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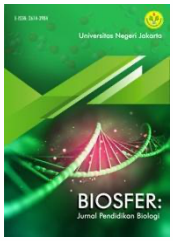

The development of the zingiberaceae book as an exploration of sabang's local wisdom

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A B S T R A C T

The integration of local wisdom into biology learning resources remains limited, particularly in transforming ethnobotanical knowledge into scientifically validated instructional materials. This study aimed to develop a Zingiberaceae book based on Sabang's local wisdom as a contextual biology learning resource. The research employed the 4D development model (Define, Design, Develop, Disseminate), but was limited to the Develop stage through expert validation. In the Define stage, curriculum needs, learner characteristics, and local biological potential were analyzed. The Design stage produced a prototype integrating scientific concepts of Zingiberaceae—such as taxonomy, morphology, phytochemistry, and ecological roles—with ethnobotanical information and cultural practices of the Sabang community. In the Develop stage, the product was evaluated by material experts, language experts, and teaching material experts using structured validation instruments. The results showed that material expert validation reached 92%, language expert validation reached 88%, and teaching material expert validation reached 90%, all categorized as very valid. The overall average validity score was 90%, indicating that the book fulfills the criteria of scientific accuracy, linguistic clarity, and instructional feasibility. The findings demonstrate that ethnobotanical knowledge can be systematically transformed into a valid contextual biology learning resource. Therefore, the developed book is recommended as an enrichment material to support contextual learning and strengthen the integration of local wisdom in biology education.

INTRODUCTION

The integration of local wisdom into biology education continues to present conceptual and practical challenges, particularly in developing contextual learning resources that connect scientific concepts with students' socio-cultural environments (Ibda et al., 2024; Rijal, 2021). Although Indonesia possesses rich biodiversity and ethnobotanical knowledge, biology learning materials still predominantly emphasize universal concepts that are detached from local ecological realities, resulting in less meaningful learning and limited ecological awareness among students (Fauzi et al., 2024; Karmadi et al., 2023).

Several studies have explored the development of biology teaching materials based on local potential and ethnobotanical contexts (Rachmawati et al., 2024; Sam et al., 2024; Fajeriadi et al., 2025; Keliat et al., 2025). However, most of these studies remain limited to biodiversity modules, medicinal plant inventories, or descriptive ethnobotanical documentation without systematically transforming local knowledge into scientifically validated instructional products (Panyadee et al., 2023). Furthermore, research specifically integrating the Zingiberaceae family as a comprehensive biological topic including taxonomy, morphology, phytochemistry, ecological roles, and ethnobotanical utilization remains scarce (Sutjaritjai et al., 2022). In the context of Sabang, Zingiberaceae species possess significant cultural and medicinal value in local communities, yet no validated biology teaching material has been developed to integrate this local wisdom into formal biology education (Inta et al., 2023). Therefore, a research gap exists in the development of expert-validated biology teaching materials that systematically combine scientific botanical concepts with ethnobotanical knowledge of Zingiberaceae (Fazriah et al., 2025).

From a biology education perspective, the study of biodiversity becomes more meaningful when scientific concepts are connected to students' local environments and socio-cultural experiences (Rijal, 2021). The Zingiberaceae family (order Zingiberales), consisting of rhizomatous aromatic herbs characterized by pseudostems, zygomorphic flowers, and inferior ovaries, provides rich biological content for learning plant taxonomy, morphology, phytochemistry, ecology, and biodiversity conservation (Li et al., 2020; Tan et al., 2020; Zhao et al., 2021). Genera such as Zingiber, Curcuma, Alpinia, and Kaempferia are widely recognized for their phytochemical compounds, essential oils, and pharmacological potential (Tran-Trung et al., 2024). According to contextual learning and ethnopedagogical perspectives, local biological resources can serve as authentic learning sources that facilitate the integration of scientific knowledge with cultural practices, thereby enhancing students' understanding of biological concepts and their relevance to everyday life (Rijal, 2021). Ethnobotanical studies further emphasize the dynamic relationship between communities and plant resources, providing opportunities to contextualize biological knowledge through local wisdom and traditional practices (Chen et al., 2024). Therefore, transforming ethnobotanical information on Zingiberaceae into a structured teaching material is important to support contextual biology learning while strengthening students' awareness of biodiversity and local cultural heritage.

Several studies have highlighted the potential of local biodiversity and ethnobotanical knowledge as learning resources in biology education. Rachmawati et al. (2024) developed a mangrove diversity e-module based on local potential and reported that contextual materials can foster students' environmental attitudes. Sam et al. (2024) identified the marine potential of Tarakan City as a valuable source of biology teaching materials, while Keliat et al. (2025) found that learning resources based on local potential enhanced students' knowledge of environmental resources. In the ethnobotanical field, Inta et al. (2023) documented the traditional utilization of Zingiberaceae species in Northern Thailand, and Panyadee et al. (2023) reported extensive plant-use knowledge among local communities. However, these studies primarily focused on documenting biodiversity or ethnobotanical information and did not develop scientifically validated instructional materials for formal biology learning. Furthermore, studies specifically integrating the biological concepts of Zingiberaceae including taxonomy, morphology, phytochemistry, ecological roles, and ethnobotanical utilization into a contextual biology teaching material remain limited. Based on this gap, the present study developed a Zingiberaceae book based on Sabang's local wisdom through the 4D development model (Define, Design, Develop, Disseminate), limited to the expert-validation stage, to provide a scientifically validated and culturally responsive biology learning resource.

METHODS

Research Design

This study employed a research and development (R&D) approach using the 4D development model proposed by Thiagarajan, Semmel, and Semmel (1974), which consists of four stages: Define, Design, Develop, and Disseminate. However, the implementation of this study was limited to the development stage, specifically expert validation, without conducting effectiveness testing or large-scale dissemination. This study employed a research and development (R&D) approach using the 4D model developed by Thiagarajan, Semmel, and Semmel (1974), which consists of four stages: Define, Design, Develop, and Disseminate. The model was selected because it provides a systematic framework for developing and validating instructional materials based on identified educational needs. However, this study was limited to the development stage, focusing on expert validation of the product without conducting field testing or dissemination.

The research design was intended to produce a contextual biology learning resource by integrating scientific information on Zingiberaceae with ethnobotanical knowledge derived from Sabang's local wisdom. The development process involved needs assessment, product design, and expert-based evaluation to ensure the scientific accuracy, linguistic quality, and instructional feasibility of the developed book. The product's feasibility was assessed through expert validation involving material, language, and teaching material experts, using structured validation instruments. The resulting quantitative data were analyzed descriptively using percentage-based validity criteria to determine the overall validity of the developed instructional material.

Population and Samples

The population of this study consisted of experts in biology education, linguistics, and instructional material development who possess academic and professional expertise relevant to the development of biology teaching materials. Since this research was limited to product development and expert validation without field testing, the population did not include students as research subjects.

The sample was selected using purposive sampling, based on predetermined criteria aligned with the research objectives. The sample comprised three categories of validators: (1) material experts with expertise in botany and/or plant taxonomy, particularly related to the Zingiberaceae family; (2) language experts with academic backgrounds in Indonesian language or applied linguistics to assess clarity, readability, and linguistic appropriateness; and (3) teaching material experts with experience in instructional design or biology education to evaluate the feasibility of presentation, graphical aspects, and pedagogical suitability.

Each expert was required to hold at least a master's degree in a relevant field and have experience in teaching, research, or instructional material development. The selection of expert validators aimed to ensure the scientific accuracy, linguistic quality, and instructional feasibility of the developed Zingiberaceae book. Therefore, the sampling approach emphasized expertise relevance rather than numerical representation, which is consistent with research and development studies focused on product validity assessment.

Instrument

The primary instrument used in this study was a validation sheet designed to assess the feasibility and validity of the Zingiberaceae book developed. The instrument was constructed based on standards for evaluating teaching materials, contextual learning principles, and relevant literature on instructional material development. The validation instrument employed a structured Likert-type rating scale to quantify expert judgments. Three types of validation instruments were developed based on the categories of experts involved. The material expert validation sheet assessed content accuracy, conceptual depth and breadth, alignment with biological scientific principles, relevance to curriculum objectives, and the integration of ethnobotanical data related to Zingiberaceae in Sabang. The indicators also evaluated the accuracy of taxonomy, morphology, phytochemical information, ecological roles, and traditional uses presented in the book.

The language expert validation sheet evaluated linguistic clarity, sentence effectiveness, coherence between paragraphs, consistency of scientific terminology, readability level, and conformity with formal academic language standards. These indicators were included to ensure that the content could be understood easily by the target readers while maintaining scientific accuracy. Through this evaluation, the developed book was assessed for its communicative quality, systematic presentation, and appropriateness as a contextual biology learning resource.

The teaching material expert validation sheet examined aspects of instructional design, including systematic organization of content, learning objectives formulation, contextual integration, presentation techniques, graphical layout, illustration quality, and overall pedagogical suitability. This instrument aimed to determine whether the book met the standards of effective and learner-oriented instructional materials.

All instruments were developed in grid form (instrument blueprint) to ensure alignment between assessment indicators and research objectives. The validation scores were analyzed descriptively using percentage-based criteria to determine the level of validity and feasibility of the developed product.

Procedure

This research followed a Research and Development (R&D) procedure adapted from the 4D model (Define, Design, Develop, Disseminate). However, the implementation was limited to the Develop stage, specifically expert validation, without conducting field trials or effectiveness testing. Through these systematic procedures, the research ensured that the developed Zingiberaceae book was scientifically accurate, linguistically appropriate, and pedagogically feasible as a contextual biology learning resource based on Sabang's local wisdom. The procedure is carried out through the following stages which are illustrated in Figure 1.

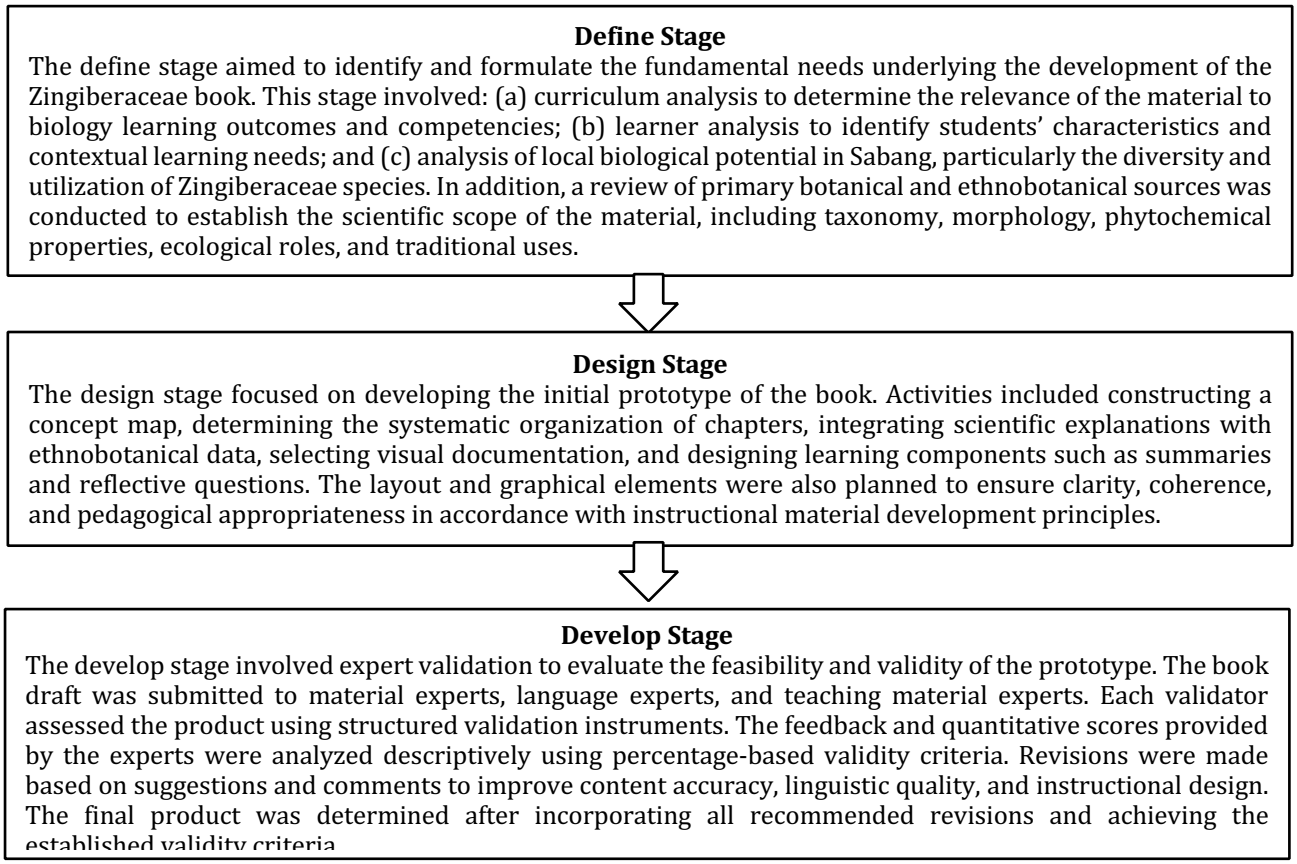

Figure 1. Research Procedures

Figure 1 illustrates the research procedures employed to develop the Zingiberaceae book based on Sabang's local wisdom, using the 4D Research and Development (R&D) model, which was limited to the Define, Design, and Develop stages. In the Define stage, the researchers conducted curriculum analysis, learner analysis, and exploration of the local biological potential of Zingiberaceae in Sabang to identify instructional needs and contextual learning relevance. The design stage focused on building the initial book prototype through concept mapping, systematic content organization, integration of scientific and ethnobotanical information, preparation of visual documentation, and development of learning components, such as summaries and reflective questions. Subsequently, the development stage involved expert validation by material experts, language experts, and teaching material experts to evaluate the scientific accuracy, linguistic clarity, instructional organization, and graphical presentation

of the product. The validation results and expert suggestions were used to revise and refine the final version of the book, ensuring its feasibility as a contextual biology learning resource.

Data Analysis Techniques

The data obtained in this study consisted of quantitative and qualitative data derived from expert validation sheets. Quantitative data were obtained from the scores given by material experts, language experts, and teaching material experts using a Likert-type rating scale. Qualitative data were obtained from written comments and suggestions provided by the validators to improve the developed product.

The quantitative data were analyzed descriptively using percentage-based validity analysis. The total score obtained from each validator was divided by the maximum possible score and multiplied by 100% to determine the level of validity. The resulting percentage values were then interpreted according to the predetermined validity criteria to assess the feasibility of the developed Zingiberaceae book as a contextual biology learning resource. The resulting percentages were then interpreted using predetermined validity criteria. The validity levels were categorized as follows: 81–100% (very valid), 61–80% (valid), 41–60% (moderately valid), 21–40% (less valid), and 0–20% (invalid). A product categorized as valid or very valid was considered feasible for use with minor or no revisions.

Meanwhile, qualitative data from expert suggestions were analyzed descriptively through data reduction, categorization, and interpretation. These data were used to refine the accuracy of content, clarity of language, instructional organization, and graphical presentation of the Zingiberaceae book. Revisions were conducted systematically based on the validators' recommendations to ensure that the final product met scientific, linguistic, and pedagogical standards. Through this analytical procedure, the study ensured *that* the developed teaching material achieved an acceptable level of validity and feasibility as a contextual biology learning resource based on Sabang's local wisdom. The analysis provided evidence regarding the scientific accuracy, linguistic quality, and instructional appropriateness of the developed book. Furthermore, the validation results served as the basis for determining whether the product was suitable for use as a contextual learning resource that integrates biological concepts with local ethnobotanical knowledge.

RESULTS AND DISCUSSION

The results of expert validation were analyzed using percentage-based validity criteria. The results of material expert validation, language expert validation, and teaching material expert validation are presented in Table 1.

Table 1
Overall Validation Results of the Zingiberaceae Book

No.	Type of Validation	Percentage (%)	Validity Category
1.	Material Expert	92%	Very Valid
2.	Language Expert	88%	Very Valid
3.	Teaching Material Expert	90%	Very Valid

Table 1 shows that the developed Zingiberaceae book obtained an overall average validity score of 90%, which is categorized as very valid. These findings indicate that the developed teaching material fulfills the criteria of scientific accuracy, linguistic clarity, and instructional feasibility. The high validation scores suggest that integrating botanical concepts with ethnobotanical knowledge from Sabang can be systematically organized into a contextual biology learning resource of high academic quality. Therefore, the results directly answer the research problem regarding the limited availability of scientifically validated local wisdom-based biology teaching materials.

The material expert validation score of 92% demonstrates that the content presented in the book is scientifically accurate and conceptually comprehensive, particularly in explaining taxonomy, morphology, phytochemistry, ecological roles, and ethnobotanical uses of Zingiberaceae. This finding indicates that the integration of local wisdom into biology learning does not merely function as cultural enrichment but also strengthens the scientific substance of the teaching material. The strong content validity reflects that ethnobotanical information derived from local communities can be reconstructed into formal scientific knowledge through systematic instructional development. This finding is consistent with Rachmawati et al. (2024), who reported that biology teaching materials developed from local biodiversity sources became more scientifically coherent and contextually meaningful when

supported by structured instructional organization. Similarly, Fajeriadi et al. (2025) emphasized that local potential-based biology learning resources improve conceptual understanding when grounded in validated scientific frameworks. In the present study, the high material validation score suggests that contextualization and scientific rigor are not mutually exclusive; rather, they complement each other to support meaningful biology learning.

The high instructional feasibility score obtained from teaching material experts (90%) further indicates that the organization of content, contextual integration, visual presentation, and learning components were pedagogically appropriate. The systematic arrangement of concepts, reflective questions, summaries, and ethnobotanical explanations enabled the teaching material to connect scientific concepts with students' real-life socio-cultural environments. This finding reinforces contextual learning theory, which emphasizes that knowledge becomes more meaningful when linked to authentic experiences and local realities (Rijal, 2021). In this context, integrating Sabang's local wisdom into the study of Zingiberaceae helps students understand plant biodiversity not only as abstract biological information but also as part of everyday cultural practices. Similar findings were reported by Sam & Maradhy (2024), who explained that teaching materials based on local potential became more pedagogically effective when organized through systematic instructional design. Keliat et al. (2025) also found that contextual science learning resources strengthened students' awareness of local environmental potential when aligned with instructional objectives. Therefore, the present findings indicate that contextualization functions not merely as an additional cultural element but as a pedagogically strategic approach that enhances instructional relevance and learning feasibility.

The linguistic validation score of 88% indicates that the scientific terminology, explanations, and cultural descriptions were presented coherently and communicatively. This result demonstrates that local ethnobotanical knowledge can be integrated into academic teaching materials without reducing clarity or scientific readability. The careful selection of terminology and the systematic organization of explanations contributed to balancing scientific language with contextual cultural narratives. This finding supports Fauzi et al. (2024), who emphasized that many local wisdom-based biology education studies still lack rigorous academic integration. The present study demonstrates that local wisdom-based content can achieve academic standards when supported by structured validation and careful editorial revision. Thus, the linguistic validity findings strengthen the argument that contextual teaching materials require not only scientific accuracy but also effective communication to ensure conceptual accessibility for learners.

From an ethnobotanical perspective, the findings of this study indicate a transition from descriptive ethnobotanical documentation toward instructional transformation. Previous studies such as Inta et al. (2023) and Panyadee et al. (2023) mainly focused on documenting the cultural uses and diversity of plants within local communities. Although such studies provided important biodiversity information, they did not transform the findings into structured educational products. In contrast, the present study systematically reconstructed ethnobotanical knowledge of Zingiberaceae into a validated instructional resource through the 4D development framework. This process demonstrates that local plant knowledge can function as an epistemologically valid component of biology education when integrated with scientific botanical analysis and pedagogical design. Consequently, the study extends ethnobotanical research from documentation-oriented exploration into education-oriented application.

The scientific validity confirmed in this study is also supported by previous botanical and phytochemical studies on Zingiberaceae. Research by Li et al. (2020) and Tan et al. (2020) provided important taxonomic and morphological foundations for understanding the structural characteristics of Zingiberaceae species, while Tran-Trung et al. (2024) and Zhao et al. (2021) highlighted the phytochemical and biological potential of this plant family. These scientific references strengthened the accuracy and conceptual depth of the developed book. Furthermore, ethnobotanical perspectives emphasizing the interaction between communities and plant biodiversity (Chen et al., 2024) support the contextual integration applied in this study. Therefore, the developed teaching material not only reflects cultural relevance but also maintains scientific legitimacy through integration with primary botanical knowledge.

Overall, the findings demonstrate that the developed Zingiberaceae book successfully bridges botanical science and local wisdom through systematic instructional development and expert validation. The study confirms existing theories of contextual learning and ethnobotanical education while extending them into the domain of structured teaching material development. The integration of

ethnobotanical verification and primary botanical analysis into the 4D model (Thiagarajan et al., 1974) strengthens the theoretical foundation of biodiversity-based contextual learning. The findings imply that biology teaching materials developed in biodiversity-rich regions should not only emphasize pedagogical design but also incorporate scientific validation and local knowledge reconstruction. Consequently, this study provides empirical evidence that local wisdom can be positioned as an academically credible and pedagogically feasible component of biology education.

The very high overall validity score (90%) indicates a strong potential effectiveness of the developed Zingiberaceae book as a contextual biology learning resource. The combination of high content validity (92%), instructional feasibility (90%), and linguistic quality (88%) suggests that the product has met the essential criteria for meaningful learning, including scientific accuracy, contextual relevance, readability, and pedagogical appropriateness. These characteristics are important determinants of instructional effectiveness because scientifically valid, contextually relevant learning resources are more likely to facilitate conceptual understanding and learner engagement. Furthermore, integrating ethnobotanical knowledge with botanical concepts provides authentic learning experiences that connect biodiversity content with students' socio-cultural environments, thereby supporting the principles of contextual learning and ethnopedagogy.

The findings are consistent with previous studies demonstrating the educational benefits of local wisdom-based teaching materials. Rofi'i et al. (2022) reported that an ethnobotany-based e-module grounded in Lombok local wisdom was not only highly valid but also effective in improving students' motivation and learning outcomes in biology learning. Similarly, Hidayat et al. (2024) found that a contextual science e-module integrated with local wisdom achieved high effectiveness, reflected by an N-Gain score of 0.83 and significant improvement in students' critical thinking skills. In addition, Dewi and Ramadan (2021) demonstrated that local wisdom-based teaching materials possessed high feasibility and contributed positively to the quality of contextual learning experiences. Compared with these studies, the present research contributes a distinctive perspective by focusing specifically on the ethnobotanical and biological dimensions of Zingiberaceae from Sabang and transforming them into an expert-validated instructional book. Therefore, although effectiveness testing remains necessary in future studies, the high validity results obtained in this research provide strong preliminary evidence that the developed book has substantial potential to support meaningful, contextual, and culturally responsive biology learning.

In summary, this study's findings demonstrate that integrating ethnobotanical knowledge and scientific botanical concepts through a systematic instructional development process can produce a contextual biology learning resource with high academic and pedagogical feasibility. The developed Zingiberaceae book not only functions as a valid instructional material but also represents an effort to preserve and scientifically reconstruct local wisdom within formal biology education. Through the integration of contextual learning principles, ethnobotanical perspectives, and expert validation, this study confirms that local biodiversity has strong potential to become a meaningful and scientifically credible foundation for biology learning. Therefore, the study contributes both theoretically and practically to the development of contextual, biodiversity-based, and culturally responsive biology education.

CONCLUSION

This study successfully developed and validated a Zingiberaceae book based on Sabang's local wisdom as a contextual biology learning resource using the 4D development model, limited to the validation stage. The validation results demonstrated that the product achieved a very valid category, with material expert validation reaching 92%, language expert validation 88%, and teaching material expert validation 90%, resulting in an overall average validity score of 90%. These findings indicate that the developed book fulfills the criteria of scientific accuracy, linguistic clarity, contextual relevance, and pedagogical feasibility. The study also demonstrates that ethnobotanical knowledge can be systematically transformed into a scientifically credible instructional resource through structured instructional design and expert validation. The integration of taxonomy, morphology, phytochemistry, ecological roles, and ethnobotanical utilization of Zingiberaceae provides a meaningful contextual learning experience that connects biological concepts with students' socio-cultural environments. The implications of this study suggest that local biodiversity and indigenous knowledge have strong potential to enrich biology education through culturally responsive and context-based learning

resources. In addition, this research contributes theoretically to the development of contextual biology education by strengthening the integration of ethnobotany, ethnopedagogy, and biodiversity-based instructional design. In practice, the developed book can serve as an enrichment resource to support meaningful biology learning and the preservation of local wisdom, while future studies are recommended to conduct effectiveness testing and dissemination to evaluate its impact on students' conceptual understanding, ecological awareness, and conservation attitudes.

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