote cultural diversity and local wisdom in physics learning, provide a sense of pride in students' cultural heritage, and appreciate cultural diversity, which is important in multicultural education in the era of globalization (Riski et al., 2022; Putra et al., 2023). Prior research has explored similar models through ethnoscience-enhanced worksheets and simulations to improve student engagement (Nisa' et al., 2024; Dewi et al., 2024).

Lamongan is one of the areas in East Java that is rich in local wisdom, including in terms of culinary culture. Es dawet *Siwalan* is one of Lamongan's popular culinary specialties and has cultural values implied in it (Widiastuti et al., 2020). Made from natural ingredients such as dawet, palm sugar, coconut milk, and pieces of ice *Siwalan*, this drink not only offers culinary pleasure but also reflects local wisdom in utilizing available natural resources (Hafied, 2018).

Physics learning faces the challenge of making abstract concepts more concrete and easier for students to understand. In this context, static fluid material was chosen because of its relevance to everyday natural phenomena that can be connected to the local wisdom of the Lamongan community through es dawet *Siwalan*. Physics concepts such as pressure, force, and density in static fluid can be explained through analogy with the process of making and the properties of es dawet *Siwalan*. For example, the concept of pressure in static fluids can be illustrated by pressing *Siwalan* ice on dawet in a glass, making it easier for students to understand the material in a concrete way.

The results of online interviews with students of SMAN 3 Lamongan revealed that they considered physics lessons quite difficult and less interesting. They felt that physics involved too many formulas and was less relevant to everyday life. In addition, physics lessons in schools are rarely associated with the local culture of Lamongan, and there is no ethnophysics-based E-LKPD used. These factors can be one of the causes of the average physics score being lower than other subjects, especially in the field of science.

Based on the background above, this study was conducted to develop an Electronic Student Worksheet (E-LKPD) based on ethnophysics and test the validity of the E-LKPD to increase students' learning motivation in static fluid material using the independent curriculum. The focus of this study is the application of ethnophysics concepts related to local culture so that learning becomes more interesting and relevant for students. The formulation of the problem in this study is how is the validity of the E-LKPD developed based on the ethnophysics of the process of making *Siwalan* dawet ice to increase the learning motivation of high school students in the static fluid material?

RESEARCH METHOD

This study aims to develop an E-LKPD based on ethnophysics in the process of making *dawet Siwalan* to increase students' learning motivation in static fluid material. The development process follows the ADDIE model (Analyze, Design, Development, Implementation, Evaluation) (Widiana et al., 2019). However, this research focuses on the first three stages, namely Analyze, Design, and Development.

The product developed is an ethnophysics-based Electronic Student Worksheet (E-LKPD) that contextualizes the traditional process of making *Siwalan* dawet ice to enhance students' motivation in learning static fluid concepts. The development process in this study was carried out through the first three stages of the ADDIE model: Analyze, Design, and Development. The final two stages, implementation and evaluation, were not conducted due to time constraints but are planned for future research. A visual representation of the ADDIE model as applied in this study is presented in Figure 1.

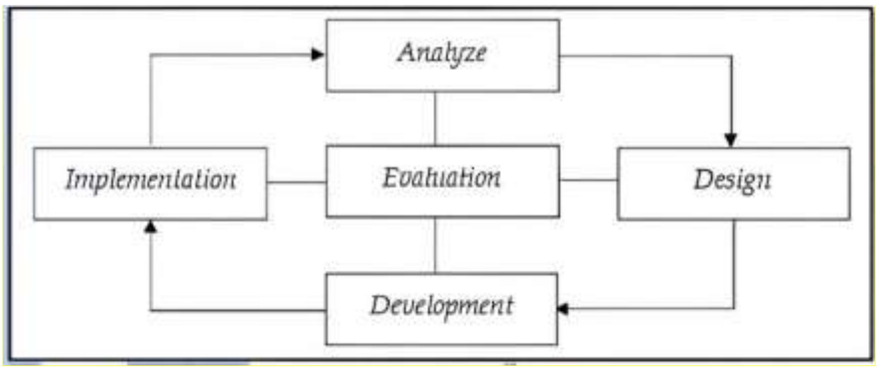

Figure 1. ADDIE development model stages

The first phase, analysis, involved several steps such as curriculum mapping, student analysis, concept breakdown, task examination, and the formulation of learning objectives. The second stage, design, included compiling the E-LKPD using the Liveworksheets platform based on findings from the analysis. The third phase, development, was conducted at the Physics Department, Faculty of Mathematics and Natural Sciences, Surabaya State University. This phase also utilized support from Liveworksheets. The validation process involved three expert validators and included revisions based on their feedback to ensure the worksheet's quality. The validation instrument was a sheet assessing three dimensions: content, presentation, and language, evaluated using a Likert scale. The results are reported in Table 1.

Table 1. Likert scale (Riduwan, 2012)

Scale Value	Evaluation
1	Not Good
2	Quite Good
3	Good
4	Very Good

The research data was then analyzed using the formula:

$$\text{Percentage (\%)} = \frac{\textit{Number of scores obtained}}{\textit{Maximum score}} \times 100 \ldots(1)$$

The learning device is declared valid or feasible if the percentage score is > 61% with the data interpretation listed in Table 2.

Table 2. Score interpretation criteria (Riduwan, 2012)

Percentage Score	Category
0%-20%	Very less
21%-40%	Less
41%-60%	Enough
61%-80%	Valid
81%-100%	Very valid

RESULTS AND DISCUSSION

The research led to the development of an E-LKPD that integrates ethnophysics by combining static fluid concepts with the local context of the Siwalan dawet production process in Lamongan. The worksheet was developed using the first three stages of the ADDIE model: Analyze, Design, and Development. Each phase was carefully executed to ensure that the resulting E-LKPD met the needs of students and aligned with the Merdeka Curriculum's vision of contextual, meaningful, and student-centered learning.

The integration of ethnophysics aims to make abstract scientific concepts easier to relate to by connecting them with students' everyday experiences and cultural heritage. This method is supported by Setyowati et al. (2025) and Fakhriyah et al. (2025), who found that embedding local cultural content into science education can improve both engagement and comprehension.

Analysis

The analysis stage includes problem identification, curriculum review, and student needs assessment. The results of observations and interviews conducted at SMAN 3 Lamongan showed that physics learning, especially in statistical fluid material, is still dominated by conventional methods such as lectures and group discussions. This method is considered unable to stimulate critical thinking and encourage active student participation. Teachers also stated that the use of contextual learning media, especially those containing local cultural elements, is still rare.

https://doi.org/10.46627/sipose.v6i3.666

In accordance with the Merdeka curriculum, which emphasizes relevant and contextual learning, this study uses a culture-based learning approach through ethnophysics. Similar approaches have been successfully applied in mathematics education using ethnomathematics to contextualize abstract concepts (Setyowati et al., 2025; Fakhriyah et al., 2025).

To further determine student needs, a questionnaire was distributed to 36 students in grades XI-7. The results showed that 94% of students supported the use of ethnophysics-based E-LKPD, while 83% of students felt that the previous learning media were less interactive and relevant. In addition, 88% expressed greater interest when physics concepts were linked to common cultural practices. These findings highlight the need for innovative, interactive, and culturally relevant learning tools.

Design

At this stage, the structure and layout of the E-LKPD were carefully planned. The learning objectives were aligned with the curriculum and focused on enhancing students' critical thinking skills in understanding static fluid concepts. The content was developed by integrating ethnophysics elements with the physics material, supported by various media elements.

Visual designs were created using Canva to ensure an attractive layout, while the digital format was built using the Liveworksheets platform to provide interactivity. The use of digital platforms in learning materials has been shown to enhance student motivation and problem-solving skills (Nasrullah et al., 2025; Kurniawan et al., 2025; Asrizal et al., 2025). This platform allows online access and includes features that promote student engagement and enable teachers to monitor student progress.

Figure 2. Display of E-LKPD cover based on the ethnophysics of the process of making Siwalan dawet ice.

Figure 3. Display of E-LKPD learning activity page based on the ethnophysics of the process of making Siwalan dawet ice.

E-LKPD based on the ethnophysics of the process of making *Siwalan* dawet ice on static fluid material has several features designed to help students in the learning process, with the hope of increasing their learning motivation. The features available in this E-LKPD include ElsQuiz, ElsAct, ElsLink, and ElsFo. An explanation of each of these features can be found in Table 3.

Table 3. Features in E-LKPD based on ethnophysics of the process of making *Siwalan* dawet ice.

Name	Appearance	Deskription
ElsQuiz	ElsQuiz	This feature provides questions to test students' understanding of physics concepts in static fluid material.
ElsAct	ELSACT	This feature contains demonstration observation activities in the process of making *Siwalan* dawet ice.
ElsLink	ELS L INK	This feature provides a website link that can be used by students to access the Virtual Lab.
ElsFo	ELSFO	This feature provides general information about how physics concepts are applied in making *Siwalan* ice dawet in everyday life.

Development

Electronic Validity of Student Worksheets The development of E-LKPD based on the ethnophysics of the process of making *Siwalan* ice dawet was validated by three lecturers from the Physics Department, Faculty of Natural Sciences, Surabaya State University. They assessed three important aspects, namely presentation, content, and language. The results of the validity analysis of E-LKPD are presented in Table 4.

Table 4. Results of electronic validation of student worksheets (E-LKPD)

No	Component	Validator 1	Validator 2	Validator 3	Average
	A. Presentation				
1.	Electronic Access to Student Worksheets	4	4	4	4
2.	Suitability of the appearance of the E-LKPD cover with the content of the material	4	3	4	3,67
3.	Layout Quality	4	3	4	3,67
4.	Image Quality	3	3	3	3
5.	Completeness of the E-LKPD section	4	4	4	4
Percentage of validation on the language criteria			**91,75%**		
Category			**Very Valid**		
	B. Content				
6.	Suitability of the E-LKPD content with the static fluid material	3	4	4	3,67
7.	Suitability of the concept with the independent curriculum	4	4	4	4
8.	Suitability of the material with the ethnophysical concept of the process of making *Siwalan* dawet ice	4	4	4	4
9.	Suitability of E-LKPD to foster student learning motivation	4	4	4	4
Validation percentage on content criteria			**98,06%**		
Category			**Very Valid**		
	C. Language				
10.	Language suitability	4	3	4	3,67
11.	Use of terms	4	4	4	4

No	**Component**	**Validator 1**	**Validator 2**	**Validator 3**	**Average**
12.	Quality of identity and information sources	4	4	4	4
Validation percentage on language criteria			**97,22%**		
Category			**Very Valid**		
Overall validation percentage			**95,75%**		
Category			**Very Valid**		

The ethnophysics-based E-LKPD on the Siwalan dawet-making process was rated as highly valid. As shown in Table 4, following criteria by S. Safitrawati (2004), a valid LKPD must fulfill three main requirements: didactic, construction, and technical aspects. Didactic validity ensures learning is effective, construction pertains to layout and structure, and technical validity involves adherence to correct formatting and language use.

The following figures and graphs present the validation scores for each component. The didactic aspect scored 98.06%, the construction 97.22%, and the technical 91.75%. These results demonstrate that the E-LKPD met the standards required in all three categories.

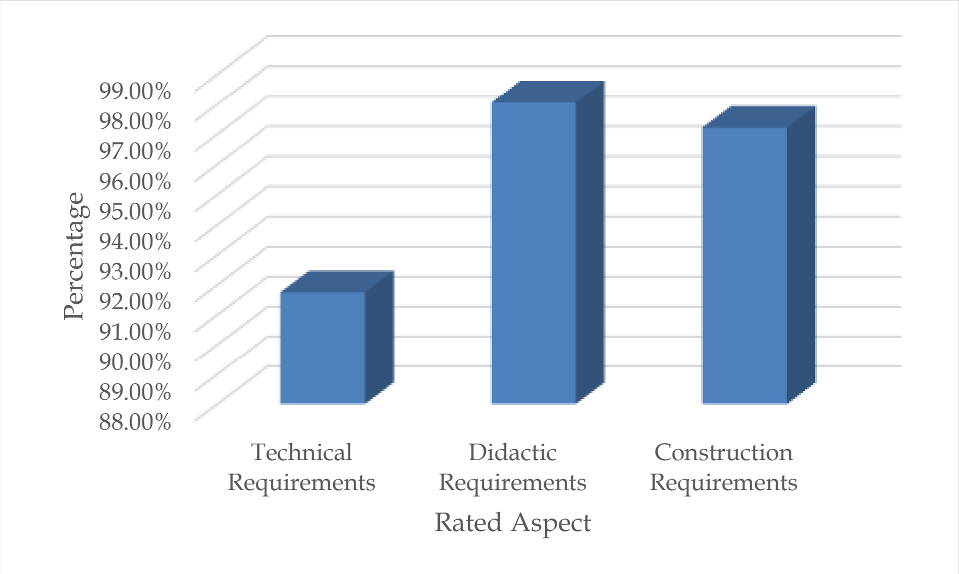

Figure 4. E-LKPD validation results graph

In terms of presentation, as seen in Table 4, E-LKPD displays a cover that reflects the content of the material and uses images to motivate students. Electronic presentations can also increase student motivation and activeness during learning. According to Kurniasih (2014), the presentation of teaching materials must be carried out systematically, interestingly, challengingly, and using scientific and formal language. This is supported by Pertiwi (2021), who emphasized that images in teaching materials should motivate students in the learning process. In terms of presentation, the developed E-LKPD obtained a score of 91.75%, which is included in the very valid category. However, the validator provided comments and suggestions regarding several images that were of poor quality, as shown in Figure. The images in E-LKPD are digital photos taken with a cellphone camera and from journals or the internet. According to Advernesia (2023), the optimal size for images in blog posts is 1200px x 630px with a resolution of 72 dpi. Before being converted to Liveworksheets, the images in E-LKPD had a resolution of around 85 dpi and were of good quality. However, after being converted to Liveworksheets, the image quality decreased slightly. To overcome this problem, it is recommended to upload images to Google Drive so that the quality is maintained properly.

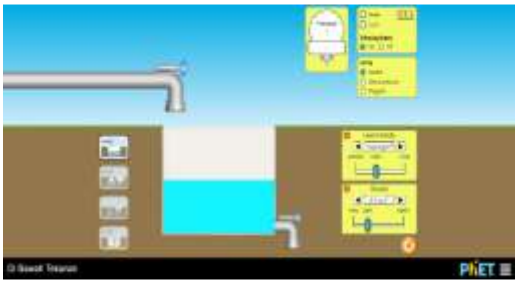

Figure 5. Image quality before being converted into liveworksheets

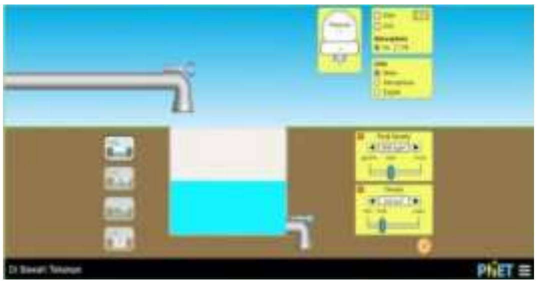

Figure 6. Image quality after being converted into liveworksheets

Table 4 shows that the content aspect obtained a score of 98.06%, which is categorized as very valid. This indicates that the content of the E-LKPD developed is in accordance with the independent curriculum and the concept of ethnophysics in the process of making *Siwalan* dawet ice on static fluid material. With ethnophysics, students can learn local wisdom and Indonesian culture and increase their sense of nationalism. The validator provided several comments and suggestions on the content aspect, namely that the flow of learning objectives does not need to be included in the E-LKPD, only the learning achievements and learning objectives. In addition, learning objectives should be formulated using the ABCD method (Audience, Behavior, Condition, and Degree). Learning objectives are very important because they are useful in evaluating learning outcomes. Hamzah (2008) stated that formulating learning objectives using the ABCD method is the most effective. Based on the validator's suggestions, the solution is to improve learning objectives with the ABCD method.

Furthermore, the linguistic aspect includes several important elements, such as the use of good and correct Indonesian, the selection of appropriate and easy-to-understand terms, and the use of simplified sentences. This is very important to ensure that the material presented can be easily understood by students. The use of good and correct language in teaching materials is very important to facilitate students' understanding of the material being taught.

The assessment in Table 4 shows a score of 97.22%, which is included in the very valid category. This score shows that the language of the E-LKPD that was developed has met all the elements and requirements needed for a good E-LKPD. This high score indicates that the language used in the E-LKPD has been adjusted to the level of understanding of students. The selection of appropriate terms and the use of simple sentences greatly affect the level of student understanding. Therefore, it can be concluded that the linguistic aspects of the E-LKPD are not only in accordance with good and correct linguistic standards but are also able to simplify complex concepts to be easier to understand. This is very important to maximize the learning process and ensure that learning objectives can be achieved effectively. Magdalena (2020) stated that the use of simple and easy-to-understand language in teaching materials can increase the effectiveness of learning and increase students' learning motivation.

CONCLUSION

Based on the research and analysis that has been done, it can be concluded that the development of E-LKPD based on the ethnophysics of the process of making *Siwalan* ice dawet to improve the learning motivation of high school students on static fluid material is said to be very valid. The validity of E-LKPD in terms of presentation, content, and language reached 91.75%, 98.06%, and 97.22% respectively, indicating a very high level of validity. The impact of this finding is that the application of the concept of ethnophysics in physics learning can be an effective strategy to increase students' interest and motivation to learn. The suggestion for this study is to test E-LKPD based on ethnophysics on a number of high school students to measure its practicality and effectiveness in learning and its impact on their learning motivation. In addition, a more in-depth evaluation of the use of E-LKPD on teachers and student responses also needs to be done. By considering these suggestions, further research is expected to provide more comprehensive insights into the potential and effectiveness of using E-LKPD based on ethnophysics in improving students' learning motivation.

ACKNOWLEDGEMENTS
The author would like to express sincere gratitude to all individuals and institutions who have contributed to the completion of this research through valuable insights, guidance, and support. Deepest appreciation is also extended to the author's parents for their unwavering encouragement and moral support. Gratitude is likewise conveyed to all peers who provided assistance and motivation throughout the research and writing process.

REFERENCES
Advernesia. (2023). *Ukuran gambar terbaik untuk situs web*. https://www.advernesia.com/blog/catatan/ukuran-gambar-terbaik-untuk-situs-web/
Alexon, & Handayani, D. (2024). The development of e-LKPD with a culture-based integrated learning model (MPTBB) to improve student learning outcomes on buffer solution material. *International Journal of Information and Education Technology*, *14*(1), 141–150. https://doi.org/10.18178/ijiet.2024.14.1.2034
Asrizal, Amnah, R., Annisa, N., Uzfa, V., Helma, & Hidayati. (2025). STEM integrated e-teaching material to promote students' conceptual understanding and new literacy skills. *International Journal of Information and Education Technology*, *15*(4), 803–811. https://doi.org/10.18178/ijiet.2025.15.4.2286
Azizha, F. S., Umamah, N., & Sumardi. (2020). The development of Patukangan local sites Situbondo e-module for history learning using the Dick and Carey model. *IOP Conference Series: Earth and Environmental Science*, *485*(1), Article 012131. https://doi.org/10.1088/1755-1315/485/1/012131
Deni, I. W. R., & Masduki. (2025). The development of e-worksheet based on multiple representations to enhance seventh-grade students' algebraic thinking. *AIP Conference Proceedings*, *3142*(1), Article 020090. https://doi.org/10.1063/5.0262118
Dewi, C. T., Kuswanto, H., Rahmat, A. D., & Sihana. (2024). The effectiveness of a virtual laboratory integrated with Blacksmith ethnophysics in enhancing data literacy and graphic representation skills. *International Journal of Information and Education Technology*, *14*(8), 1155–1163. https://doi.org/10.18178/ijiet.2024.14.8.2144
Dewi, P. S., Suryanto, R. A., & Kuswanto, H. (2024). The development of 2D augmented reality–integrated physics e-worksheet to improve mathematical representation ability. *AIP Conference Proceedings*, *2622*(1), Article 020014. https://doi.org/10.1063/5.013355
Emda, A. (2018). Kedudukan motivasi belajar siswa dalam pembelajaran. *Lantanida Journal*, *5*(2), 181–188. https://doi.org/10.22373/lj.v5i2.2838
Fakhriyah, E. N., Ishartono, N., Setyaningsih, R., Zulkarnaen, Ansyari, R. M., Halili, S. H. B., & Razak, R. B. A. (2025). Ethnomathematics: An exploration of geometric concepts in Sidomukti Solo batik. *AIP Conference Proceedings*, *3142*(1), Article 020039. https://doi.org/10.1063/5.0262004
Fitriyah, I. J., Salamah, I. D., & Ramadhan, U. L. (2024). The effectiveness of e-LKPD with a scientific approach using Liveworksheets in improving learning outcomes on the interaction of living things with the environment. *AIP Conference Proceedings*, *3106*(1), Article 030040. https://doi.org/10.1063/5.0210190
Hafied. (2018). *Kuliner Lamongan: Es dawet siwalan*. Penerbit Kuliner Nusantara.
Halim, A., & Yusrizal. (2022). The impact of smartphones on students' interests and grade point average. *AIP Conference Proceedings*, *2600*, Article 070009. https://doi.org/10.1063/5.0113562
Hamzah, B. (2008). *Perencanaan pembelajaran*. PT Bumi Aksara.

Haryanto, Asrial, & Ernawati, M. D. W. (2020). E-worksheet for science processing skills using Kvisoft Flipbook. *International Journal of Online and Biomedical Engineering*, *16*(3), 46–58. https://doi.org/10.3991/ijoe.v16i03.12381

Hashrin, M. A. A., & Lestyanto, L. M. (2024). Development of interactive flipbook learning material on trigonometric ratio. *AIP Conference Proceedings*, *3049*(1), Article 030009. https://doi.org/10.1063/5.0194448

Janifa, D., & Gokula Krishnan, A. (2025). Building confidence: The impact of learning strategies on self-efficacy and academic motivation in Chennai's arts and science students. *AIP Conference Proceedings*, *3306*(1), Article 030062. https://doi.org/10.1063/5.0275764

Johnson, S. K. (2021). The effectiveness of edutainment on student engagement and motivation. In R. Brown & M. Green (Eds.), *Education and entertainment in the digital age* (pp. 1–12). Springer. https://doi.org/10.1007/978-3-662-61510-2_1

Kim, S. M., & Lee, J. Y. (2020). The future of educational technology in physics education: A vision of emerging technology for transforming physics education. *International Journal of Science and Mathematics Education*, *18*(1), 1–21. https://doi.org/10.1080/09500693.2020.1756051

Kozub, H., Sipii, V., Kozub, Y., Bratytsya, G., & Bondarenko, L. (2025). Effectiveness of gamification in mobile and interactive learning: Analysis of approaches and outcomes. *International Journal of Interactive Mobile Technologies*, *19*(8), 27–41. https://doi.org/10.3991/ijim.v19i08.50917

Kurniasih, I., & Sani, B. (2014). *Implementasi Kurikulum 2013: Konsep & penerapan*. Kata Pena.

Kurniawan, R., Fitria, Y., & Ramadhani, F. (2025). Development of science e-module on trait treatment interaction models for student self-efficacy. *AIP Conference Proceedings*, *3038*(1), Article 020017. https://doi.org/10.1063/5.0256915

Magdalena, I., Sundari, T., Nurkamilah, S., Nasrullah, N., & Amalia, D. A. (2020). Analisis bahan ajar. *Jurnal Nusantara*, *2*(2), 311–326. https://doi.org/10.36088/nusantara.v2i2.828

Maharani, S. D., & Hidayah, I. N. (2024). Development of e-LKPD based on the team-assisted individualization learning model using Wizer.me on social arithmetics. *AIP Conference Proceedings*, *3049*(1), Article 030013. https://doi.org/10.1063/5.0195460

Misbah, M., Sasmita, F. D., Dinata, P. A. C., Deta, U. A., & Muhammad, N. (2021). The validity of an introduction to nuclear physics e-module as teaching material during the COVID-19 pandemic. *IOP Conference Series: Journal of Physics: Conference Series*, *1796*(1), Article 012070. https://doi.org/10.1088/1742-6596/1796/1/012070

Nadzirin, A., Suprapto, N., Admoko, S., Hidaayatullaah, H. N., & Prahani, B. K. (2024). Ethnophysics on the dynamical concept of "ancak robyong": A local wisdom in East Java, Indonesia. *AIP Conference Proceedings*, *3116*(1), Article 060040. https://doi.org/10.1063/5.0210080

Nasrullah, A., Aminah, M., Umalihayati, Rahmadani, K., Widodo, S. A., & Husni, M. (2025). Blended learning in mathematics: The fusion of GeoGebra and Edmodo for enhanced problem-solving abilities. *International Journal of Evaluation and Research in Education*, *14*(1), 423–432. https://doi.org/10.11591/ijere.v14i1.27713

Nisa', K., Suprapto, N., Shofiyah, N., & Cheng, T.-H. (2024). How does ethnoscience students' worksheet (ESW) influence science learning? *Journal of Education and Learning*, *18*(2), 403–412. https://doi.org/10.11591/edulearn.v18i2.21178

Pertiwi, W. J., Solfarina, & Langitasari, I. (2021). Pengembangan lembar kerja peserta didik (LKPD) berbasis etnosains pada konsep larutan elektrolit dan nonelektrolit. *Jurnal Inovasi Pendidikan Kimia*, *15*(1), 2717–2730. https://doi.org/10.15294/jipk.v15i1.23228

Pratama, A. S., & Widowati, A. (2022). Development of natural science e-student worksheet based on nature of science within guided inquiry-based learning to improve students' digital literacy. *AIP Conference Proceedings*, *2600*, Article 070007. https://doi.org/10.1063/5.0112266

Putra, I. S., Aswirna, P., & Asrar, A. (2023). Development of e-module on ethno-STEM physics for the creation of Jambi batik and its impact on students' creative thinking abilities. In *Proceedings of the Imam Bonjol International Conference on Islamic Education (IBICIE)* (pp. 801–813). https://ibicie.uinib.ac.id/index.php/ibicie/article/view/123

Rahman, M. M., Chung, C. C., Shanana, A., Hua, S. A. S. C., Thiviyashree, & Elleyajasmin. (2025). Utilization of generative artificial intelligence technologies as learning tools among university students: A cross-sectional study. *International Journal of Online and Biomedical Engineering*, *21*(7), 4–14. https://doi.org/10.3991/ijoe.v21i07.54227

Riduwan. (2012). *Belajar mudah penelitian: Untuk guru, karyawan, peneliti, pemula*. Alfabeta.

Rizki, I. A., Mirsa, F. R., Islamiyah, A. N., Saputri, A. D., Ramadani, R., & Habibbulloh, M. (2025). Ethnoscience-enhanced physics virtual simulation and augmented reality with inquiry learning: Impact on students' creativity and motivation. *Thinking Skills and Creativity*, *57*, Article 101846. https://doi.org/10.1016/j.tsc.2025.101846

Rizki, I. A., Suprapto, N., & Admoko, S. (2022). Exploration of physics concepts with traditional engklek (hopscotch) game: Is it potential in physics ethno-STEM learning? *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *11*(1), 19–33. https://doi.org/10.24042/jipfalbiruni.v11i1.10900

Safitri, A. I., Admoko, S., Suprapto, N., Putri, R. T., & Alhusni, H. Z. (2023). An exploration of physics concepts in pletokan (luthang) traditional game: Potential as physics learning media in the Merdeka Belajar curriculum. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *12*(2), 195–204. https://doi.org/10.24042/jipfalbiruni.v12i2.18234

Saputri, F., Wiyarsi, A., Ikhsan, J., & Rohaeti, E. (2024). Profile of students' practicum skills in oxidation–reduction reactions using e-worksheet based on chemicals at home. *AIP Conference Proceedings*, *3106*(1), Article 040012. https://doi.org/10.1063/5.0214812

Sari, P. M., Herlina, K., & Abdurrahman. (2021). Preliminary research: Developing physics electronic student worksheet based on ExPRession model with the STEM approach. *IOP Conference Series: Journal of Physics: Conference Series*, *1796*(1), Article 012080. https://doi.org/10.1088/1742-6596/1796/1/012080

Setyawan, D., Rizki, M., Kartika, A. D., & Manisa, T. (2024). Need analysis of local potential-based biodiversity modules for high school students. *AIP Conference Proceedings*, *2622*(1), Article 030007. https://doi.org/10.1063/5.0133671

Setyowati, E., Nurcahyo, A., Sunaryo, I., & Jaya, H. P. (2025). Ethnomathematics in the bekel ball game to introduce the concept of multiples. *AIP Conference Proceedings*, *3142*(1), Article 020038. https://doi.org/10.1063/5.0262198

Smaragdis, E., Dovros, N., & Diamantopoulos, V. (2020). Physics education and learning in the digital era. *Education Sciences*, *10*(9), 228. https://doi.org/10.3390/educsci10090228

Sunarti, T., Suprapto, N., Hidaayatullaah, H. N., Suliyanah, Admoko, S., & Jauhariyah, M. N. R. (2025). Evaluating student responses to ethnophysics learning: Improving scientific literacy and problem-solving skills using a PLS-SEM approach. *Multidisciplinary Science Journal*, *7*(10), Article e2025454. https://doi.org/10.31893/multiscience.2025454

Suprapto, N., Rizki, I. A., Saphira, H. V., Alfarizy, Y., & Jannah, S. N. (2024). Exploration of science concepts in Indonesian indigenous culture: Actualization of the Indonesian curriculum. *Journal of Turkish Science Education*, *21*(3), 410–429. https://doi.org/10.36681/tused.2024.022

Susanti, & Widowati, A. (2022). Potential of science e-student worksheet through nature of science within inquiry-based learning approach to improve creative thinking skills. *AIP Conference Proceedings*, *2600*, Article 070002. https://doi.org/10.1063/5.0112263

Syahda, E., & Deta, U. A. (2023). Needs analysis of physics learning media integrated with local wisdom. *International Journal of Research and Community Empowerment*, *1*(2), 39–45. https://doi.org/10.58706/ijorce

Sytnykova, Y., Kyrpenko, V., Palevych, S., Pochuieva, O., Lamtiuhova, S., & Chaika, O. (2025). Implementation of professionally oriented tasks with an interactive cloud environment using Google Colab. *International Journal of Interactive Mobile Technologies*, *19*(9), 73–91. https://doi.org/10.3991/ijim.v19i09.53459

Thuan, P. D. (2025). Gamified mobile learning: EFL students' attitudes toward Quizizz for grammar instruction. *International Journal of Interactive Mobile Technologies*, *19*(12), 38–54. https://doi.org/10.3991/ijim.v19i12.54921

Widiastuti, S. (2020). *Kearifan lokal dalam es dawet siwalan Lamongan*. Penerbit Kuliner Nusantara.

Winartoa, Putri, A. F., Fahrezy, M., Arti, Y., Kristyaningrum, D. H., & Rahayu, R. (2025). Improving students' problem-solving skills and environmental awareness through worksheet problem-based learning on local landfill potential. *Multidisciplinary Science Journal*, *7*(12), Article e2025564. https://doi.org/10.31893/multiscience.2025564

Yanto, D. T. P., Ganefri, Sukardi, Yanto, J. P., Samala, A. D., Dewi, I. P., Kurani, R., Setiawan, H., & Kabatiah, M. (2024). Innovative laboratory learning: Evaluating the practicality of integrated e-worksheets with augmented reality in electrical machines courses. *International Journal of Information and Education Technology*, *14*(7), 996–1005. https://doi.org/10.18178/ijiet.2024.14.7.2127

Author (s):

Anggita Rusmaya
Department of Physics, Faculty of Mathematics and Natural Science,
Universitas Negeri Surabaya,
Jl. Ketintang, Surabaya 60231, Indonesia
Email: anggitarusmaya.21028@mhs.unesa.ac.id

* Nadi Suprapto (Corresponding Author)
Department of Physics, Faculty of Mathematics and Natural Science,
Universitas Negeri Surabaya,
Jl. Ketintang, Surabaya 60231, Indonesia
Email: nadisuprapto@unesa.ac.id

Binar Kurnia Prahani
Department of Physics, Faculty of Mathematics and Natural Science,
Universitas Negeri Surabaya,
Jl. Ketintang, Surabaya 60231, Indonesia
Email: binarprahani@unesa.ac.id

Eko Hariyono
Department of Physics, Faculty of Mathematics and Natural Science,
Universitas Negeri Surabaya,
Jl. Ketintang, Surabaya 60231, Indonesia
Email: ekohariyono@unesa.ac.id

Hanandita Veda Saphira
Digital Technologies for Learning, Faculty of the Arts, Social Sciences and Humanities
University of Wollongong,
Northfields Ave, Wollongong NSW 2500, Australia
Email: hanandita.saphira346@ouwmail.edu.au