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Development of Science E-Modules Based on Ethnoscience Work, Energy, and Simple Machine Junior High School

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ABSTRACT

The goal of this development is to produce teaching materials that are valid, practical, and feasible, while also integrating science concepts with the local wisdom of the Riau community to enhance students' understanding and engagement in learning. The development process follows the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. During the Analysis stage, the focus is on identifying students' needs, as well as analyzing the curriculum and learning materials. The Design stage involves developing the e-module's format and content based on the ethnoscience framework. In the Development stage, an initial product is created and validated by expert lecturers, followed by one-on-one trials with three grade VIII students of SMP Negeri 4 Tambang who represent different ability levels high, medium, and low. The Implementation stage includes practicality testing with science teachers and grade VIII students. The results indicate that the e-module achieved a validation score of 0.88 (very valid category), teacher response of 92.86 (very practical category), and student response of 90.74 (very practical category). Therefore, the e-module is considered valid, practical, and suitable for use in science learning.

1. Introduction

Technological advances in education are developing rapidly along with the development of science and information technology. In the era of globalization driven by advances in information and communication technology (ICT), developments in education are becoming increasingly crucial (Rahmah, 2024). Education must be able to adapt to rapid technological changes to meet human needs for relevant knowledge and skills. One important aspect in improving the quality of education is the ability of teachers and students to use technology in the learning process and improve skills that are in accordance with the 21st century (Ambarwati et al., 2022; Alimuddin et al., 2023).

The context of 21st-century education encourages educators and educational institutions to focus on future needs, such as the 4C labeling process (Creativity, Critical Thinking, Collaboration, and Communication) (Partono et al., 2021). This implementation has the potential to have a positive impact on the development of students' thinking skills, which can ultimately increase students' interest in learning, innovation skills, and technological and digital literacy (Dewi, 2019). In Indonesia, education is constantly updating its curriculum with the aim of achieving better education. Independent Learning Curriculum present as answer on challenge global competition in the 21st century. This curriculum is designed to form a millennial generation that is not only adept at memorizing material but also able to understand concepts quickly and efficiently. In addition, students are expected to be able to use technology in their learning process Indarta et al. (2022) and be able to adapt to changes and develop a deeper and more meaningful understanding of the material being studied (Fakhri Akhmad, 2023).

The government has implemented various curricula as an effort to improve the quality of education in Indonesia, including in the learning of Natural Sciences (IPA). However, its implementation has not been fully optimal and still faces various challenges. This can be seen from the results of the 2022 PISA (Program for International Student Assessment) of the science abilities of students in Indonesia at a score of 383 while the average score based on the OECD (Organization for Economic Co-operation and Development) is 485. Based on the analysis of Yusmar & Fadilah (2023) this 2022 PISA score places Indonesian students at level 1a, which means they are generally only able to use basic scientific knowledge. This reflects that the science learning process in the classroom is not yet effective and has difficulty in absorbing the concepts taught.

Natural Sciences (IPA) is one of the important subjects in the Junior High School (SMP/MTs) curriculum. Science learning is defined as a process that focuses on providing direct experience to students, with the aim of developing their competence in exploring and understanding natural phenomena scientifically (Fadhili & Qodri, 2022). In the Independent Curriculum for junior high school level, phase D of science learning consists of two main elements. The first element is understanding science concepts, and the second element is developing scientific process skills, both of which support each other to strengthen students' understanding of the natural world around them (Triwati et al., 2024).

The science subjects for grade VIII in the Independent Curriculum include material on work, energy, and simple machines. The main characteristic of this subject is that there are many concepts that must be understood, which often confuse students in understanding them. The material actually consists of interrelated concepts. Therefore, science learning requires students to be able to understand each concept well. If conceptual understanding is low, this will have an impact on low learning outcomes. Therefore, it is important for students to have a comprehensive understanding of concepts (Febriyana et al., 2021; Ulfa et al., 2023).

Based on interviews with science teachers at SMPN 4 Tambang, it was revealed that students had significant difficulties in understanding the material on work,

energy, and simple machines. This material consists of various complex subtopics with similar structures. Brief delivery and only focusing on practice questions can lead to misconceptions, so that students tend to memorize formulas without gaining a deep understanding of these concepts. The learning process that emphasizes the role of the teacher makes students passive, they only listen and take notes of directions without trying to find and understand the concepts being studied independently. As a result, many students are physically present in class, but often feel bored or sleepy during the lesson. Most of the material delivery relies more on textbooks, which makes students focus more on books and interact less with real phenomena and the lack of relevant and contextual learning resources. Students' difficulties in understanding the material on work, energy, and simple machines can also be seen from the results of daily tests for grade VIII in the 2023/2024 academic year, where the average score of students in grades VIII.5 and VIII.6 was 66.77, and 72% of students had not achieved completion.

One of the efforts used to link ethnoscience in science learning is by using ethnoscience-based Science E-Modules. The selection of E-Modules as teaching materials does have several advantages, one of which is the ability to be studied independently by students, according to their respective speeds and abilities (Istiqoma et al., 2023). Independent learning allows students to be more focused and deeply involved in the learning material. They can repeat difficult material or explore topics that interest them, which can improve overall understanding of concepts. Based on the results of interviews at SMPN 4 Tambang, the use of notebooks, laptops, and computers is allowed during the learning process.

The design of the E-Module in this study is an E-Module that includes a local or cultural context in the presentation of learning materials with clear stages of activities in order to help teachers and students in implementing more focused learning and in accordance with the demands of the independent curriculum which is based on active and student-centered learning. Learning using ethnoscience-based science modules has great potential to increase students' interest and enthusiasm for the learning process. With this approach, students are not only taught rigid scientific theories, but are also given insight into how scientific concepts relate to facts or phenomena that exist in their society. This is important because it helps students understand that science is not separate from everyday life, but is integrated with the culture and local wisdom around them (Chasani & Fakhruddin, 2023).

The relevance of learning content to Riau's local wisdom can be utilized effectively through materials on business, energy, and simple machines. For example, in learning about business, students can be invited to understand how local communities use the principle of business in daily activities, such as in the tradition of pulling ships or the use of traditional tools that rely on the principles of physics. In this way, students can see the real application of the business concepts they learn. This will not only strengthen their understanding of scientific concepts, but also increase their sense of pride in the culture and local wisdom they have.

Based on research conducted by Yachod et al. (2024), the use of local wisdom-based e-modules has proven effective in improving students' understanding and knowledge of concepts related to traditional and ethnic values. Mubin et al. (2024) research shows that when students are given material relevant to local wisdom, they are better able to relate the lessons to the context of local wisdom they experience daily, thus increasing their interest in learning. This not only improves students' conceptual understanding but also strengthens their identity.

This research aims to produce teaching materials in the form of an e-module that are valid, practical, and feasible, as well as capable of integrating science concepts with the local wisdom of the Riau community. Through this development, it is expected that students' understanding of science concepts and their engagement in learning will increase. The e-module is designed to help students relate the concept of work, energy, and simple machines to real-life practices found in their cultural environment, thereby making learning more meaningful, contextual, and relevant to their daily experiences.

2. Methodology

Development using the ADDIE type Instructional Design model consisting of 5 stages, namely Analyze, Design, Development, Implementation, and Evaluate. Support for the ADDIE model was also stated by Hidayat & Nizar (2021) who stated that this model has clear, systematic, effective, and efficient steps. In addition, according to Safri et al (2017) the ADDIE model has flexible guidelines. This research model can be seen in Figure 1.

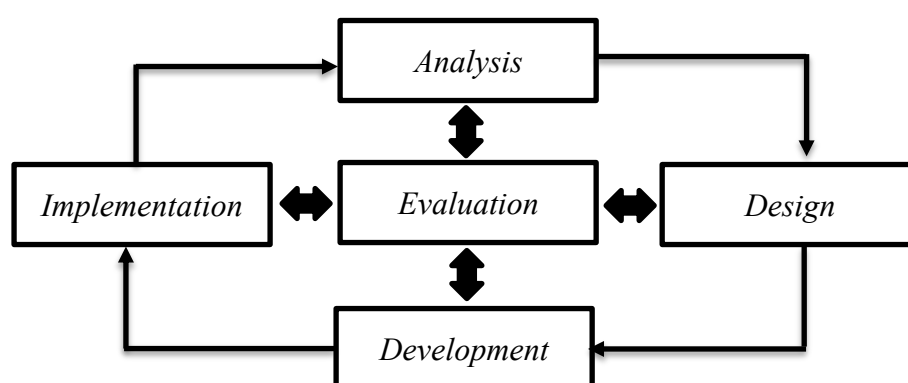


Figure 1. ADDIE Development Model (Branch, 2010)

This study used a population of grade VIII students at SMPN 4 Tambang in the 2024/2025 academic year. The data collection techniques applied in this study were non-test, including interviews, questionnaires, and documentation. The questionnaire was given to expert validators, consisting of material experts, pedagogical experts, and media experts, to assess the validity of the product. In addition, trials and practicality tests were carried out through responses from teachers and students to assess the ease of use of the developed product.

Instrument validation was conducted by pedagogical experts, media experts, and material experts using a questionnaire that had been prepared by the researcher. This validation questionnaire used a Likert scale with five levels of assessment. The Likert scale used has a score range of 1–4. The assessment categories based on the Likert Scale can be seen in Table 1.

Table 1. Categories Likert Scale Assessment

No	Likert Scale	Category Evaluation	Information
1	5	Strongly agree	SS
2	4	Agree	S
3	3	Disagree Less	KS
4	2	No Agree	TS
5	1	Absolutely Not Agree	STS

Source : Sugiyono (2018)

After the qualitative data is changed into quantitative data, the next step is to determine the validity value obtained by using the Aiken's V formula in equation (1).

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

Information :

V = value validity

s = the number given by the validator minus with minimum score

n = number of validators

c = score maximum

This value Then interpreted in a way descriptive based on Table 2.

Table 2. Interpretation Coefficient Aiken's V

No.	Interval Average Score	Criteria
1.	$0.80 < V \leq 1.00$	Very Valid
2.	$0.60 < V \leq 0.80$	Valid
3.	$0.40 < V \leq 0.60$	Quite Valid
4.	$0.20 < V \leq 0.40$	Less Valid
5.	$0.00 < V \leq 0.20$	Not Valid

Source: Adaptation of Nasir & Fakhruddin (2023)

The product is declared feasible or valid if all assessment indicators on the validity instrument have a validity coefficient value of Aiken's $V > 0.4$. However, if the V value < 0.4 , then the product is declared unfeasible or invalid. Then, the calculation to obtain the average score of the practicality test on teachers and students uses the following Equation 2:

$$Praktikalitas = \frac{\text{Jumlah Skor}}{\text{Skor maksimum}} \times 100$$

This value Then interpreted in a way descriptive based on Table 3.

Table 3. Criteria Evaluation Practicality

No.	Mark Practicality (P)	Criteria
1.	$P \leq 20$	No Practical
2.	$20 < P \leq 40$	Not enough Practical
3.	$40 < P \leq 60$	Enough Practical
4.	$60 < P \leq 80$	Practical
5.	$80 < P \leq 100$	Very Practical

Source : Riduwan (2011)

A product is declared practical and suitable for large-scale usage testing if all assessment indicators on the practicality instrument have $P > 40$. However, if the P value < 40 , then the product is declared impractical so that improvements or revisions are needed to the relevant assessment aspects.

3. Results and Discussion

This development research produces an ethnoscience-based science e-module designed for the material of Effort, Energy, and Simple Machines for grade VIII junior high school students. The advantage of this product lies in the utilization of local wisdom of the Riau Malay community which is used as part of the learning resources. Through this e-module, students are invited to understand science concepts more concretely and contextually, especially in relation to everyday life. Not only does it foster understanding of the material, this e-module also enriches students' knowledge of local culture, so that learning becomes more relevant and meaningful. The e-module is developed with an organized structure and presented interactively to increase student involvement in the learning process. The development of this module follows the stages of the ADDIE model, which includes five main steps: Analysis, Design, Development, Implementation, and Evaluation. The following are the results obtained from the development process:

Analysis Stage

This stage is carried out through observation and identification of problems to determine the needs and information needed in product development. The analysis stage includes interviews with science teachers of SMP Negeri 4 Tambang, needs analysis, student analysis, curriculum analysis, and material analysis. The results obtained are 1) The limitations of teachers have not yet developed interactive teaching materials in the form of e-modules, especially those based on ethnoscience so that they are less attractive; 2) The learning models and methods used are less related to scientific activities and the real world of students so that they pay less attention, learning becomes boring for students; 3) Awareness of cultural integration in science learning is still lacking so that an Ethnoscience-based e-module is needed in science learning. Based on the analysis of the needs of students and teachers through filling out a questionnaire on the google form, which states that 100% of 6 science teachers and 88% of 92 students need to include local wisdom in the science learning e-module. Learning with Ethnoscience-based e-modules helps improve conceptual understanding by linking materials to local

wisdom Kristiyaningsih & Febrianti, (2024), while also answering students' needs for interesting teaching materials equipped with interactive images, videos, and animations (Widyastuti et al., 2024). These problems are the basis for determining materials, designing assignments, and formulating learning objectives that are arranged in e-modules.

Design Stage

The design stage consists of several activities, namely format design, learning design in Ethnoscience-based E-Modules, Ethnoscience-based E-Modules design and research instruments. The design of Ethnoscience-based E-Modules begins with format adjustments according to Utari et al., (2021) criteria which include three main parts, namely the introduction (cover, foreword, table of contents, user instructions, concept maps, introduction to ethnoscience, learning outcomes and objectives), content (learning activities, ethnoscience activities accompanied by videos and experiments, and formative tests), and closing (summary, glossary, concept understanding tests, bibliography, and author identity). After the format is designed, the next step is to compile a storyboard as the e-module storyline which is then developed into a complete storyboard containing scenes, boards, and display descriptions. Based on this design, researchers compile an initial draft of the e-module by collecting various sources such as readings, images, videos, and links that support the development of ethnoscience-based content. This ethnoscience-based e-module is designed in a structured manner according to the curriculum and packaged in electronic devices such as computers or androids. This e-module provides students with the opportunity to learn independently by working on problems that support conceptual understanding. Furthermore, this e-module is designed to support independent learning with clear, structured, and engaging criteria (Qotimah & Mulyadi, 2021)



Figure 2. E- module display design (<https://online.flipbuilder.com/tudoh/vlic/>)

Development Stage

This stage is the implementation phase of e-module development which includes validation by experts, product revision, and one on one trials. Validation is carried out to obtain input and assessments regarding the suitability of the developed e-

module. The results of this process are used as a basis for making improvements before field trials are conducted. The assessment of the e-module's feasibility is carried out by expert lecturers using a questionnaire covering material, pedagogical, and media aspects. The assessment of the material aspect includes 4 indicators, namely material suitability, material accuracy, material up to dateness and language. The material suitability indicator consists of 9 statement items, the material accuracy indicator consists of 2 statement items, the material up-to-dateness indicator consists of 1 item, while the language indicator consists of 1 statement item. The overall assessment consists of 11 items. The results of the validation of the E-Module based on Ethnoscience on the material aspect are shown in Table 4.

Table 4. Results of Validation of E-Module Based on Ethnoscience on Aspects Material

No	Aspect Evaluation	Validation Result Score	
		Average	Criteria
1	Compliance Material	0.91	Very Valid
2	Accuracy Material	0.93	Very Valid
3	Updates Material	0.75	Valid
4	Language	1.00	Very Valid
	Average Validation Score	0.89	Very Valid

Each indicator in Table 4 is declared valid with an average validation score of 0.89 indicating that the E-Module based on Ethnoscience is appropriate, accurate, up-to-date, and uses clear language. The material accuracy indicator received the highest score because the presentation is based on facts and local wisdom that is relevant to students' lives. Ethnoscience-based learning helps students relate science to everyday life, hone conceptual understanding, and instill cultural and scientific values (Sari et al., 2020).

The assessment of the pedagogical aspect includes 3 indicators, namely presentation, ethnoscience approach, and conceptual understanding. The presentation indicator consists of 6 statement items, the ethnoscience approach indicator consists of 2 statement items, while the conceptual understanding indicator consists of 7 statement items. The total assessment consists of 15 items. Each indicator in Table 5 is declared valid with an average validation score of 0.86, indicating that the pedagogical aspect in the Ethnoscience-based E-Module is appropriate. The learning stages are aligned with the ethnoscience approach and the concept understanding indicator. The validation results of the E-Module based on the Ethnoscience pedagogical aspect are shown in Table 5.

Table 5. Results of Validation of E-Module Based on Ethnoscience on Aspects Pedagogy

No	Aspect Evaluation	Validation Result Score	
		Average	Criteria
1	Presentation	0.87	Very Valid
2	Ethnoscience	0.87	Very Valid
3	Understanding Draft	0.83	Very Valid
	Average Validation Score	0.86	Very Valid

Each indicator in Table 5 is declared valid with an average validation score of 0.86, indicating that the pedagogical aspect in the Ethnoscience-based E-Module is appropriate. The learning stages are aligned with the ethnoscience approach and the concept understanding indicator. The ethnoscience and presentation indicators scored higher because ethnoscience-based learning allows students to explore and apply concepts in the context of local wisdom. Research by Mubin et al. (2024) shows that presenting interesting material in digital media can increase student engagement in the learning process. The assessment of the media aspect includes 2 indicators, namely the display and program indicators. The display indicator consists of 7 statement items, while the program indicator consists of 5 statement items. The total assessment consists of 12 items. The results of the validation of the Ethnoscience-based E-Module media in the media aspect are shown in Table 6.

Table 6. Results of Validation of E-Module Based on Ethnoscience in Media Aspects

No	Aspect Evaluation	Validation Result Score	
		Average	Criteria
1	Appearance	0.92	Very Valid
2	Program	0.88	Very Valid
	Average Validation Score	0.90	Very Valid

Each indicator in Table 6 is declared valid with an average validation score of 0.90, indicating that the display and program aspects in the Ethnoscience-based E-Module are appropriate and attractive. The display indicator scored higher than the program, due to the attractive design, use of appropriate colors and images, and consistent learning videos. These advantages make the E-Module more interactive and support student understanding. Research by Mahendra et al. (2024) emphasized that the use of appropriate colors, images, and multimedia elements in digital modules can help improve conceptual understanding and make the material more accessible to students.

The overall validation results on the assessment aspects of material, pedagogy, and media as in Table 4.5 show that the E-Module based on Ethnoscience is valid with an average validation score of 0.88. This means that the E-Module based on Ethnoscience is feasible and can be continued to the trial stage before being used in science learning. Furthermore, a one-on-one trial was conducted with the aim of obtaining information from users, especially regarding students' difficulties in using the E-module based on Ethnoscience. Participants in this one-on-one trial were 3 students of class VIII of SMP Negeri 4 Tambang who had different characteristics based on their abilities, namely having high, medium, and low abilities. Result data validation in a way overall from aspect evaluation materials, pedagogy, and media can shown in Figure 3.

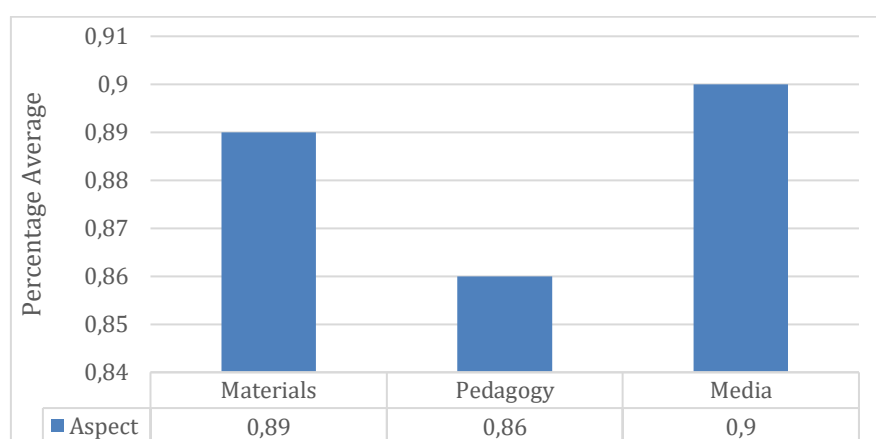


Figure 3. Validation Results Overall

Based on the one-on-one trials and interviews that had been conducted, it was obtained that students enjoyed learning when using the E-module based on Ethnoscience because it was something new for students. Previously, students had never studied using the E-module. The summary of the results of the one-on-one trials from 3 participants is as in Table 7.

Table 7. Results of One on One Trial of E-modules Based on Ethnoscience

Aspect	Response Student
Difficulty	- Students with high and medium abilities: Able to operate the Ethnoscience-based E-Module smoothly, including icon and navigation features.
	- Students with low abilities: Having difficulty in navigation and using icon features, requiring teacher guidance.
	- Audio and visual constraints: The sound in the video is not clear enough, so students have difficulty understanding the material. The recommended solution is to use additional speakers.
	- Difficulty answering questions: Students with low abilities tend to write answers on paper first before entering them into the E-Module.
Convenience	The E-Module is easy to use because it is equipped with clear instructions, quiz links, and explanations in simple language.
Benefit	Students felt that the E-Module helped them understand the concepts of work, energy, and simple machines in a way that was more relevant to everyday life and local culture.
Interesting	Students enjoy learning using E-Modules because they have an attractive appearance and an ethnoscience approach that enriches understanding.
Time Efficiency	Students with high and medium abilities can complete assignments on time, while students with low abilities still need guidance from teachers.

Implementation Stage

The practicality of the E-Module is assessed based on the responses given by teachers and students through a response questionnaire distributed at the end of the meeting. This assessment aims to determine the extent to which the E-Module can be used effectively in the learning process. The product was tested by three science

teachers and one class consisting of 20 students at SMP Negeri 4 Tambang. The data obtained from the results of the response questionnaire provide an overview of the ease of use, understanding of the material, and the relationship between the E-Module and the learning media used. The data obtained from the results of the science teacher and student respondents are as shown in Figure 4 below.

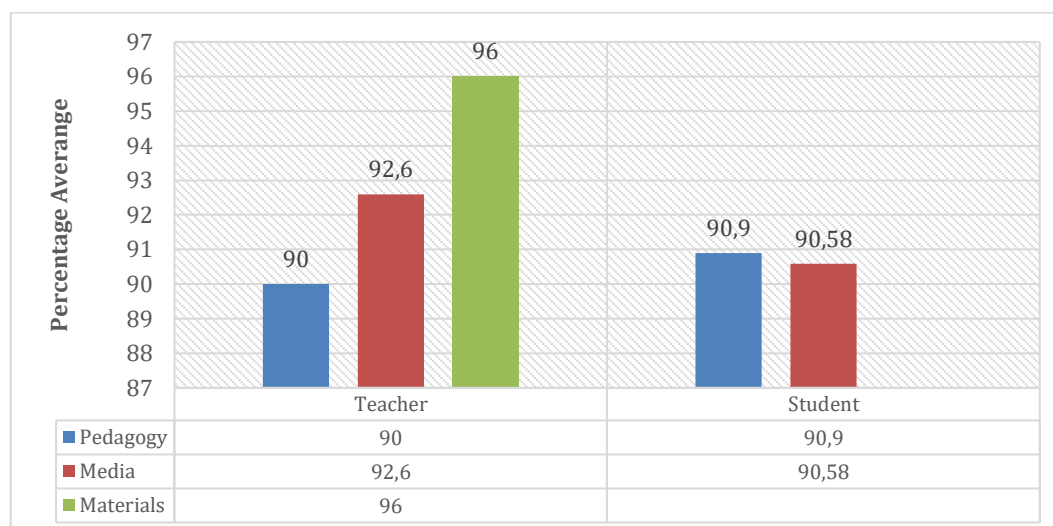


Figure 4. Results of Teacher and Participant Practicality Educate

The results of the teacher's practicality assessment of the E-module based on E-module are classified as very practical in all assessment indicators with an average practicality percentage of 92.86% and the results of the student's practicality assessment of the E-module based on Ethnoscience show that this module is included in the very practical category in all assessment indicators, with an average practicality percentage of 90.74%. The findings show that the E-module based on Ethnoscience is interesting, practical, and useful in science learning, both for students and teachers. These results are in line with Putri et al (2023) and Pratiwi & Bakti (2024) who stated that the E-module ethnoscience supports independent learning and facilitates the delivery of material in the context of local culture.

Evaluation Stage

Evaluation was conducted at each stage of development, namely analysis, design, development, and implementation. At the analysis stage, it was found that the material on Effort, Energy, and Simple Machines was difficult for students to understand, and their digital literacy level was still low. As a solution, an ethnoscience-based e-module was developed. At the design stage, the e-module was compiled and revised based on input from lecturers and validators, with an emphasis on the integration of local ethnoscience and the relationship with the Independent Curriculum. The development stage produced a feasible e-module based on the results of validation and practicality tests. The module is equipped with interactive features such as videos, simulations, and quizzes that facilitate independent learning. At the implementation stage, the e-module proved effective

in improving conceptual understanding and digital literacy in the experimental class.

4. Conclusion

E-module based on Etnoscience has been successfully developed through a series of research and testing stages. The validation process by experts shows that this E-module has met the validity criteria in terms of material, pedagogy, and media. In addition, the results of one on one trials and practicality tests involving students and teachers show that this module is easy to understand and can be used effectively in learning about business, energy, and simple machines. The development of e-modules as complementary teaching materials for further research is expected to be carried out on a large scale with more innovative and up to date designs or covering other science topics so that they can be improved as learning resources and improve the quality of students' learning activities.

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