



Ethnophysics Flipbook Based on Acehese Islamic Values to Improve Students' Physics Literacy

Saminan^{1*}, Umami Hanik², Zainuddin³, Muhammad Sattar Rasul⁴, Zainal Abidin⁵

^{1,3}Department of Physics Education, Universitas Syiah Kuala, Indonesia

²Department of Science Education, Universitas Syiah Kuala, Indonesia

⁴Director of STEM Culture Research Center, Universiti Kebangsaan Malaysia, Malaysia

⁵Department of Islamic Education, Universitas Islam Negeri Ar-Raniry, Indonesia

*Correspondence to: saminanfis@usk.ac.id

Abstract: Acehese have long used measuring instruments for various daily needs, but these measuring instruments have not been utilized as media in the teaching and learning in schools. This study aims to develop an Ethnophysics flipbook based on Islamic values from Acehese culture to improve students' physics literacy. The flipbook is designed by integrating basic physics concepts, such as the measurement of mass, volume, and time, with local cultural practices, for example, the use of *kai*, *are*, *naleh*, and *mayam*, as well as the application of time in economic and religious activities, including *zakat*. This integration is expected not only to improve understanding of physics concepts but also to instill religious values and strengthen local wisdom. This study uses the Research and Development (R&D) method with the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The research subjects were high school students in Banda Aceh, and the instruments included expert validation sheets, student response questionnaires, and physics literacy tests. The results of expert validation showed very high feasibility. The limited trial obtained a positive response from 95% of students and a significant increase in physics literacy with an N-Gain of 0.78 (high category). In conclusion, the Islamic-values-based Ethnophysics flipbook effectively increased physics literacy that was contextual, religious, and relevant to local culture, while strengthening Islamic identity and preserving Acehese culture.

Keywords: acehese culture; ethnophysics flipbook; islamic values; media development; physics literacy

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INTRODUCTION

Scientific literacy is a crucial competence that students must develop to understand scientific concepts, interpret natural phenomena, and make informed decisions based on scientific evidence in everyday life (OECD, 2019). However, Indonesia's scientific literacy performance continues to face serious challenges, as reflected in international assessments. According to the Programme for International Student Assessment (PISA), Indonesia's average science literacy score decreased from 383 in 2018 to only 366 in 2022, far below the OECD average of 489 (PISA, 2022). This position also lags neighboring Southeast Asian countries such as Malaysia (420) and Thailand (431). Even more concerning, around 80% of Indonesian students are below the minimum proficiency level (Level 2), indicating limited ability to interpret data, understand scientific concepts, and apply them in real-life contexts. These findings are reinforced by national education reports (Kementerian Pendidikan, Kebudayaan, Riset Republik Indonesia, 2023), which reveal disparities in science learning outcomes between regions, limited teacher innovation, and low integration of contextual learning media.

Preliminary studies conducted in Indonesia confirm these statistical findings (Yana et al., 2023), found that students struggle to connect chemistry and environmental concepts, thereby limiting their ability to make sustainable, evidence-based decisions. Similarly, (Putri & Wulandari, 2023) found that science classes in Indonesian high schools remain dominated by conventional teaching methods that emphasize memorization rather than inquiry, creativity, and digital interaction (Jihannita et al., 2024), also found that low scientific literacy and weak attitudes toward cultural preservation require innovative approaches that integrate science with students' cultural contexts. Furthermore, a comparative study by (Ayu et al., 2025), reported that Indonesia's science literacy achievement remains below both OECD averages and Mexico's, and is influenced by inequalities in school facilities, economic backgrounds, and student motivation. These preliminary studies indicate the urgent need for transformative learning innovations that are contextual, culturally responsive, and digitally integrated.

The persistent low performance in scientific literacy is strongly associated with traditional learning approaches that emphasize rote memorization rather than fostering deep understanding or application skills (Holbrook & Rannikmae, 2007). To address this, recent educational innovations have emphasized contextual and cultural learning models such as ethnoscience and Ethnophysics, which bridge modern scientific concepts with local cultural (Saminan, 2018). Ethnophysics provides students with opportunities to relate scientific concepts to real experiences through local practices and measurements. For instance, the Acehese traditional

units (*kai*, *are*, *naleh*, and *mayam*) used in social, economic, and religious contexts can serve as authentic media for introducing the concepts of mass, volume, and unit conversion in physics. This approach not only supports the understanding of scientific ideas but also reinforces the preservation of local wisdom that reflects identity and values (Zainal, 2021).

The gap between students' theoretical understanding and its practical application also highlights the need for new paradigms in meaningful science learning. Dentzau (2019) found that students often fail to connect academic knowledge to real-life phenomena, while (Vamvakas et al., 2023), emphasized that classroom practices must translate contemporary scientific knowledge into culturally relevant contexts. The constructivist perspective (Vygotsky, 1978) underlines that learning should build on learners' experiences, culture, and social interaction. Within this paradigm, integrating ethnoscience and religious values offers a holistic approach to learning one (Piaget, 1997), that develops scientific literacy while nurturing moral and spiritual growth (Aisyah et al., 2021).

Aceh, with its rich cultural heritage, provides significant potential for contextual science learning integrated with Islamic values. Traditional Acehnese measurement systems have been used for generations in trade and religious activities, including *zakat* and *mahar* (Munzir, 2011). These traditional systems reflect both scientific principles and spiritual values, illustrating how physics concepts are embedded within local life. However, despite their potential, integration of local wisdom into formal science education remains limited, and globalization increasingly threatens the preservation of this cultural knowledge (Abidin, 2021). In line with the Merdeka Belajar and Kampus Merdeka policies, this integration is even more relevant to achieving the Pancasila Student Profile, which emphasizes faith, global diversity, and critical reasoning (Kementerian Pendidikan, Kebudayaan, Riset Republik Indonesia 2023).

Digital transformation in education offers an opportunity to revitalize local wisdom through technology-based learning. Flipbook media, which combines text, images, animations, and videos, has been shown to enhance engagement and understanding of abstract scientific concepts (Fitrian et al., 2025). Integrating Ethnophysics and Islamic values into a digital flipbook thus provides a multidimensional learning model that bridges scientific knowledge, cultural identity, and spirituality in a visually interactive format. This integration aligns with the current needs of digital-native learners and supports the development of contextual, culturally relevant, and value-based science literacy (Saminan et al., 2024). Thus, the novelty of this research lies in developing an Ethnophysics flipbook based on Acehnese Islamic values as a digital learning innovation to strengthen students' scientific literacy. Theoretically, it contributes to expanding constructivism by incorporating religiosity and culture into science education. In practice, it provides a replicable model that connects science learning to local contexts, fostering both conceptual understanding and cultural preservation among students. In essence, this research responds to the urgent national challenge of improving scientific literacy through culturally grounded, technology-enhanced learning innovations (Sari & Rohmani, 2024).

METHODS

This study uses a Research and Development (R&D) approach to develop an Ethnophysics flipbook based on Acehnese Islamic values to improve students' physics literacy. The development model used is the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). An overview of the research and development stages using the ADDIE model, is presented in Figure 1.

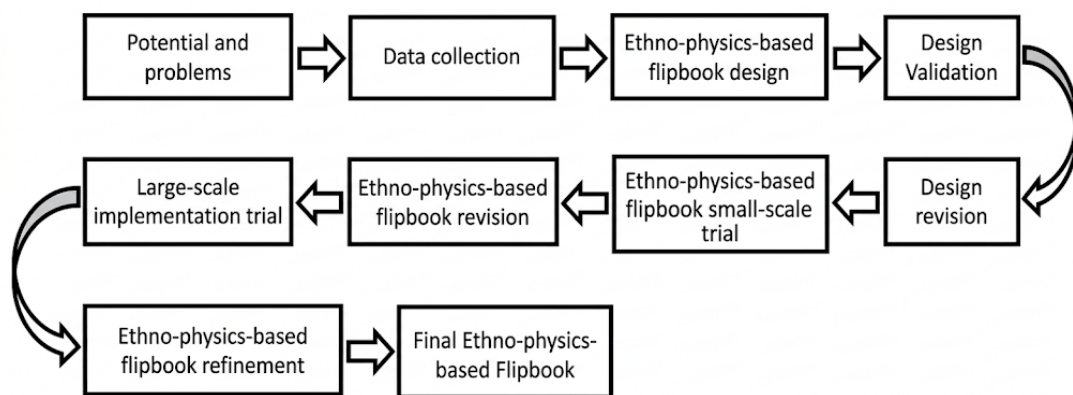


Figure 1. Research and Development Stages

This model was chosen because it is systematic, easy to implement, and well-suited for designing digital media grounded in local wisdom and religious values. The research subjects were high school students in Banda Aceh, selected purposively based on having studied basic physics measurement material and on representing the Acehnese cultural context. A total of 30 students participated in a limited trial, while the validation process

involved experts in material, media, and Islamic education to assess the suitability of the content, design, and integration of Islamic values.

The research stage began with a needs analysis that included a review of the high school physics curriculum, an examination of measurement concepts relevant to Acehese culture, and an analysis of students' and teachers' characteristics as media users. The next stage was design, which involved building a *flipbook structure* that combined basic physics concepts (mass, volume, time) with traditional Acehese units such as *kai*, *are*, *naleh*, and *mayam*, used in economic and religious activities, including the payment of *zakat fitrah* during Ramadan. The design was carried out by compiling a storyboard, visual design, and research instruments, including validation sheets, response questionnaires, and physics literacy tests that referenced science literacy indicators (content, context, and competency). In addition, student worksheets were prepared and integrated into the flipbook as a guide for simple Ethnophysics-based practicum.

Student worksheets in the Ethnophysics flipbook provide a structured learning experience for students and serve as an instrument for assessing conceptual understanding and physics literacy. Following the design stage, product development involves transforming the design into an *interactive flipbook* using digital software. Experts validate the resulting product to assess content, media, and integration of Islamic values. The validation results serve as the basis for revisions until they are categorized as valid. In the implementation stage, students used the Ethnophysics flipbook to conduct simple learning and practical activities related to measuring physical quantities. To test the practicality of flipbooks, students were allowed to engage in practice-based learning using the worksheets in the flipbook. Implementation activities were observed during students' practical activities guided by the Ethnophysics flipbook based on Acehese Islamic values, as shown in Figure 2.



Figure 2. Implementation Activity of Flipbook

The next stage is implementation, which involves testing the flipbook with students through limited classroom learning. At this stage, practicality is assessed through a student response questionnaire, while effectiveness is measured using a pretest-posttest design to analyze the increase in physics literacy, using the N-Gain calculation. The final stage is evaluation, which assesses the overall quality of the flipbook across three aspects, according to (Sari & Rohmani, 2024) criteria: validity, practicality, and effectiveness. The evaluation also includes final revisions based on student, teacher, and expert input to ensure the media is ready for wider use. The success criteria are met if the flipbook achieves validity and practicality scores above 70% and an effectiveness rating in the medium to high N-Gain category (≥ 0.3). With this procedure, it is hoped that the Ethnophysics flipbook based on Acehese Islamic values can become a contextual, religious, and relevant learning innovation with an independent curriculum and can significantly improve students' physics literacy.

RESULT AND DISCUSSION

This research develops an innovative learning medium in the form of an Ethnophysics flipbook based on Acehese Islamic values, created through the ADDIE model (Analysis–Design–Development–Implementation–Evaluation) to ensure systematic product development and evaluation. The flipbook features an interactive, culturally contextual design that combines Acehese visual motifs and physics symbols to engage learners and foster meaningful connections between science and culture. The content integrates core physics concepts such as mass, volume, and time with traditional Acehese measurement systems *kai*, *are*, *naleh*, and *mayam*, which remain relevant in social and religious practices such as *zakat fitrah* and *mahar* calculations.

This study extends previous works (Sari & Rohmani, 2024) by integrating digital Ethnophysics learning with Islamic contextualization. While (Sari & Rohmani, 2024) highlighted improved learning engagement through digital flipbooks, and (Fitrian et al., 2025) explored problem-based digital learning, this research contributes by embedding local ethnocultural dimensions that strengthen both scientific literacy and moral values. Unlike prior studies that mainly evaluated flipbook feasibility or cognitive outcomes, this research emphasizes the novel integration of Islamic values and culturally responsive teaching (CRT) in the context of Ethnophysics. The

combination of digital learning, culture, and religion provides a distinctive pedagogical innovation rarely addressed in previous STEM-based studies. The main output of this research is a validated digital Ethnophysics flipbook based on Acehne Islamic values, as illustrated in [Figure 3](#).



Figure 3. Display of Digital Ethnophysics Flipbook Based on Acehne Islamic Values

The cover in [Figure 3](#) integrates Acehne cultural motifs and physics symbols, reinforcing the theme that scientific learning is deeply rooted in daily life and local wisdom. The cover provides an initial glimpse of the product's identity, combining elements of Acehne culture with basic physics concepts. This cover is designed not only to capture students' attention but also to demonstrate that science learning can be *connected* to real life and local wisdom. After examining the cover, the flipbook presents various traditional Acehne measuring instruments still in use today.



Figure 4. Acehne Traditional Measuring Instrument

All these traditional units displayed in [Figure 4](#) are still used by the Acehne people today. For example, *kai* is made from coconut shells and is used to measure smaller volumes than are used in agricultural activities. *Are* is made from bamboo and bark, with a content equivalent to four *kai*, used to measure the volume and area of agricultural produce and to pay zakat fitrah during the month of Ramadan, which amounts to two ares and two handfuls for adults/people (the smallest *kai* grip). *Naleh* is used to measure volume and area; its measurement is 16 ares. While *Mayam* is a measure of gold weight, namely one Mayam is approximately 3.3 grams, it is often used by the Acehne in paying dowries for marriage contracts and in debt agreements in community life. In addition to displaying traditional Acehne measuring instruments, this flipbook also explicitly integrates Islamic values. The integration of Islamic values is achieved through the presentation of verses from the Quran and hadith, along with contexts of worship, so that students not only understand physics concepts but also internalize religious values and local wisdom. The resulting products include a digital flipbook, semester lesson plans, and student worksheets, designed to support an independent curriculum ([Saminan et al., 2024](#)).

The development stage began with a needs analysis, which included a review of the high school physics curriculum and an analysis of physics concepts related to quantities and units. Physics recognizes standard and non-standard units. Culture-based measurement in Acehne culture includes non-standard units that students must know and understand, as well as the characteristics of students and teachers as media users. In the design

stage, the flipbook structure was developed by combining physical materials, local cultural measurement tools, and religious narratives. The development process resulted in an interactive digital product, which was subsequently validated by material, media, and Islamic education experts. Validation included aspects of content, design, and the integration of Islamic values.

Table 1. Validity of Ethnophysics Flipbook Based on Acehese Islamic Values

Aspect	Percentage	Validity
Semester Lesson Plan	84.3%	Valid
Student Worksheet	79.5%	Valid
Digital Flipbook	80.5%	Valid

The validation results showed an average score of 81.9%, which is considered adequate. Semester Lesson Plan scored 84.3%, Student Worksheet 79.5%, and Digital Flipbook 80.5%. These findings indicate that the Ethnophysics flipbook based on Acehese Islamic values meets academic standards and is ready for student trials. During the implementation stage, a limited trial was conducted with 30 high school students in Banda Aceh. The results of the practicality analysis of the Ethnophysics flipbook are shown in Table 2.

Table 2. Practicality of Ethnophysics Flipbook Based on Acehese Islamic Values

Aspect	Minimum Score	Maximum Score	Results	Criteria
Learning Experience	58	232	195	Very Practical
Learning Motivation	348	1392	1149	Very Practical
Learning Resources	87	348	289	Very Practical
Time Management	87	348	290	Very Practical

Table 2 indicates that all aspects, from learning experience and motivation to learning resources and time management, are categorized as very practical. The results of the questionnaire showed that the practicality of the flipbook was 96.15%, which is categorized as very practical. Students responded positively because the media facilitated understanding of physics concepts through the visualization of local culture and the reinforcement of religious values. [Saminan \(2024\)](#) explained that learning innovation through Ethnophysics is highly relevant to the Merdeka Curriculum, which emphasizes contextualization, independent learning, and the strengthening of the Pancasila Student Profile. The Ethnophysics flipbook developed by combining Acehese local wisdom and Islamic values has proven effective in improving students' physics literacy. This product not only presents physics material but also provides a meaningful learning experience, because students can directly see the relationship between scientific concepts and their real lives. Thus, Ethnophysics plays a strategic role as a pedagogical approach that preserves culture while improving the quality of science education in Indonesia. They also feel motivated and more active in the learning process because of the material presented. Connect directly to their everyday life experiences. Flipbooks are considered time-efficient because they allow students to learn independently or in groups without relying entirely on teacher explanations. To provide a clearer picture of the score distribution for each aspect, the analysis results are visualized in [Figure 5](#).

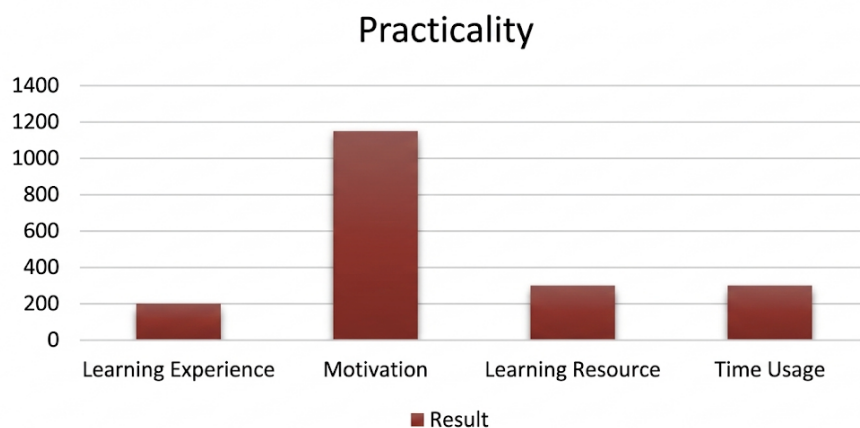


Figure 5. Practicality of Ethnophysics Flipbook based on Acehese Islamic Values

[Figure 5](#) shows that learning motivation received the highest score compared to other aspects. This indicates that the Ethnophysics flipbook can foster students' enthusiasm for learning because the material presented is directly related to everyday life experiences. Meanwhile, the learning experience, learning

resources, and time management also received high scores in the very practical category, indicating that this flipbook can be an effective, efficient, and relevant medium for improving physics literacy.

Table 3. The Effectiveness of the Ethnophysics Flipbook Based on Acehese Islamic Values

Average Score		Normality		N Gain	Category
Pre-test	Post-test	Pre-test Significance	Post-test Significance	0.80	High
24.57	84.45	0.57	0.19		

The effectiveness of the flipbook was analyzed through a pretest-posttest design. The average pre-test score was 24.57, and the post-test score was 84.45, with an N-Gain of 0.80 (high category), as presented in Table 3. The Kolmogorov-Smirnov normality test showed that the data were normally distributed ($p > 0.05$), so the N-Gain calculation was valid. These results confirm that the use of *Islamic-based Ethnophysics flipbooks* can significantly improve students' physics literacy, especially in content competency, context, and science literacy, as defined by PISA. This increase in literacy is relevant to the PISA 2022 findings, which showed that Indonesia's science literacy score remains low (396) compared to the OECD average (489) (PISA, 2022). Therefore, innovations based on local wisdom, such as *Ethnophysics flipbooks*, can be a strategic solution to improve the quality of science learning in Indonesia. The uniqueness of this research lies in its novelty, namely the combination of Ethnophysics and Islamic values in a digital flipbook format. Previous research has generally developed only ethnoscience-based flipbooks or worksheets, without integrating religious values. Therefore, this research provides new contributions both theoretically and practically.

A practical product that benefits teachers and students. For teachers, flipbooks provide a learning media contextually aligned with the Curriculum Independent and supportive achievement Profile Pancasila students, especially in the dimension of global faith and diversity. For students, this media provides meaningful, applicable, and religious learning, because they learn concepts related to physics directly in everyday life and gain an understanding of the fundamentals that tools used in physics have been used for in life, social practice, and religious practice to fulfil the obligation of Sharia as outlined in the Qur'an and Hadith. Furthermore, this supports the view that integrating culture and religion into science not only increases cognitive understanding but also forms students' character and identity (Hasan et al., 2022). With high validation, excellent practicality, and significant effectiveness, the Ethnophysics flipbook based on Islamic values can be recommended as an innovative, physics-based learning resource for local wisdom and implemented widely in schools in Aceh and other areas with rich culture (Yusuf et al., 2023).

CONCLUSION

A flipbook based on Islamic values from Acehese culture serves as a learning medium to improve high school students' physics literacy. The development process follows the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. Expert validation results show a very high feasibility level (84%), while the practicality test, based on student responses, reached 95%, and the effectiveness test showed a significant increase in physics literacy, with an N-Gain value of 0.78 (high category). The integration of traditional Acehese units, such as *kai, are, naleh, and mayam*, with modern physics measurement concepts (standard units) and Islamic values in the practice of zakat fitrah during Ramadan makes learning more contextual, religious, and in accordance with the spirit of the Independent Curriculum. This study provides new findings in the field of developing teaching media based on Ethnophysics and religion. It requires students to think critically and provides real experiences showing that physics measuring instruments have long been used by society for various daily needs, such as bartering, and to fulfil Islamic legal obligations, while supporting the Pancasila Student Profile. Many non-standard measuring instruments are still used in Acehese society, differing across districts/cities, and were not identified in this study. Future research is recommended to expand the scope of the physics materials and to include more diverse samples from various ethnic groups to strengthen the generalizability of the results.

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