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Research Article

Integrating Local Wisdom in Science: Development and Validation of Ethnoscience Teaching Modules for Improving Science Literacy of Junior High School Students

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ABSTRACT

Purpose of the study: The low level of science literacy among Indonesian students requires innovative and contextual learning approaches. This study aims to develop and test the validity of an Ethnoscience-Based Teaching Module on the subject of Vibrations and Waves. The uniqueness of the module lies in its deep integration of the local wisdom of East OKU Regency as a learning context to bridge abstract scientific concepts with the cultural reality of students.

Methodology: This study used the Research and Development (R&D) method with a 4-D model, limited to the Develop stage. Validation was carried out by four experts (material, media, language, and culture) using adapted assessment instruments. Quantitative data were analyzed using Aiken's V coefficient.

Main Findings: The developed ethnoscience-based teaching module was declared "Highly Valid" with an average Aiken's V score of 0.90. All validation aspects scored highly: subject matter (0.90), media design (0.88), language (0.85), and cultural integration (0.95). The module is therefore feasible for further testing.

Novelty/Originality of this study: The developed module has met the eligibility criteria in terms of content, design, language, and authentic cultural integration. The implication of this research is the availability of valid and contextual teaching materials, which are ready to be further tested for their effectiveness in learning to improve science literacy while building students' cultural awareness.

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1. INTRODUCTION

The developments of the 21st century, marked by the 4.0 industrial revolution and society 5.0, require students to master various competencies, one of which is science literacy[1]–[3]. Science literacy is not merely the ability to master scientific concepts, but also includes the ability to use that knowledge to solve problems, explain natural phenomena, and make decisions that impact daily life [4], [5]. Science literacy is considered the foundation for the progress of a nation, because a scientifically literate society is believed to be able to contribute more significantly in facing the challenges of the times, such as global warming, health crises, and rapid technological developments[6], [7]. This low achievement indicates that the majority of Indonesian students are

not yet able to apply their scientific knowledge in real-life contexts. The main gap analysis lies in the science learning paradigm, which is still abstract, textual, and separated from the context of students' lives and culture [8]–[11]. This is reflected in the results of the Programme for International Student Assessment (PISA), in which Indonesia consistently ranks at the bottom in science [12]. This low achievement indicates that the majority of Indonesian students are not yet able to apply their scientific knowledge in real-life contexts, analyze data, and evaluate scientific investigation designs [13], [14].

The root cause of this low level of science literacy is strongly suspected to be related to learning paradigms and approaches that are still abstract, textual, and disconnected from the context of students' lives and culture [15]–[17]. Science education, especially physics, is often presented as a collection of formulas, laws, and facts that students must memorize [18]–[21]. The subject of Vibration and Waves, for example, is taught more through mathematical equations than through observation of phenomena familiar to students' world [22]. This decontextualized approach makes it difficult for students to understand the essence of learning, see the relevance of science in their lives, and ultimately lose interest in exploring it further [23]–[25]. The gap between the science studied in school ("school science") and the reality and local wisdom in the students' environment ("life science") widens the distance between students and science[26]–[28]. This condition also occurs in East Ogan Komering Ulu (OKU) Regency, where students may consider science as a foreign subject that does not directly touch on their local wisdom. Based on initial observations and interviews with several junior high school science teachers in the region, it was found that students often consider physics, including the material on Vibrations and Waves, to be difficult, abstract, and not directly relevant to their local wisdom.

They do not realize that, in fact, modern scientific concepts have been practiced by their ancestors in the form of local wisdom. East OKU Regency is rich in culture and local wisdom that is actually full of scientific values, especially in the subject of Vibrations and Waves. Cultural practices such as traditional musical instruments, house-building techniques, or certain traditional rituals are actually manifestations of physics concepts that can be used as a bridge to understand science [29], [30]. This local wisdom is the most authentic and meaningful learning context for students in East OKU. The ethnoscience approach is a strategic solution to bridge this gap [31]. Ethnoscience integrates local culture into science learning, making abstract concepts more contextual, meaningful, and easier to understand [32], [33]–[36]. Based on this description, the development of an ethnoscience-based teaching module for the Vibration and Waves material is a necessity [37], [38]. Through this approach, science is no longer seen as an import from the West, but as part of their own civilization and cultural identity [4]–[7]. This is in line with the spirit of the Merdeka Curriculum, which emphasizes differentiated learning that is relevant to the local context [39]–[41].

This module is expected to serve as a supplement to teaching materials that not only present theoretical physics concepts but also relate them to local wisdom in East OKU. However, before the module can be implemented in learning, a validation process is required to ensure that the developed module meets the eligibility criteria in terms of content, construct, language, and graphics. Validity is a fundamental prerequisite before the module is further tested to see its effectiveness in improving students' science literacy [42], [43]. This study aims not only to create contextual teaching materials but also to ensure that these materials have been scientifically validated, thereby potentially becoming an innovative and measurable solution in efforts to improve students' science literacy while preserving local cultural heritage.

2. RESEARCH METHOD

This study uses Research and Development (R&D) as its research type. The objective is to produce a specific product and test its effectiveness [44]. However, considering that the scope of this study is limited to validity testing, the stages carried out are limited to product feasibility testing (validity). The reliability of the instrument was tested by calculating the Cronbach's Alpha coefficient based on the responses of the four validators to all items in the questionnaire. The calculation results showed a Cronbach's Alpha value of 0.87, indicating that the instrument has good internal consistency (reliability). The research design used is the 4-D development design proposed by Thiagarajan [45], [46]. This model consists of four stages, namely: Define, Design, Develop, and Disseminate. Specifically, this study will focus on the first three stages, namely the Define stage: the stage of analyzing requirements to formulate the objectives and basis for module development; the Design stage: the stage of designing the initial draft of the ethnoscience-based teaching module; and the Develop stage: the stage of producing a final valid module through a process of validation and revision [47]. This research will be conducted in East Ogan Komering Ulu (OKU) Regency, South Sumatra Province. Data collection was conducted by providing validation sheets and draft modules to the four experts for assessment. Quantitative data analysis was performed by calculating the average score for each aspect and using Aiken's V formula (as described above) to determine the level of validity. Qualitative data analysis was conducted by reducing, presenting, and drawing conclusions from all constructive suggestions and input from the validators, which were then used as the basis for revising the module.

In this study, to assess the validity of the Teaching Module, data analysis techniques were used in the form of the following Aikens V formula:

$$V = \frac{\sum s}{n(c-1)} \dots (1)$$

Description:
S = Total score from validators
C = Highest score from validation assessment
n = Number of validators

After the results are obtained, grouping is carried out based on the Aikens V scale validity assessment criteria, which can be seen in Table 1.

Table 1. Assessment Categories from Aiken's V Scale

Aiken's V Scale	Validity
V ≤ 0.4	Not Valid
0.4 < V ≤ 0.8	Valid
0.8 < V	Very Valid

3. RESULTS AND DISCUSSION

This discussion will analyze in depth every aspect of validation, including the quality of scientific content, media design and presentation, accuracy of language use, and depth of integration of local wisdom values[49]. The analysis is conducted using a quantitative approach through the calculation of Aiken's V coefficient and supported by qualitative evaluation based on constructive suggestions and input from validators[50]. Through this discussion, the extent to which the developed module meets the eligibility criteria as innovative teaching material that is not only academically valid but also relevant to the cultural context of junior high school students in East OKU Regency will be evaluated.

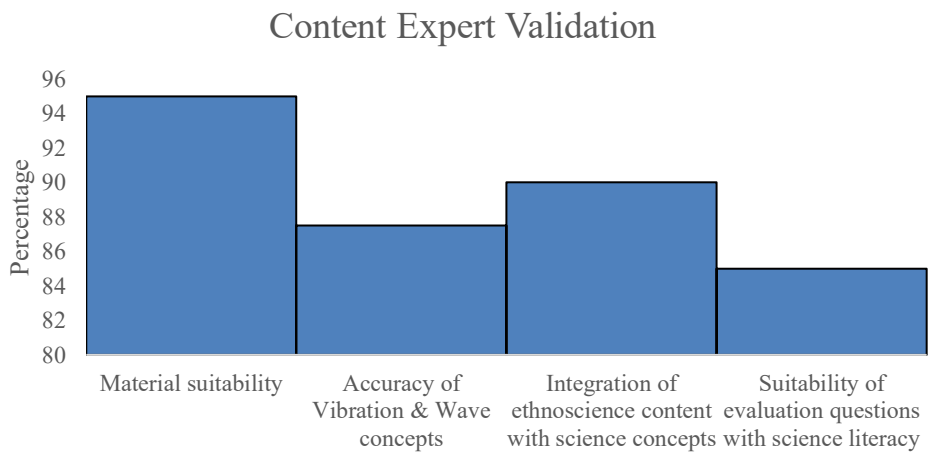

Figure 1. Results of Content Expert Validation

Based on figure 1, the results of subject matter expert validation, it can be analyzed that the ethnoscience-based teaching module received very high scores in all aspects that were validated. The aspect of material suitability achieved the highest percentage of 95%, followed by the integration of ethnoscience content with scientific concepts at 90%, the accuracy of vibration and wave concepts at 87.5%, and the suitability of evaluation questions with scientific literacy at 85%.

This high validation score proves that the module has successfully integrated scientific concepts with local wisdom in a harmonious manner without sacrificing scientific accuracy. The achievement of 95% in the aspect of ethnoscience integration is clear evidence that a local cultural approach can be successfully implemented in modern science education. Meanwhile, the relatively narrow range of scores between 85% and 95% indicates high consistency in quality across all aspects of assessment. These validation results reinforce the module's position as a contextual learning medium that is relevant to the needs of students in East OKU Regency. However, there is still room for improvement, particularly in the aspect of evaluation question preparation, which received the lowest score, although it was still in the very good category. Overall, it can be

concluded that this teaching module has met very high material eligibility standards and is ready to be implemented in the science learning process at junior high schools in East OKU Regency.

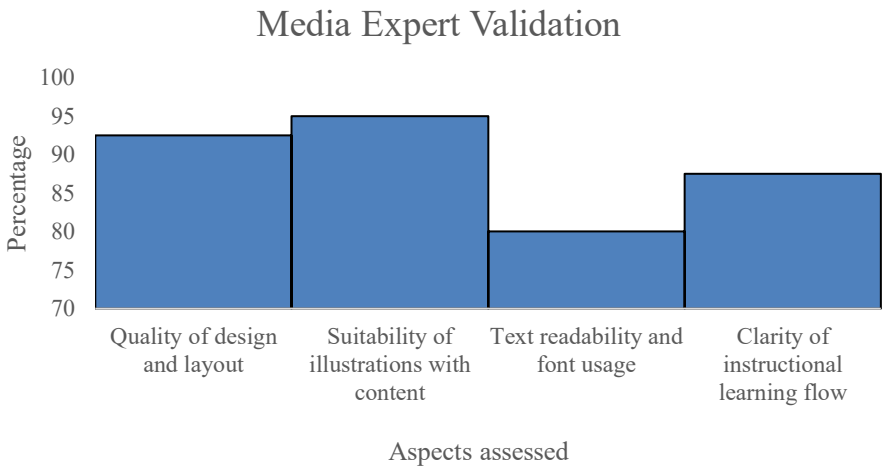

Figure 2. Media Expert Validation Results

Based on figure 2, the results of media expert validation, it can be concluded that this ethnoscience-based teaching module received very high scores in all aspects of media evaluated. The aspects of design quality and suitability of illustrations and layout received a score of 92.5%, indicating that the visual design of the module has met excellent graphic standards. The aspect of illustration suitability with content scored 95%, indicating that the teaching module is attractive and suitable for implementation with students. The aspect of text readability and font usage also scored 80%, indicating that the typography used is optimal for supporting readability. Meanwhile, the aspect of clarity of the instructional flow received a score of 87.5%, which is still in the excellent category even though it is the lowest score among the three aspects. The high validation of this media reinforces the module's position as teaching material that is not only substantive in content but also effective in presentation, where attractive and user-friendly designs can increase student motivation to learn and facilitate understanding of abstract concepts of vibrations and waves through a contextual ethnoscience approach.

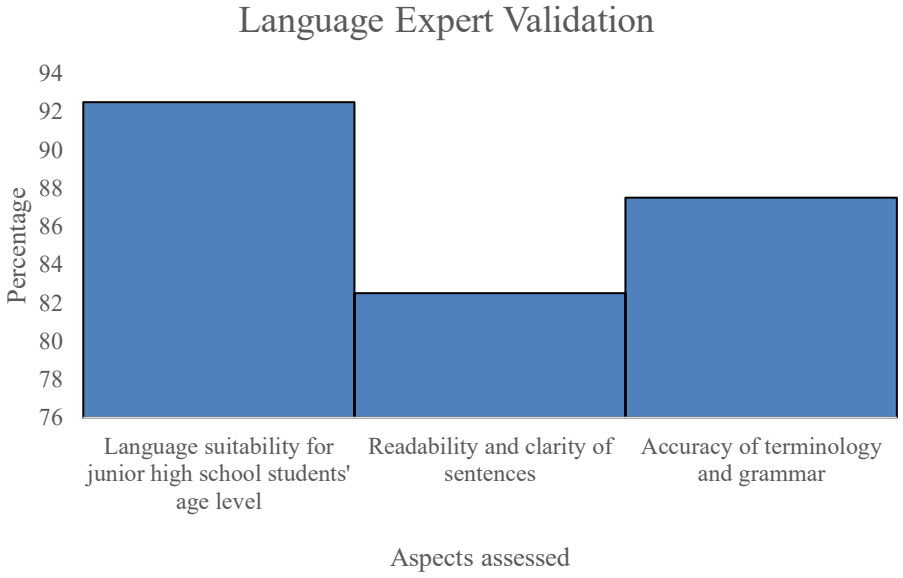

Figure 3. Language Expert Validation Results

Based on Figure 3, the results of linguistic validation, it can be concluded that this ethnoscience-based teaching module received a very satisfactory assessment in terms of language. The aspect of language suitability for the developmental level of junior high school students reached a percentage of 92.5%, indicating that the language used was appropriate for the cognitive characteristics and reading abilities of students at the junior high school level. Meanwhile, the aspect of accuracy in the use of terminology and grammar obtained a score of 87.5%, indicating that the scientific terminology and sentence structure used in the module are appropriate and in

accordance with the rules of good and correct Indonesian. The readability and clarity of the sentences obtained a score of 82.5%, indicating that the language used in the teaching module is acceptable and can be understood well by students. The high score for language appropriateness (92.5%) proves that the module has been designed with consideration for the psycholinguistic aspects of junior high school students, where the sentences used are simple enough to understand but still maintain the depth of scientific concepts.

The achievement of scores in the aspects of accuracy in the use of terminology and grammar confirms that this module is not only communicative but also academic, with consistent use of physics terminology and logical sentence structure. The success of this language validation is a crucial factor that supports the effectiveness of the module as a learning medium, because clear and precise language will facilitate the understanding of abstract concepts of vibration and waves, while minimizing misinterpretations that may arise due to linguistic errors. Thus, the linguistic aspects of this module not only meet technical standards but also successfully fulfill their pedagogical function as a communication bridge between complex scientific content and the comprehension abilities of junior high school students.

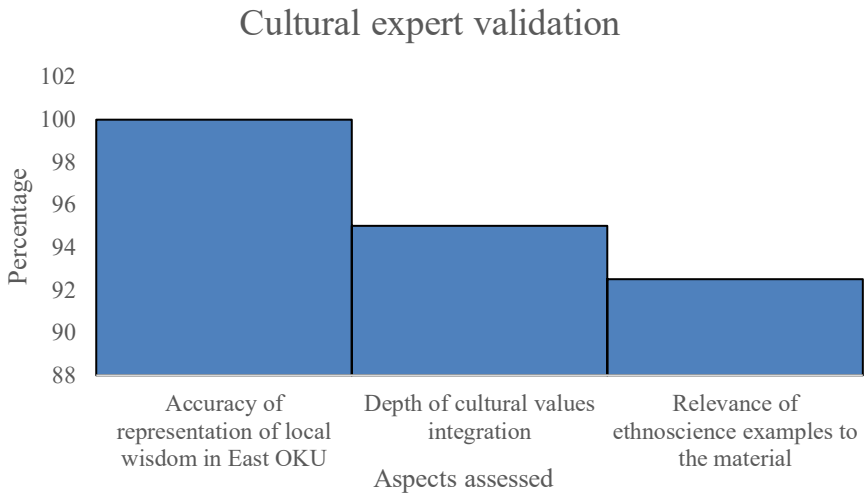

Figure 4. Results of Cultural Expert Validation

Based on figure 4, the results of cultural expert validation, it can be concluded that this ethnoscience-based teaching module received an exceptional rating in terms of cultural integration. The aspect of depth of cultural value integration achieved the highest percentage of 100%, indicating that this module did not merely insert cultural elements superficially, but had succeeded in internalizing local wisdom values deeply and comprehensively. Meanwhile, the aspect of the relevance of ethnoscience examples to the material received a score of 92.5%, indicating that the cultural examples used have a strong and contextual connection to the concepts of vibrations and waves being taught. A score of 95% shows that the teaching module has depth in its integration of cultural values. This proves that the development of this module has been carried out with a holistic and meaningful approach, where local wisdom values are not only visual complements but have become an integral part of students' scientific knowledge construction [51].

The high score for the relevance of ethnoscience examples (92.5%) confirms that the selection of cultural examples such as traditional musical instruments, traditional house-building techniques, or other cultural practices is truly relevant and can effectively illustrate abstract physics concepts in a more concrete and understandable way. These validation results reinforce the module's position as an authentic and contextual learning medium, where the ethnoscience approach not only functions as a learning strategy but also as a means of preserving and appreciating the local cultural heritage of East OKU. Thus, this module has the potential to not only improve students' science literacy, but also build cultural awareness and a strong cultural identity among the younger generation. To measure the validity of the content holistically, Aiken's V coefficient was calculated based on the assessments of the four validators of all items in the validation sheet.

Table 2. Results of Aiken's V Coefficient Calculations

Validation Aspects	Aiken's V Score	Category
Content Expert Validation	0.90	Very Valid
Media Expert Validation	0.88	Very Valid
Language Expert Validation	0.85	Very Valid
Cultural Expert Validation	0.95	Very Valid
Average	0.90	Very Valid

Based on Table 2, the results of statistical analysis using Aiken's V show that this ethnoscience-based teaching module has met very high validity standards overall. The Aiken's V values for all aspects of validation are in the "Highly Valid" category, with the following details: subject matter expert validation scored 0.90, media expert validation scored 0.88, language expert validation scored 0.85, and cultural expert validation achieved the highest score of 0.95. Overall, this module achieved an average Aiken's V score of 0.90, confirming the high validity of the product and its readiness for implementation in learning.

The high validity score reflects the consistency of the module's quality from various evaluation perspectives. The highest score in cultural expert validation (V = 0.95) indicates the module's excellence in integrating local wisdom values with scientific concepts in a harmonious and profound manner. Meanwhile, material validity (V = 0.90) indicates conceptual accuracy and alignment with the applicable curriculum. Although the media expert validation score (V = 0.88) and language expert validation score (V = 0.85) are slightly lower than other aspects, both scores remain in the "Highly Valid" category and prove that the module has met the eligibility standards in terms of graphic design, layout, and use of language appropriate to the developmental level of junior high school students. The high consistency of scores across all aspects (ranging from 0.85 to 0.95) reinforces the module's position as a comprehensive teaching material product, with no aspect significantly lagging in quality. Thus, this ethnoscience-based teaching module for vibration and wave material is worthy of further testing for its effectiveness in improving the science literacy of junior high school students in East OKU Regency.

4. CONCLUSION

Based on the entire research process and findings obtained, it can be concluded that the development of an ethnoscience-based teaching module on Vibrations and Waves for junior high school students in East OKU Regency has successfully produced a product that meets very high feasibility criteria. This module is declared "Highly Valid" based on the assessment of four experts, with an average Aiken's V score of 0.90 covering the validation of material (0.90), media (0.88), language (0.85), and culture (0.95) aspects. The high validation score, particularly in the aspect of cultural integration, proves that the module is not only scientifically accurate and visually appealing, but also successfully internalizes local wisdom values in a deep and contextual manner with the learning material. Thus, this ethnoscience-based teaching module has met all eligibility standards and is ready to be implemented and further tested for effectiveness in efforts to improve student science literacy while preserving local cultural heritage in East OKU Regency.

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AUTHOR CONTRIBUTIONS

TS, HA, K, designed the study, conducted the analysis, collected the data, and wrote the manuscript.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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