

Development of a Problem-Based Learning Ethnoscience E-Module on the Topic “Pikukuh Karuhun: Baduy Customary Rules” to Foster Junior High School Students’ Scientific Literacy

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Abstract

The urgency of this study lies in the need to develop culturally relevant learning materials that integrate ethnoscience and Problem-Based Learning to strengthen junior high school students’ scientific literacy. This study was motivated by the need to develop contextual ethnoscience-based teaching materials to foster students’ scientific literacy through problem solving related to the local wisdom of the Baduy community. This study aimed to develop a Problem-Based Learning (PBL) ethnoscience E-Module on the topic “Pikukuh Karuhun: Baduy Customary Rules,” integrated with biodiversity content, and to determine the validity level and students’ responses to the developed product. The low scientific literacy of Indonesian students, as reflected in the 2022 PISA science score of 383 points, far below the OECD average of 485 points, constituted the main background of this study. The study employed the Research and Development (R&D) method using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The product was validated by four expert validators, consisting of two subject-matter experts and two teaching-material experts, and was subjected to a limited trial involving 20 Grade VII students at SMP Negeri 2 Cilegon. The instruments consisted of expert validation sheets and a student response questionnaire. The validation results showed an overall validity percentage of 89.18%, categorized as “Highly Valid,” comprising 87.5% from subject-matter expert validation and 90.86% from teaching-material expert validation. The student response test yielded an average percentage of 89.52%, categorized as “Good.” The developed E-Module successfully integrates the local wisdom of the Baduy community with science content in a contextual manner and is suitable for use as teaching material to foster junior high school students’ scientific literacy.

Keywords: *E-Module, Ethnoscience, PBL, Scientific Literacy, Pikukuh Karuhun, Baduy Community.*

Introduction

Twenty-first-century education requires students to possess various competencies needed to address the increasingly rapid development of science and technology. Critical thinking, creativity, collaboration, and communication are essential skills that enable students to adapt to social changes and global developments. Twenty-first-century education aims to equip students with skills that support their ability to respond to changing times and technological advances (Tillah & Subekti, 2025 ; Sikubwobo, 2026). In this context, science education plays an important role in preparing high-quality human resources because it contributes to the sustainable development of science and technology (Della & Dahlan, 2024). One of the competencies emphasized in twenty-first-century science education is scientific literacy (Osborne & Allchin, 2025 ; Tijani & Adeduyigbe, 2026).

Scientific literacy is an individual’s ability to engage reflectively with science-related issues, explain phenomena scientifically, evaluate and design scientific investigations, and

interpret scientific data and evidence to make appropriate decisions in everyday life (OECD, 2023). Scientific literacy also provides a means for students to develop critical and creative thinking as well as problem-solving skills related to scientific phenomena in their surrounding environment (Sureni et al., 2023 ; Salam et al, 2026). Although scientific literacy is one of the major competencies emphasized in modern education, the scientific literacy achievement of Indonesian students remains low. The 2022 Programme for International Student Assessment (PISA) results showed that Indonesia obtained a science literacy score of 383 points, substantially below the OECD average of 485 points (OECD, 2023). These results indicate that most Indonesian students remain at a basic level of scientific literacy and are not yet able to optimally apply scientific reasoning to solve more complex problems.

This condition is consistent with previous research reporting that Indonesian students' scientific literacy remains in the low category despite the implementation of literacy programs at various levels of education (Sukowati & Rusilowati, 2017). Low scientific literacy has also been identified at the regional level. Previous research showed that the scientific literacy of secondary-level students in Banten Province was in the very low category, with an average score of 230.19 (Bilqis et al., 2021). This finding is reinforced by another study reporting that the scientific literacy of junior high school students in Kabupaten Serang remains low and is influenced by the learning model used by teachers and students' level of curiosity (Ismi, 2022). These conditions indicate that learning processes that are insufficiently contextual and do not adequately encourage scientific thinking contribute to students' low scientific literacy. Science learning plays a strategic role in developing scientific literacy because science is understood not only as a collection of concepts but also as a process and way of thinking for understanding natural phenomena occurring around humans (Kristiyaningsih et al., 2026). Therefore, science learning needs to be designed contextually so that students can connect scientific concepts with real-life problems.

Individuals with strong scientific literacy are able to use scientific knowledge to understand various issues, assess the risks and benefits of scientific developments, and make decisions based on available scientific evidence (Handayani et al., 2018). One approach that can be used to create contextual science learning is ethnoscience. Ethnoscience is the process of integrating local knowledge developed within a community with scientific knowledge that has been academically recognized (Hosana et al., 2023). The ethnoscience approach allows students to learn scientific concepts through cultural and environmental contexts that are close to their lives, making learning more meaningful. Previous research has explained that ethnoscience-based learning can improve scientific literacy because students are trained to apply scientific concepts in everyday life through familiar local cultural contexts (Hidayah et al., 2025). In addition to an appropriate learning approach, innovative teaching materials are needed to support the development of students' scientific literacy. One type of teaching material relevant to current technological developments is the E-Module. An E-Module is an electronic module that can be accessed through digital devices such as smartphones and computers and can incorporate multimedia elements such as images, videos, animations, and interactive assessments (Pardianiati et al., 2025).

The use of E-Modules enables students to learn independently, flexibly, and more interactively than with conventional teaching materials (Suryani et al., 2022). In addition, E-Modules can provide more engaging learning experiences and therefore have the potential to increase students' engagement in the learning process (Atdhini et al., 2023). Various studies have shown that ethnoscience-based E-Modules are effective in improving students' scientific literacy. Previous research found that an ethnoscience-based E-Module using the context of

Kris Madura for the topic of elements, compounds, and mixtures improved students' scientific literacy with an N-gain of 0.69 in the moderate category (Anjelina et al., 2025). Another study reported that an ethnoscience-based E-Module assisted by Heyzine Flipbook for acids and bases demonstrated high levels of validity, practicality, and effectiveness, with an N-gain of 0.79 in the high category (Alifa et al., 2025). In addition, previous research showed that an ethnoscience-based E-Module on food additives obtained an Aiken's validity index of 0.95 and was suitable for fostering junior high school students' scientific literacy (Pardianti et al., 2025).

Nevertheless, a review of previous studies shows that most ethnoscience-based E-Module development has focused on cultural products such as traditional foods, regional crafts, and other cultural artifacts. Research integrating local wisdom in the form of customary rules related to environmental conservation remains very limited. In fact, Indigenous communities in Indonesia possess diverse ecological knowledge systems that can be integrated into science learning. One form of local wisdom with high ecological value is *Pikukuh Karuhun*, practiced by the Indigenous Baduy community in Kabupaten Lebak, Banten Province.

Pikukuh Karuhun comprises customary rules passed down from generation to generation and serves as a guide for the Baduy community in maintaining a balanced relationship between humans and nature. These rules include prohibitions against damaging forests, requirements to preserve the environment, and principles for using natural resources wisely (Halmahera et al., 2019). This local wisdom demonstrates that the Baduy community possesses ecological knowledge consistent with modern scientific principles of environmental conservation and biodiversity preservation. The values embedded in *Pikukuh Karuhun* are closely related to biodiversity content in science learning, particularly species preservation, ecosystem conservation, and the sustainable use of natural resources. However, this local wisdom has not been widely utilized as a context for science learning in schools. Integrating local culture into learning can help students understand scientific concepts more concretely while also fostering concern for the environment and their own regional culture.

To make the learning process more meaningful and capable of fostering students' scientific literacy, the integration of ethnoscience into teaching materials needs to be supported by an appropriate learning model. One recommended model is Problem-Based Learning (PBL). PBL is a student-centered learning model that uses real-world problems as the starting point for learning. Through this model, students are encouraged to identify problems, gather information, analyze data, and formulate solutions based on the scientific concepts they have learned (Larasati & Agustina, 2023). Thus, the implementation of PBL can foster critical thinking while also developing students' scientific literacy.

Based on the preceding discussion, a research gap remains in the limited development of ethnoscience-based E-Modules that integrate the local wisdom of the Baduy community, particularly *Pikukuh Karuhun*, with Problem-Based Learning to foster junior high school students' scientific literacy. Therefore, this study aimed to develop a Problem-Based Learning ethnoscience E-Module on the topic "*Pikukuh Karuhun: Baduy Customary Rules*" to foster junior high school students' scientific literacy and to analyze the validity level and students' responses to the developed product. The novelty of this study lies in integrating the local-wisdom values of *Pikukuh Karuhun* from the Baduy community into a Problem-Based Learning E-Module developed for biodiversity content. This integration is expected not only to foster students' scientific literacy but also to strengthen their understanding of local culture and environmental-conservation values relevant to everyday life.

Method

This study employed the Research and Development (R&D) method, which focuses on developing a product while also refining an existing product. In education, the R&D method is widely used to produce learning products that can support improvements in the quality, effectiveness, and efficiency of teaching and learning processes. The ADDIE development model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. In this study, the development process was conducted only up to the Implementation stage. This limitation was established because the study focused on producing a product suitable for use based on expert validation results and obtaining students' responses to the developed product. Accordingly, the study was directed toward product validation and limited implementation to determine students' responses to the developed teaching material.

The Analysis stage was the initial step in the development process and was conducted to identify various needs related to the product to be developed. At this stage, the researchers examined the urgency of developing the teaching material, analyzed the existing learning conditions, and assessed the need for and feasibility of the proposed product. The needs analysis was conducted by collecting information on learning resources used at school. In addition, the researchers conducted observations and interviews with a teacher at a junior high school in Kota Cilegon to obtain information on the teaching materials used in learning and the condition of students' scientific literacy.

The Design stage involved preparing the initial design of the product in the form of an E-Module. Activities at this stage included selecting the type of teaching material, determining the presentation format, and preparing a storyboard as a guide for the product-development process. The design was prepared by considering students' characteristics, learning objectives, and the content to be presented. Subsequently, the Development stage focused on producing the product according to the previously prepared design. At this stage, the components of the E-Module were prepared, including Learning Outcomes, Learning Objectives, learning content, student activities, and other supporting elements. The completed product was then validated by experts to determine its feasibility and validity. The validation results, together with suggestions and feedback, were used as the basis for revising and refining the product so that it aligned with the development objectives. The Implementation stage was conducted through a limited trial involving Grade VII junior high school students. This trial aimed to obtain information on students' responses to the use of the PBL-based ethnosience E-Module on the topic "Pikukuh Karuhun: Baduy Customary Rules." In addition, the implementation stage was used to examine the potential of the E-Module to support the development of students' scientific literacy during the learning process.

The participants in this study consisted of teaching-material expert validators and subject-matter expert validators. The validators assessed product feasibility using the provided validation instruments and offered feedback and suggestions regarding the components of the PBL-based ethnosience E-Module on the topic "Pikukuh Karuhun: Baduy Customary Rules." Product implementation was conducted through a small-group trial at a junior high school in Kota Cilegon. The trial involved 20 Grade VII students selected from a population of 380 students. The sample size was determined by selecting a portion of the population according to the needs of the study. Thus, the number of students involved represented approximately 5% of the total Grade VII population at the school. Students were randomly selected so that every member of the population had an equal opportunity to be included in the sample. During the trial, students were asked to use the developed E-Module and then complete a response

questionnaire. The questionnaire data were used to determine students' responses regarding the quality, ease of use, and attractiveness of the developed product.

The instruments used in this study consisted of expert validation sheets and a student response questionnaire. The expert validation sheets were used to assess the feasibility and validity of the developed E-Module, whereas the student response questionnaire was used during the limited trial to obtain information about students' responses to the developed product. Students completed the response questionnaire after all learning activities using the E-Module had been completed. The research instruments used a four-point Likert scale (1-4). This scale was selected to provide respondents with more definite response options because it does not include a neutral category. Consequently, respondents were expected to provide more specific judgments for each statement. In addition, a 1-4 Likert scale is considered simpler for data processing and interpretation because it reduces the likelihood of ambiguous responses. Therefore, this scale was considered effective for assessing the quality of the developed product (Widyastuti, 2022).

The data obtained in this study consisted of qualitative and quantitative data. Qualitative data were obtained from comments, criticisms, and suggestions provided by expert validators as material for product improvement. Quantitative data were obtained from validator assessments and student responses collected through questionnaire instruments using a four-point Likert scale. Both types of data were used as the basis for determining product feasibility and revising the developed E-Module. The quantitative assessment data in this study were evaluated using a four-point rating scale consisting of four categories: Very Good, Good, Poor, and Very Poor. Each category represents a different level of performance and is assigned a corresponding score. A score of 4 indicates the Very Good category, 3 indicates Good, 2 indicates Poor, and 1 indicates Very Poor. After obtaining the validation percentage data, the next step was to interpret them according to the validator instrument criteria to determine the effectiveness level of the E-Module.

Table 1. *Validation Test Percentage Criteria*

Percentage	Category
$81,25\% \leq NP \leq 100\%$	Highly Valid
$62,5\% \leq NP \leq 81,25\%$	Valid
$43,75\% \leq NP \leq 62,5\%$	Moderately Valid
$25\% \leq NP \leq 43,75\%$	Invalid

Data were collected through the student response questionnaire to determine the practicality level of the developed learning media. Students' responses were used as the basis for assessing the ease of use of the teaching material during the learning process. The assessment results were then interpreted according to criteria proposed in previous research, which grouped student responses into four categories: very positive, positive, less positive, and negative. The student response assessment in this study was measured using a four-point Likert scale consisting of four response categories: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). Each response category was assigned a numerical score to quantify students' perceptions of the learning process and instructional media. A score of 4 indicates Strongly Agree (SA), 3 indicates Agree (A), 2 indicates Disagree (D), and 1 indicates Strongly Disagree (SD).

Table 2. *Student Response Test Assessment Categories*

Score Percentage	Category
90,00% - 100%	Very Good
80,01% - 90,00%	Good
60,01% - 80,00%	Fair
20,01% - 60,00%	Poor
20,00%	Very Poor

Table 2 presents the categories used to assess students' responses based on score percentages. The assessment categorizes student responses into five levels, ranging from very poor to very good. Scores of 90.00%–100% are categorized as very good, while scores of 80.01%–90.00% are classified as good. Scores ranging from 60.01%–80.00% fall into the fair category, whereas scores of 20.01%–60.00% are categorized as poor. Finally, a score of 20.00% is classified as very poor. These categories provide a clear basis for interpreting the quality of students' responses to the learning assessment.

Results

Instrument Validation

Before use, all research instruments were first evaluated through expert judgment by one lecturer-validator to assess their feasibility. The judgment results are presented in Table 5.

Table 3. *Research Instrument Validation Results*

No	Instrument Assessed	Pct.	Category
1	Subject-Matter Expert Validation Instrument	95%	Highly Valid
2	Teaching-Material Expert Validation Instrument	95%	Highly Valid
3	Student Response Questionnaire Instrument	92,5%	Highly Valid
	Total	94,17%	Highly Valid

All three instruments were categorized as Highly Valid, indicating that they demonstrated good alignment among aspects, indicators, and statement items. This is consistent with previous findings that instrument quality is influenced by clarity of presentation and appropriateness of content (Ningtyas & Rahmawati, 2023).

Expert Validation Results

Validation of the developed PBL-based ethnoscience E-Module was conducted by four expert validators. The cumulative assessment results are presented in Table 6.

Table 4. *Overall Expert Validation Results*

No	Expert Validator	Pct.	Category
1	Subject-Matter Experts	87,5%	Highly Valid
2	Teaching-Material Experts	90,86%	Highly Valid
	Total	89,18%	Highly Valid

Based on Table 4, the overall validity percentage was 89.18%, categorized as Highly Valid. These results indicate that the E-Module met academic feasibility criteria and was ready for use as teaching material after revision based on validator feedback. Subject-matter expert validation yielded a percentage of 87.5%, categorized as Highly Valid. The assessment results for each aspect are presented in Table 5.

Table 5. Subject-Matter Expert Validation Results

No	Aspect	Validation (%)	Category
1	Content Feasibility	88.63%	Highly Valid
2	Language Feasibility	83%	Highly Valid
Total		87,5%	Highly Valid

The content-feasibility aspect comprised three indicators. The material-alignment indicator obtained 79% (Valid) because the formulation of the Learning Outcomes (Capaian Pembelajaran, CP) in the E-Module was not yet fully aligned with the latest Kemendikdasmen guidelines. According to the latest guidelines, Phase D CP emphasizes that students should be able to analyze interactions between living organisms and their environment in designing efforts to prevent and address climate change. Previous research has emphasized the importance of formulating learning objectives based on the cognitive hierarchy of Bloom's Taxonomy so that learning progresses gradually from lower- to higher-order thinking (Nafati, 2021).

The supporting-material alignment indicator obtained 95% (Highly Valid), reflecting the successful integration of the Pikukuh Karuhun context as Baduy customary rules that include prohibitions against damaging forests, maintaining environmental balance, and using natural resources wisely. Previous research has stated that ethnoscience-based science learning serves as a bridge between scientific concepts and students' cultural experiences (Selviana et al., 2026). The scientific-literacy alignment indicator obtained 90% (Highly Valid), indicating that the material facilitated students' ability to identify scientific issues, explain phenomena, and use scientific evidence. Other research has reported that PBL can improve scientific literacy because students are trained to solve problems through investigation (Ramadhani et al., 2026).

The language-feasibility aspect obtained 83% (Highly Valid). The less-than-maximum percentage was due to several typographical errors and inconsistencies in the use of foreign terms. Previous research has emphasized that spelling errors can affect readers' understanding of learning content (Salma et al., 2024). Teaching-material expert validation yielded 90.86%, categorized as Highly Valid. Table 6 presents the results for each aspect.

Table 6. Teaching-Material Expert Validation Results

No	Aspect	Validity (%)	Category
1.	Content Feasibility	92,70%	Highly Valid
2.	Language	87,5%	Highly Valid
3.	Accessibility	95,8%	Highly Valid
4.	Usefulness	87,5%	Highly Valid
Overall		90,86%	Highly Valid

The content-feasibility aspect obtained 92.70% across four indicators. Contextual alignment received a perfect score of 100% because the Pikukuh Karuhun material successfully connected biodiversity concepts with real-world issues in students' surrounding environment. Previous research has stated that contextual learning helps students understand concepts more meaningfully. Media suitability reached 93.75% but was not optimal because the resolution of several images still needed improvement. Presentation suitability obtained 87.5%, with a recommendation to improve the cover design to make it more attractive.

The accessibility aspect achieved the highest percentage (95.8%), indicating that the E-Module was easy to access using smartphones and laptops. Teaching materials need to be aligned with technological developments. However, the E-Module did not yet provide direct hyperlinks to videos, requiring an additional step. The usefulness aspect (87.5%) indicated that

the E-Module could help teachers foster three dimensions of students' scientific literacy: analyzing scientific issues, identifying scientific evidence, and communicating the results of analysis (Dal et al., 2024).

Student Response Test Results

The response test involved 20 Grade VII students from SMPN 2 Cilegon and was conducted offline. The student response results are presented in Table 7.

Table 7. Student Response Test Results

No	Aspect	Response (%)	Category
1	Material Suitability	91,5%	Very Good
2.	Language	87,08%	Good
3.	Visual Display	88,25%	Good
4.	Scientific Literacy	91,25%	Very Good
Overall		89,52%	Good

The material-suitability aspect obtained the highest percentage (91.5%, Very Good). The items measuring alignment of the material with the topic and ease of understanding the content each reached 92.5%, reflecting the successful integration of biodiversity concepts with the local wisdom of Pikukuh Karuhun. Good teaching materials should provide sufficient content so that students can understand learning more easily (Magdalena et al., 2020). Previous research found that learning based on real-world problems improves conceptual understanding and scientific literacy (Ismi, 2022).

The language aspect obtained 87.08% (Good). Ease of understanding the language (item 5) and coherence of presentation (item 7) each reached 90% (Very Good), while clarity of sentence meaning (item 6) reached only 81.2% because several instructions for investigation activities were considered insufficiently clear. Improvements are needed to make the instructional sentences more operational and unambiguous. The visual-display aspect obtained 88.25% (Good). Visual attractiveness received the highest score (90%, item 9), indicating that the E-Module design featuring Baduy cultural motifs successfully attracted students' reading interest. The suitability of image illustrations obtained the lowest percentage (86.25%, item 10) because the resolution of several images was less than optimal.

The scientific-literacy aspect obtained 91.25% (Very Good). Clarity in presenting scientific phenomena (item 13) achieved the highest overall score (95%), demonstrating that the Pikukuh Karuhun phenomenon successfully provided an authentic and relevant scientific context. Previous research found that PBL significantly improves scientific literacy, particularly in identifying problems and interpreting scientific evidence (Andayani & Agustina, 2025). The item on communicating analysis results (item 16, 88.75%) received the lowest score, indicating that scientific communication skills still require more intensive practice among Grade VII students.

Discussion

The overall validation results showed a percentage of 89.18%, categorized as "Highly Valid." These results indicate that the developed E-Module met feasibility criteria in terms of content, language, accessibility, and usefulness for learning. Within the content-feasibility assessment by subject-matter experts, the supporting-material alignment indicator received the highest score (95%), indicating that the integration of Pikukuh Karuhun as Baduy customary rules for preserving nature and biodiversity was considered highly appropriate. This

supports previous statements that ethnoscience-based science learning serves as a bridge between scientific concepts and students' cultural experiences (Selviana et al., 2026). Integrating local wisdom into learning has also been shown to improve scientific literacy and foster environmental awareness. Meanwhile, the material-alignment indicator was categorized as "Valid" (79%) because adjustments were still required to the Learning Outcomes (CP), which needed to be aligned with the latest Kemendikdasmen guidance related to Deep Learning. The formulation of learning objectives and materials should consider the hierarchy of cognitive abilities in the revised Bloom's Taxonomy so that learning progresses gradually from lower-order to higher-order thinking skills (Nafiati, 2021).

In the teaching-material expert validation, accessibility received the highest score (95.8%), indicating that the E-Module could be accessed through various devices, including smartphones and laptops, and was supported by a barcode feature linked to learning videos. This finding is consistent with previous research stating that E-Modules combining text, images, video, audio, and animation are more practical because they can accommodate learning needs and increase student engagement (Putra et al., 2023). Nevertheless, the validators recommended adding direct hyperlinks to make access more efficient. The language aspects in the subject-matter expert validation (83%) and teaching-material expert validation (87.5%) were categorized as "Highly Valid," although the scores were not optimal because several typographical errors and inconsistent terms were still found. Other research has stated that the language feasibility of teaching materials is determined by clarity of information, accuracy of language use, and suitability for students' developmental level (Ningtyas & Rahmawati, 2023).

The overall student response test obtained 89.52%, categorized as "Good." The material-suitability aspect obtained the highest percentage (91.5%), categorized as "Very Good," reflecting students' perceptions of the relevance of biodiversity content integrated with the cultural context of Pikukuh Karuhun. One criterion for good teaching materials is the adequacy of the material so that students can understand the learning content more easily (Magdalena et al., 2020). The scientific-literacy aspect ranked second (91.25%), with the item concerning clarity in presenting scientific phenomena receiving the highest score (95%). This indicates that the ethnoscience approach successfully presented authentic and contextual scientific phenomena through environmental issues close to students' lives. Other research has also found that the implementation of PBL can significantly improve scientific literacy, particularly in identifying problems and interpreting scientific evidence (Andayani & Agustina, 2025).

The visual-display aspect obtained 88.25% (categorized as "Good"), with the E-Module's visual attractiveness receiving the most positive student ratings. The use of an aesthetically designed interface featuring Baduy cultural motifs contributed to students' reading interest. Previous research has stated that realistic, high-quality images in teaching materials can help clarify content and make it easier for students to understand. The language aspect received the lowest score (87.08%) but remained in the "Good" category. The item concerning clarity of sentence meaning obtained the lowest score (81.2%) because several sentences in the investigation-activity instructions could potentially lead to multiple interpretations. Improvements can focus on editing the instructional sentences so that they are more operational and unambiguous, enabling students to follow the learning sequence independently with greater ease.

Conclusion

Based on the results and discussion, it can be concluded that the PBL-based ethnoscience E-Module on the topic “Pikukuh Karuhun: Baduy Customary Rules” developed to foster junior high school students’ scientific literacy was categorized as Highly Valid, with an average validation percentage of 89.18%. Subject-matter expert validation yielded 87.5%, while teaching-material expert validation yielded 90.86%; both were categorized as “Highly Valid.” In addition, the student response test obtained an average percentage of 89.52%, categorized as “Good,” indicating that the E-Module received a positive response from students. The E-Module is suitable for proceeding to the next stage of development, namely an effectiveness test, after revisions are made in accordance with validator recommendations. This study was limited by the scope of the material, which covered only Grade VII biodiversity, and by the trial participants, who were drawn from only one school. Future researchers are recommended to continue development through the effectiveness-testing stage and broaden both the content coverage and research participants. Teachers are advised to introduce procedures for using the E-Module before learning begins because access to the learning videos requires an internet connection. This study is expected to serve as a reference for developing ethnoscience- and scientific-literacy-based teaching materials at the junior high school level.

Acknowledgment

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