



From Hombo Batu to the Realm of Physics: Implementation of Ethnophysics-Based Mobile Learning to Increase Learning Independence and Learning Outcomes

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Abstract:

This study examines the effectiveness of Ethnophysics-based mobile learning (Hombo Batu) in enhancing students' learning independence and outcomes. This research is quantitative, employing a pretest-posttest control group design. The research sample consists of 23 students from class XIc as the control group, who received instruction using PowerPoint media, and 23 students from class XI d as the experimental group, who received instruction using Ethno-Based Mobile Learning media. The study was conducted at Xin Zhong High School in Surabaya. The research instruments include learning outcome tests (pretest and posttest) and non-test instruments (learning independence questionnaires). The data analysis includes N-Gain analysis and Hotelling's Trace Multivariate Test (MANOVA). The results of the study indicate that learning with Ethno-Based Mobile Learning is more effective in enhancing learning independence compared to learning using PowerPoint, with an N-Gain value of 0.74 for learning independence and 0.79 for learning outcomes, as well as Hotelling's Trace results with a significance value of 0.00 (H_a accepted). The implication of using Ethno-Based Mobile Learning as a learning medium is that it can be utilized by Physics teachers to enhance students' learning independence and learning outcomes.

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Introduction

The rapid development of information and communication technology (ICT) has brought about profound changes in various sectors, with education being one of the most significantly impacted (Timotheou et al., 2023; Wang et al., 2024). The integration of ICT into education has not only transformed traditional teaching methods but has also paved the way for innovative learning approaches that were previously unimaginable. One of the most promising innovations is mobile learning, often abbreviated as m-learning. This form of learning harnesses the capabilities of mobile devices—such as smartphones, tablets, and other portable gadgets—to facilitate learning that can occur at any time and in any place, transcending the limitations of traditional classroom settings (Onyema et al., 2019; Haleem et al., 2022).

As technology continues to evolve rapidly, the popularity of mobile learning in the educational sector has surged. This popularity is driven by several factors, including the increasing ubiquity of mobile devices, the widespread availability of high-speed internet, and the growing demand for more flexible and personalized learning experiences. Mobile learning provides a level of convenience and accessibility that is unparalleled, enabling learners to access educational content, participate in discussions, and complete assignments from virtually anywhere—whether they are commuting, at home, or in a remote location (Kang, 2024). This flexibility is particularly beneficial in today's fast-paced world, where learners often juggle multiple responsibilities, such as work, family, and other commitments.

In comparison, conventional learning often faces challenges in meeting the diverse learning needs of students. These challenges include a lack of flexibility, dependence on teachers, and limited interactivity, all of which can hinder the effectiveness of the learning experience. Mobile learning is an alternative offering more flexible, interactive, and individualized learning opportunities (Barnard & Henn, 2023; Bakkar & Ziden, 2024). However, the implementation of mobile learning in Indonesia, particularly in physics education, still needs to be improved (Sulisworo et al., 2021; Fayanto et al., 2023). A key challenge is how to integrate this technology with practical pedagogical approaches. One innovative approach combines mobile learning with the concept of Ethnophysics, specifically Hombo Batu, which is part of local cultural traditions with a physics understanding rooted in local wisdom.

Local culture embodies a vast reservoir of knowledge, traditions, and wisdom that can be effectively harnessed to enrich and deepen the learning experience (Saputra & Kuswanto, 2018a, 2019). By integrating this cultural heritage into educational content, students can engage with learning materials that feel more relevant and meaningful to their personal experiences and cultural backgrounds (Orphanidou et al., 2024). Numerous research studies have demonstrated that integrating Indonesian culture into physics education can significantly enhance classroom learning outcomes, such as critical thinking, creative thinking, academic achievement, representational abilities, problem-solving skills, and other higher-order thinking skills (Husna & Kuswanto, 2018; Kuswanto, 2018; Permata Sari et al., 2020; Saputra & Kuswanto, 2019; Sasmitatias & Kuswanto, 2018). Ethnophysics, as an interdisciplinary field, offers a unique opportunity to contextualize scientific concepts within the framework of cultural practices and beliefs. This approach demystifies complex scientific ideas and

fosters a deeper appreciation for how these concepts are interwoven with everyday life and cultural identity.

Ethnophysics, by exploring the intricate relationship between culture and the natural world, presents scientific knowledge in a way that resonates with students' lived experiences and local traditions. This cultural relevance can significantly enhance students' motivation as they see direct connections between the physics they learn in the classroom and the cultural phenomena they observe in their communities (Derlina et al., 2019; Batlolona et al., 2022). Moreover, this approach can also promote learning independence, as students are more likely to take ownership of their education when they perceive it as being directly tied to their cultural identity and daily life (Lestari & Apsari, 2022; Susanti & Maulana, 2023). By incorporating elements of their culture into the learning process, students may feel more empowered to explore, question, and understand scientific concepts independently, leading to a more active and self-directed learning experience. Through the Ethnophysics approach, students can learn about the cultural values embedded in natural phenomena, such as Hombo Batu, which can foster a sense of pride and ownership of their culture. By integrating Ethnophysics concepts into physics education, it is hoped that students will gain a deeper and more meaningful understanding of the subject matter. Mobile learning offers high flexibility and interactivity as a form of digital education.

Learning independence and motivation are key factors in students' academic success (Eriyanto et al., 2021; Isa, 2023). Students who are independent in their learning tend to be more proactive in seeking knowledge and are better equipped to solve problems independently. Meanwhile, high motivation drives students to keep learning and achieve optimal performance. However, several studies have shown that students' independence in learning, especially in science subjects like physics, still needs to be improved. Technology, such as mobile learning, can stimulate students to learn independently (Saputra et al., 2019; Ingkavara et al., 2022; Kurnianto et al., 2023). Using Ethnophysics-based mobile learning, specifically the Hombo Batu model, is expected to enhance students' learning independence and motivation.

The Hombo Batu tradition, as part of Indonesia's rich cultural heritage, provides a tangible example of how local wisdom can be linked to scientific concepts. The hombo batu, a traditional stone-jumping ritual in Nias, Indonesia, is a fascinating blend of culture and physics. This rock jumping movement involves several physics principles that are interesting to discuss. Key physics concepts Involved: (1) Projectile Motion: When a jumper leaps, their body follows a parabolic path, influenced by gravity pulling them downward and the initial upward force of the jump. Factors affecting projectile motion are the height of the stone, jump angle, initial velocity, and the jumper's muscular force. (2) Newton's Second Law states that force equals mass times acceleration. In the context of Hombo batu, the jumper's muscular force accelerates their body upward against gravity – factors affecting force: Jumper's mass, muscle strength, and jumping technique. (3) Energy: During the jump, energy transforms from potential energy (at the peak of the jump) to kinetic energy (during motion) – factors affecting energy, height of the stone, jumper's mass, and velocity at the peak. (4) Momentum: Momentum is the product of mass and velocity. A jumper's momentum changes as its velocity changes throughout the jump. Factors affecting

momentum: Jumper's mass and velocity (Saputra et al., 2022; Saputra & Kuswanto, 2018, 2019).

In an educational context where the focus is increasingly on student-centered learning and the development of 21st-century skills, integrating mobile learning with Ethnophysics represents an innovative and culturally responsive approach. By connecting the learning material to students' cultural backgrounds, educators can create a more engaging and meaningful learning experience (Basar et al., 2021). Moreover, the flexibility offered by mobile learning allows students to access learning materials at their own pace and convenience, thereby promoting self-directed learning.

By incorporating this tradition into physics lessons, students learn about the scientific principles involved and develop a deeper appreciation for their cultural heritage. This dual focus on cultural relevance and scientific inquiry has the potential to make learning more engaging and relevant for students. Additionally, as mobile learning becomes more integrated into educational practices, it is crucial to consider how it can be used to address the diverse learning needs of students. The personalized nature of mobile learning allows for adapting teaching methods to suit different learning styles, thereby supporting a more inclusive approach to education. This study's exploration of the effectiveness of Ethnophysics-based mobile learning is particularly timely, as it aligns with broader efforts to enhance educational outcomes through the use of technology while also preserving and promoting cultural heritage.

This study aims to evaluate the effectiveness of Ethnophysics-based mobile learning (Hombo Batu) in improving the learning independence and motivation of middle school students in eleventh grade. By exploring this integration, it is hoped that the study will reveal how this approach can encourage students to be more active and independent in their learning processes and increase their interest and motivation in the subject matter. The findings of this study are expected to contribute significantly to developing more relevant and effective teaching methods.

Overall, this research not only seeks to enhance the quality of physics education through innovative teaching approaches but also aims to contribute to the broader discourse on the role of technology in education. By highlighting the potential of Ethnophysics-based mobile learning, this study underscores the importance of integrating local culture and technological advancements in pursuing a more effective and culturally responsive educational system.

Research Method

This follow-up research applies learning media developed from previous educational media advancements (Saputra & Kuswanto, 2018). The study subjects consisted of experimental and control groups, randomly selected from all the eleventh-grade students at Xin Zhong High School in Surabaya. The experimental design is a pretest-posttest control group design (Creswell & Creswell, 2018). Cluster random sampling was utilized to select classes from the entire Grade XI class population randomly. The research sample includes 23 students from class XIc as the control group, who received instruction using PowerPoint media, and 23 students from class XIId as the experimental group, who received instruction using mobile learning Ethnophysics media.

Data collection techniques included tests and questionnaires. The research instruments comprised learning outcome test sheets (pretest and posttest) and a learning independence questionnaire. The improvement in learning outcomes was assessed using pretest and posttest scores while learning independence was measured using a Likert-scale questionnaire. The results from the pretest, posttest, and questionnaire are expressed in standard Gain. According to [Creswell & Creswell, \(2018\)](#), the standard Gain is calculated as follows, with the resulting Gain scores interpreted according to Table 1.

$$Std\ gain\ <g> = \frac{\bar{X}_{Posttest} - \bar{X}_{Pretest}}{X - \bar{X}_{Pretest}}$$

Table 1. Gain Value Criteria

Score <g>	Classification
<g> ≥ 0,7	High
0,7 ><g> ≥ 0,3	Medium
<g> < 0,3	Low

The MANOVA statistical test was conducted using SPSS software. Using the MANOVA test requires meeting several assumptions, namely normality and homogeneity. In this study, the MANOVA test was performed using Hotelling’s Trace with a significance level of 5%. The decision criterion is that H0 is rejected if the significance value is less than 0.05. The research hypotheses for this MANOVA test are as follows:

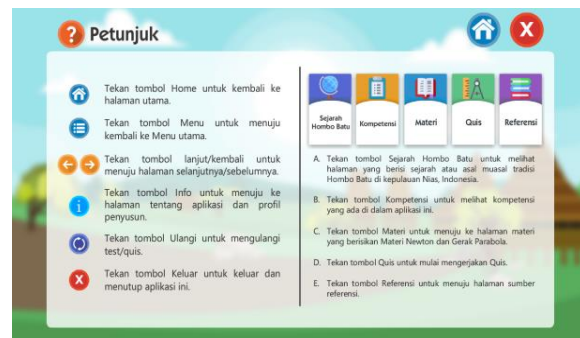
- H0: There is no difference in the improvement of learning independence and outcomes between students taught using Ethnophysics-based mobile learning media and those taught using PPT media.
- H1: There is a difference in the improvement of learning independence and outcomes between students taught using Ethnophysics-based mobile learning media and those taught using PPT media.

Results and Discussion

This study compares the effectiveness of two different learning approaches. The experimental class utilized Ethno-based mobile learning, uniquely incorporating the cultural element of the Hombo Batu tradition from Nias into the learning material delivered through mobile devices. On the other hand, the control class used a more straightforward learning medium, namely PowerPoint presentations, without including any local cultural elements.



(a)



(b)



Figure 1. Appearance of Ethnophysics-Based Mobile Learning: (a) Cover, (b) Navigation, (c) Main menu, (d) Physics Materials, (e) Concept of Newton Laws, and (f) Assessment

The mobile learning platform "Hombo Batu" for physics education represents an innovative approach rooted in ethnophysics, specifically integrating the cultural elements of the Hombo batu. The platform includes several key components to enhance the learning experience. The cover of the platform (figure 1a) showcases thematic elements related to ethnophysics, establishing a cultural connection right from the outset. The table of contents is meticulously organized to facilitate easy navigation through various topics, ensuring students can access relevant materials efficiently.

The provided visual, depicting a Hombo batu ritual, is an effective tool for teaching parabolic motion in Figure 1 (e) within the context of cultural practices. Figure 1 (e) shows the Hombo batu ritual, parabolic trajectory, vector diagrams, labels, and text. This media provides a strong foundation for teaching parabolic motion. Combining cultural relevance with explicit visual representations offers a powerful tool for engaging learners and fostering a deeper understanding of physics concepts (Saputra & Kuswanto, 2018).

Author biographies included in the platform provide background information on the creators, offering insights into their expertise and contributions to ethnophysics and mobile learning. The available materials are diverse and designed to align with the principles of ethnophysics, incorporating local cultural contexts to make learning more relatable and engaging. The content is captivating and innovative, featuring interactive elements and multimedia resources that leverage mobile technology to enhance comprehension and retention of complex physics concepts (Gómez-García et al., 2020; Zawaideh, 2017).

Additionally, the platform includes a range of evaluation questions (figure 1f) designed to assess students' understanding and application of the material. These questions are integrated throughout the learning modules, providing ongoing opportunities for self-assessment and feedback. Overall, "Hombo Batu" offers a comprehensive and culturally enriched mobile learning experience that combines traditional physics education with the unique cultural heritage of the Nias Islands, fostering deeper engagement and improved educational outcomes.

The primary difference between the two classes lies in using learning media and integrating local culture. After conducting the research activities from the pretest to the post-test stages, data on N-gain in learning outcomes and learning independence was obtained by analyzing the students' pretest and post-test results using Standardized Gain analysis. The researcher can present the learning independence and learning outcomes of the experimental and control class students, as shown in Table 2.

Table 2. Learning Independence and Learning Outcomes Data

Variable	Class	N	Average		Average Gain Value	Category
			Pretest	Posttest		
Learning Independence	Control (PPT)	23	53.34	75.34	0,47	Medium
	Experiment (Mobile Learning)	23	52.89	87.76	0,74	High
Learning Outcomes	Control (PPT)	23	43.56	76.78	0,58	Medium
	Experiment (Mobile Learning)	23	43.64	88.45	0,79	High

Table 2 presents data on learning independence and outcomes, comparing the results of a control group using traditional PowerPoint presentations (PPT) and an experimental group utilizing mobile learning. The data suggests that the experimental group, which employed mobile learning, exhibited significantly higher gains in learning independence and learning outcomes than the control group that used traditional PowerPoint presentations. The "High" category for the experimental group in both variables indicates a substantial improvement in students' learning abilities and capacity to learn independently.

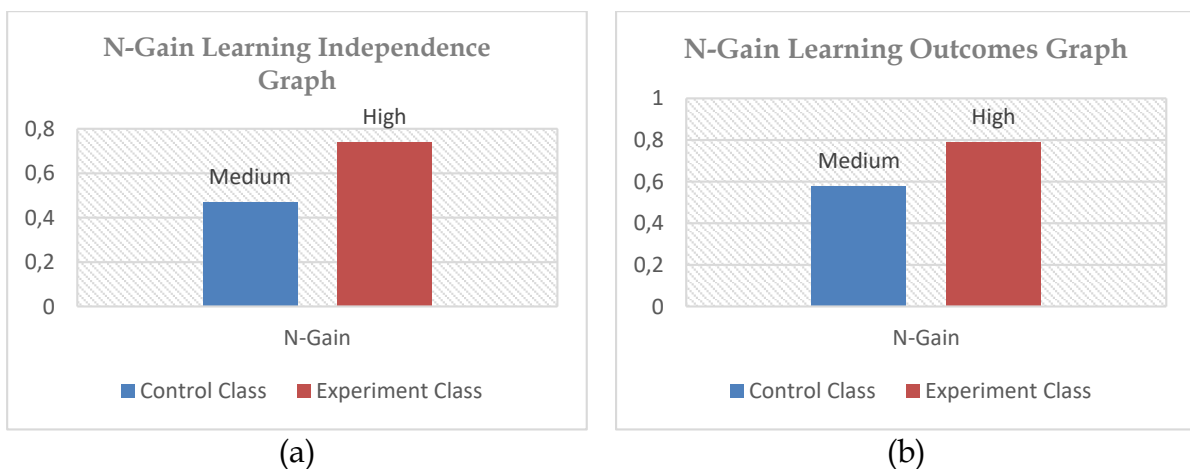


Figure 2. N-Gain Improvement Graphs: (a) Learning Independence (b) Learning Outcomes

The results of this study demonstrate the impact of Ethno-based mobile learning on enhancing learning independence and learning outcomes among students. As illustrated in Figure 2 (a), the N-Gain for learning independence in the Experimental Class, which utilized Ethno-based mobile learning, was categorized as High (0.74). In contrast, the Control Class, which used traditional PowerPoint (PPT) presentations, achieved only a Medium (0.47) N-Gain, reflecting moderate improvement. This stark contrast suggests that integrating cultural elements, such as the Hombo Batu tradition from Nias, into the learning process through mobile devices significantly boosted students' independence in learning. The tailored and culturally relevant content likely made the learning experience more engaging and personally meaningful, encouraging students to take greater ownership of their learning process (Samuels, 2018; Wardani et al., 2023).

Similarly, the N-Gain results for learning outcomes, depicted in Figure 1(b), reveal a substantial difference between the two groups. The Experimental Class again outperformed the Control Class, with a High N-Gain indicating significant improvement in learning outcomes, whereas the Control Class only showed moderate gains. These findings suggest that the Ethno-based mobile learning media were more effective in facilitating a deeper understanding of the material and better retention of knowledge, likely due to the contextualized and interactive nature of the learning experience (Gómez-García et al., 2020; Husna & Kuswanto, 2018; Kuswanto, 2018; Permata Sari et al., 2020; Saputra et al., 2022; Saputra & Kuswanto, 2018, 2019; Sasmitatias & Kuswanto, 2018; Zawaideh, 2017).

The experimental class showed a significantly more improvement in learning outcomes and independent learning. This was because the learning process was heavily focused on students independently learning physics concepts through mobile learning. Additionally, integrating Hombo Batu culture further motivated and engaged students, particularly in the parabolic motion topic. The statistical analysis further supports these observations. The MANOVA test results, as shown in Table 3, reveal a highly significant difference between the two groups, with a Hotelling's Trace significance value of 0.000. This result leads to rejecting the null hypothesis (H_0) and accepting the alternative hypothesis (H_a), confirming that the Ethno-based mobile learning media had a more pronounced effect on improving learning independence and learning outcomes than conventional PPT-based instruction.

The results underscore the effectiveness of Ethno-based mobile learning in fostering a more autonomous and successful learning experience. Educators can enhance student engagement, motivation, and academic performance by incorporating culturally relevant content into mobile learning platforms. These findings suggest that integrating cultural elements into educational technology not only enriches the learning experience but also aligns the learning process more closely with students' backgrounds, thereby improving educational outcomes (Kulshreshta et al., 2023; Rafiq et al., 2024).

Tabel 3. Result of Hotelling's Trace MANOVA

Effect	F	Sig	Partial eta Squared	Criteria	Decision
Hottelling's Trace	21.876 ^a	.000	.945	Sig<0.05	H ₀ rejected

Tabel 4. Tests of Between-Subjects Effects

Source	Dependent Variable	Df	Mean Square	F	Sig
Class	Independence learning	1	9849.411	43.803	.000
	Learning outcomes	1	9756.412	43.763	.000

The results of this study underscore a significant difference in the enhancement of learning independence and learning outcomes between students exposed to Ethno-based mobile learning media and those who received conventional learning media. The experimental group, which engaged with the Ethno-based mobile learning approach, demonstrated consistently higher improvements across both metrics, as reflected by the "High" category N-Gain values. This suggests that the integration of culturally relevant content into mobile learning technology effectively enhances the overall quality of student learning (Gómez-García et al., 2020; Kuswanto, 2018; Saputra & Kuswanto, 2019; Zawaideh, 2017).

The MANOVA test results reinforce these findings, with the Hotelling's Trace test showing a significance value of 0.000, indicating that the differences between the experimental and control groups are statistically significant. As a result, the alternative hypothesis (H_a) is accepted, confirming that Ethno-based mobile learning has a more profound impact on learning independence and outcomes than conventional methods.

These findings substantially impact educational practices, particularly in integrating technology into learning. The success of Ethno-based mobile learning media, which aligns with students' cultural and contextual backgrounds, highlights the importance of designing learning experiences that are both student-centered and contextually meaningful. By doing so, educators can significantly boost student motivation, engagement, and academic performance, ultimately contributing to the overall improvement of educational quality (Saraswati et al., 2022; Ardianti et al., 2023).

The difference between this article and other articles is that the learning media uses ethnophysics in the form of hombo batu from Nias to improve learning outcomes and student learning independence. So, the important point to focus on is whether this learning media can improve learning outcomes and student learning independence by using mobile learning media for them to learn independently. Meanwhile, in previous research, this media was used to improve diagrammatic representation and students' critical thinking. Apart from that, the research subject was carried out in a different location, namely at SMA Xin Zhong in Surabaya, and carried out/collaborated with a physics teacher at that school.

Future research could delve deeper into understanding the mechanisms that drive these improvements, exploring whether they stem from intrinsic factors like heightened motivation or extrinsic factors like peer influence. Additionally, while this

study presents promising results, it is essential to acknowledge its specific context. Broader research with more diverse samples and varying contexts will be necessary to generalize these findings fully. Moreover, this study opens the door for developing more innovative and interactive culture-based learning media, which could further optimize the potential of technology-enhanced learning to elevate educational outcomes.

Conclusion

This study underscores the benefits of integrating Ethno-based mobile learning with traditional educational methods. The research findings reveal that students using the Ethno-based mobile learning approach, incorporating the Hombo Batu tradition, demonstrated a marked improvement in learning independence and academic outcomes compared to those using conventional PowerPoint presentations. The experimental group achieved higher N-Gain values, indicating more substantial enhancements in learning independence and performance, which was confirmed by the MANOVA test with a highly significant p-value of 0.000.

Several recommendations are proposed to build on these findings. First, future research should broaden the scope by including diverse samples and educational contexts to assess the generalizability of these results. Investigating various cultural settings and educational levels could provide a more comprehensive understanding of the effectiveness of Ethno-based mobile learning. Second, it is crucial to explore the underlying mechanisms driving the observed improvements, whether they stem from intrinsic motivation or extrinsic factors such as peer support. Developing more interactive and innovative Ethno-based learning media could further enhance student engagement and learning outcomes. Integration of these media with effective pedagogical practices and educator training will also be vital. Lastly, conducting longitudinal studies to evaluate the long-term impact of Ethno-based mobile learning on academic performance and cultural appreciation will offer insights into the sustainability of its benefits. By addressing these areas, the educational community can optimize the potential of Ethno-based mobile learning to enrich teaching and learning experiences.

References

- Ardianti, S. D., Wanabualiandari, S., & Tanghal, A. B. (2023). Thematic Ethno-Edutainment Learning to Improve Student's Concept Understanding in Science. *Asian Journal of Applied Education (AJAE)*, 2(2), 167-178. <https://doi.org/10.55927/ajae.v2i2.3740>
- Bakkar, I. B., & Ziden, A. A. (2023). Analysis of Perceptions and Insights of E-Learning Implementation in Educational Institutions by Educators, Students, and Parents. *International Journal of Academic Research in Progressive Education and Development*, 12(4). <https://doi.org/10.6007/ijarped/v12-i4/20191>
- Barnard, R. W., & Henn, R. H. (2023). Overcoming Learning Obstacles: Strategies for Supporting Students with Diverse Needs. *OALib*, 10(08), 1-14. <https://doi.org/10.4236/oalib.1110509>
- Basar, Z. M., Mansor, A. N., Jamaludin, K. A., & Alias, B. S. (2021). The Effectiveness and Challenges of Online Learning for Secondary School Students - A Case Study.

- Asian Journal of University Education*, 17(3), 119–129.
<https://doi.org/10.24191/ajue.v17i3.14514>
- Batlolona, J. R., Leasa, M., Papilaya, P. M., Jamaludin, J., & Taihuttu, J. (2022). Exploration of Students' Conceptual Understanding and Ethnophysics: A Case Study of Tifa In The Tanimbar Islands, Indonesia. *Jurnal Penelitian Pendidikan IPA*, 8(6), 2717–2727. <https://doi.org/10.29303/jppipa.v8i6.2154>
- Chima, A. E., Onyebuchi, N. C., & Idowu, S. A. (2024). Cultural competence in education: Strategies for fostering inclusivity and diversity awareness. **International Journal of Applied Research in Social Sciences*, 6*(3), 383–392. <https://doi.org/10.51594/ijarss.v6i3.895>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications, Inc.
- Derlina., Sinulingga, K., Maryono., Sahyar., & Sinaga, B. (2019). Ethnophysics in learning based on javanese culture to improve the generic skills of students' science. *International Journal of Innovation, Creativity and Change*, 9(9), 226–241.
- Eriyanto, M. G., Roesminingsih, M. V., Soedjarwo, & Soeherman, I. K. (2021). The effect of learning motivation on learning independence and learning outcomes of students in the Package C equivalence program. *IJORER: International Journal of Recent Educational Research*, 2(4), 455–467. <https://doi.org/10.46245/ijorer.v2i4.122>
- Fayanto, S., Ulfa, S., Praherdhiono, H., Shinta, N. D., Takda, A., Sahara, L., & Balulu, N. (2023). Design of Exophysics: Book-Based Mobile Application for Literacy Learning in the Remote Access Areas of Indonesia. *Journal of Learning for Development*, 10(3), 411–426. <https://doi.org/10.56059/jl4d.v10i3.846>
- Gómez-García, M., Soto-Varela, R., Morón-Marchena, J. A., & del Pino-Espejo, M. J. (2020). Using mobile devices for educational purposes in compulsory secondary education to improve student's learning achievements. *Sustainability (Switzerland)*, 12(9). <https://doi.org/10.3390/su12093724>
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022a). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3(May), 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022b). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3(May), 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Husna, M., & Kuswanto, H. (2018). Development of physics mobile learning based on local wisdom to improve vector and diagram representation abilities. *International Journal of Interactive Mobile Technologies*, 12(6), 85–100. <https://doi.org/10.3991/ijim.v12i6.8746>
- Ingvavara, T., Panjaburee, P., Srisawasdi, N., & Sajjanroj, S. (2022). The use of a personalized learning approach to implementing self-regulated online learning. *Computers and Education: Artificial Intelligence*, 3(June), 100086. <https://doi.org/10.1016/j.caeai.2022.100086>
- Isa, A. (2023). The Relationship between Learning Independence and Learning Motivation with Student Academic Achievement. *Journal of Education Method and Learning Strategy*, 1(01), 1–8. <https://doi.org/10.59653/jemls.v1i01.11>
- Kang, J. (2024). Benefits and Challenges of Mobile-Learning Brought to Student

- Learning Outcomes in Higher Education: A Systematic Review from 2014-2023. *International Journal of Academic Research in Progressive Education and Development*, 13(1), 2107-2123. <https://doi.org/10.6007/ijarped/v13-i1/20698>
- Kulshreshtha, M., Chinta, S., Saxena, T., Mishra, P., & Baliga, D. (2023). The Effects of Technology-Integrated Curriculum on Student Engagement and Outcomes. *Harbin Gongcheng Daxue Xuebao/Journal of Harbin Engineering University*, 44(August), 1338-1347.
- Kurnianto, F., Rahmat, A. D., & Kuswanto, H. (2023). Identification of Student Independence and Physics Learning Achievements During COVID-19 Pandemic. *Jurnal Penelitian Pendidikan IPA*, 9(11), 9431-9437. <https://doi.org/10.29303/jppipa.v9i11.4004>
- Kuswanto, H. (2018). Android-Assisted Mobile Physics Learning Through Indonesian Batik Culture: Improving Students' Creative Thinking and Problem Solving. In *International Journal of Instruction* (Vol. 11, Issue 4). www.e-iji.net
- Lazaro, G. R. de, & Duart, J. M. (2023). Moving Learning: A Systematic Review of Mobile Learning Applications for Online Higher Education. *Journal of New Approaches in Educational Research*, 12(2), 198-224. <https://doi.org/10.7821/naer.2023.7.1287>
- Lestari, N., & Apsari, N. (2022). e-Modul Ethnophysics for Critical Thinking Skills in the Covid-19 Pandemic. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, 8(2), 193-206. <https://doi.org/10.21009/1.08202>
- Nurzaiyanah, Akmal Hamsa, K. D. (2022). Journal of Asian Multicultural Research for Educational Study. *Journal of Asian Multicultural Research for Educational Study*, 3(3), 7-12.
- Onyema, E. M., Deborah, E. C., & Anthonia, U. O. (2019). Potentials of Mobile Technologies in Enhancing the Effectiveness of Inquiry-based Learning Approach. *International Journal of Education (IJE)*, 2(1), 1-25. <https://doi.org/10.5121/IJE.2019.1421>
- Orphanidou, Y., Efthymiou, L., & Panayiotou, G. (2024). Cultural Heritage for Sustainable Education Amidst Digitalisation. *Sustainability (Switzerland)*, 16(4). <https://doi.org/10.3390/su16041540>
- Permata Sari, F., Nikmah, S., Kuswanto, H., & Wardani, R. (2020). Development of physics comic based on local wisdom: Hopscotch (engklek) game android-assisted to improve mathematical representation ability and creative thinking of high school students. *Revista Mexicana de Fisica E*, 17(2), 255-262. <https://doi.org/10.31349/REVMEXFISE.17.255>
- Rafiq, S., Iqbal, S., & Afzal, A. (2024). The impact of digital tools and online learning platforms on higher education learning outcomes. *Al-Mahdi Research Journal (MRJ)*, 5(4), 359-369.
- Samuels, A. J. (2018). Exploring Culturally Responsive Pedagogy: Teachers' Perspectives on Fostering Equitable and Inclusive Classrooms. *SRATE Journal*, 27(1), 22-30.
- Saputra, A. T., Wilujeng, I., Sobiatin, E., Aji, S. H., & Tuada, R. N. (2020). Implementation of physics mobile learning media to improve student physics perseverance. *Journal of Physics: Conference Series*, 1440(1). <https://doi.org/10.1088/1742-6596/1440/1/012035>

- Saputra, M. R. D., Fahroky, F., & Putri, J. K. (2022). Pengembangan Perangkat Pembelajaran Berbasis Smartphone dengan Tema Budaya Hombo Batu Pada Hukum Newton dan Gerak Parabola. In *Jurnal Ilmu Pendidikan dan Sains* (Vol. 2, Issue 1). <http://jupisi.untara.ac.id>
- Saputra, M. R. D., & Kuswanto, H. (2018). Development of Physics Mobile (Android) Learning Themed Indonesian Culture Hombo Batu on the Topic of Newton's Law and Parabolic Motion for Class X SMA/MA. In *Journal of Physics: Conference Series* (Vol. 1097, Issue 1). <https://doi.org/10.1088/1742-6596/1097/1/012023>
- Saputra, M. R. D., & Kuswanto, H. (2019). The effectiveness of Physics Mobile Learning (PML) with HomboBatu theme to improve the ability of diagram representation and critical thinking of senior high school students. *International Journal of Instruction*, 12(2). <https://doi.org/10.29333/iji.2019.12230a>
- Saraswati, S. A., Widiyaningrum, P., & Indriyanti, D. R. (2022). Development of Mobile Learning (My Repro) Based on Contextual Teaching Learning to Improve Cognitive Understanding Senior High School Student. *Journal of Innovative Science Education*, 11(1), 38–47. <https://doi.org/10.15294/jise.v10i1.47824>
- Sasmitatias, F., & Kuswanto, H. (2018). *The Development of Science Learning Device Based on Serukam Local Culture To Improve Students' Analytical Skill* ARTICLE IN FO ABSTRACT. www.ijere.com
- Sulisworo, D., Kusumaningtyas, D. A., Prasetyo, E., Fitriah, Fitriawanati, M., & Erviana, V. Y. (2021). The Mobile Learning Implementation for Physics Lesson in Indonesia: A Narrative Review. *Journal of Physics: Conference Series*, 1933(1), 0–7. <https://doi.org/10.1088/1742-6596/1933/1/012123>
- Susanti, D., & Maulana, S. (2023). Ondel-ondel: ethno-physics-based learning media to achieve meaningful learning on rigid body equilibrium material. *Gravity: Jurnal Ilmiah Penelitian Dan ...*, 9(2), 166–176. <https://doi.org/10.30870/gravity.v9i2.19606>
- Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Monés, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. In *Education and Information Technologies* (Vol. 28, Issue 6). Springer US. <https://doi.org/10.1007/s10639-022-11431-8>
- Wang, C., Chen, X., Yu, T., Liu, Y., & Jing, Y. (2024). Education reform and change driven by digital technology: a bibliometric study from a global perspective. *Humanities and Social Sciences Communications*, 11(1). <https://doi.org/10.1057/s41599-024-02717-y>
- Wardani, L. K., Mulyani, B., Ariani, S. R. D., Yamtinah, S., Masykuri, M., Ulfa, M., & Shidiq, A. S. (2023). Effect of an Ethnochemistry-based Culturally Responsive Teaching Approach to Improve Cognitive Learning Outcomes on Green Chemistry Material in High School. *Jurnal Penelitian Pendidikan IPA*, 9(12), 11029–11037. <https://doi.org/10.29303/jppipa.v9i12.5532>
- Zawaideh, F. H. (2017). The Effect of Mobile Learning on the Development of the Students' Learning Behaviors and Performance at Jordanian University. In *International Journal of Business and Management Invention ISSN* (Vol. 6). Online. www.ijbmi.org