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Development of a Nature Exploration Based Plantae Module Utilizing Home Garden Medicinal Plants for High School Students

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A B S T R A C T

Teacher distribution inequality remains a major challenge to achieving equitable and high-quality education in Indonesia. Schools in urban areas generally experience a surplus of teachers, whereas 3T regions (frontier, outermost, and disadvantaged areas) face shortages of qualified educators. This study analyzes teacher distribution policies and their implementation in Indonesia during 2010–2025 and evaluates government interventions to reduce disparities. The study employs a Systematic Literature Review (SLR) guided by the PRISMA 2020 protocol, covering identification, screening, eligibility, and inclusion. A total of 31 relevant scientific articles were thematically analyzed using educational human resource management and public policy perspectives. The findings indicate that civil servant redistribution, PPPK recruitment, and Dapodik have supported the development of evidence-based policymaking. However, implementation remains constrained by uneven institutional capacity, teacher resistance to assignments in remote areas, and limited inter-agency coordination. Recent research also shows a shift toward strengthening educational information systems and using digital data for teacher workforce planning. The study concludes that equitable teacher distribution requires integration of national policies, local government capacity, and a humanistic approach grounded in social justice.

1. Introduction

Interactive activities form the essence of a learning process. These activities engage individuals to acquire knowledge, skills, and positive values by utilizing various learning resources. (Aria, R., Liani, N. S., & Rahmi, 2026) defines learning resources as all components available or systematically modified to support educational instruction. In the classroom context, teaching materials hold a crucial

position. Teachers design these structured learning resources to help students assimilate academic information. (Famulaqih & Lukman, 2024) state that developing teaching materials aims to make instructional dynamics more effective, meaningful, and engaging for students. A module represents a systematic and structured independent teaching material.(Puspitasari et al., 2021) show that using print or electronic instructional modules correlates positively with strengthening student learning independence in secondary education. In Indonesia, module integration now adapts to the Merdeka Curriculum framework. According to Sukmanasa et al. (2025) this framework simplifies the management of culturally responsive teaching modules to achieve sustainable educational development. Furthermore, contextual teaching materials that integrate local environmental resources are strongly encouraged because they promote meaningful learning experiences and improve students' ability to connect scientific concepts with their daily lives (Sabilla et al., 2026). Therefore, developing biology modules based on local potential is highly relevant to support the implementation of the Merdeka Curriculum (Waluyo et al., 2026).

Empirical facts in the field confirm that innovative teaching devices based on real environments are still very limited. Observations and interviews at SMAN 1 Pademawu revealed that biology instruction for the Kingdom Plantae topic still relies on one-way lectures. It depends entirely on textbooks or student worksheets that tend to be theoretical. Agustina et al. (2022) state in a biology pedagogy analysis that overly abstract learning models trigger cognitive barriers for students. Students struggle to master botany concepts due to the burden of memorizing Latin nomenclature and a lack of real visualization. The rural ecosystem of Madura holds rich biodiversity in the form of herbal vegetation cultivated for generations in domestic areas. However, this valuable local potential has not been integrated into biology learning as a contextual learning resource. Previous ethnobotanical studies by Muryanto et al. (2023) and Agustina et al. (2022) primarily focused on documenting medicinal plant diversity and its benefits for society, while their educational potential as learning resources for Plantae has received limited attention. This condition indicates a research gap that needs to be addressed through the development of innovative teaching materials (Prayudi et al., 2025). Responding to these conditions, teachers and students at SMAN 1 Pademawu show great enthusiasm for developing a learning module that integrates the surrounding environment as a concrete natural laboratory.

Integrating the Nature Exploration approach into the Plantae material learning module offers a strategic solution to overcome this instructional gap. Putra. (2021) explains that the approach is a pedagogical strategy focusing on utilizing the students' real environment including physical, social, and cultural aspects as a biology study object whose phenomena are explored directly. Implementing teaching materials with content is empirically proven to reduce learning boredom, foster independence, and optimize cognitive outcomes and student science process skills (Royani et al., 2023). Wikanta et al. (2021) strengthen this argument by stating that biology modules integrated with significantly boost student learning activity because they are applicable outside the classroom. However, previous studies generally applied the approach to biodiversity and ecosystem topics,

whereas its implementation in Plantae learning through the exploration of family medicinal plants remains limited. This study offers a novel contribution by integrating the approach with locally available as contextual learning resources. Through direct observation of medicinal plants, students are expected to understand plant classification, morphological characteristics, biological functions, and the importance of local biodiversity more meaningfully while simultaneously strengthening environmental awareness and appreciation of local wisdom. Based on these considerations, the objective of this study is to develop and evaluate the feasibility of a Nature Exploration based biology learning module utilizing family medicinal plants for teaching Plantae to senior high school students. Furthermore, this study seeks to provide an alternative contextual teaching material that supports the implementation of the Merdeka Curriculum by integrating local wisdom into biology learning and promoting meaningful exploration of students' surrounding environment.

2. Methodology

This study employed a Research and Development (R&D) method using the 4-D development model proposed by Thiagarajan et al. (1974), which consists of four sequential stages: Define, Design, Develop, and Disseminate. This model was selected because it provides systematic procedures for developing educational products through needs analysis, product design, expert validation, product revision, and product dissemination. The study was conducted at SMAN 1 Pademawu, Pamekasan, Indonesia. The research subjects consisted of two material expert lecturers, two media expert lecturers, two biology teachers, and sixteen Grade X students who participated in the limited field trial. The overall development procedures referred to Waruwu (2024).

Define Stage

The Define stage aimed to identify instructional problems and determine the needs for developing a biology learning module by Damayanti et al. (2024). This stage included front end analysis through classroom observations and interviews with biology teachers, learner analysis to identify students' characteristics and prior knowledge, curriculum analysis based on the learning outcomes of the Kurikulum Merdeka, concept analysis to determine the scope of Plantae material, and formulation of learning objectives. The results showed that biology learning on Plantae still relied primarily on textbooks and student worksheets, while contextual teaching materials utilizing local environmental resources, particularly Family Medicinal Plants, had not yet been developed. These findings became the basis for developing a Nature Exploration based biology learning module.

Design Stage

The Design stage involved preparing the initial draft (Draft I) of the biology learning module. The module was designed using Microsoft Word and Canva and consisted of a cover page, preface, table of contents, concept map, learning

objectives, Plantae learning materials, student worksheets based on the Nature Exploration approach, observation activities, formative tests, glossary, and references. Learning activities were designed according to the Nature Exploration approach by encouraging students to directly observe and identify Family Medicinal Plants found in their surrounding environment.

Research Instruments

The research instruments consisted of material expert validation questionnaires, media expert validation questionnaires, biology teacher response questionnaires, and student response questionnaires. The instruments were developed based on the module evaluation criteria proposed by Akbar (2013) and adapted to the objectives of this study, the learning outcomes of the Kurikulum Merdeka, the Plantae content, and the characteristics of the developed Nature Exploration based biology learning module. The material expert validation questionnaire consisted of 43 assessment indicators distributed into four aspects, namely content feasibility (15 indicators), language (10 indicators), presentation (12 indicators), and motivational value (6 indicators). The instrument was assessed by two material expert lecturers to evaluate the accuracy, completeness, relevance, clarity, and suitability of the module content with the Plantae learning objectives.

The media expert validation questionnaire consisted of 27 assessment indicators covering three aspects, namely graphical appearance (12 indicators), presentation (10 indicators), and technical feasibility and usability (5 indicators). The instrument was assessed by two media expert lecturers to evaluate the visual quality, layout, readability, consistency, and technical usability of the developed module. The biology teacher response questionnaire consisted of 32 assessment indicators covering four aspects, namely content suitability (8 indicators), presentation (8 indicators), language (9 indicators), and graphical appearance (7 indicators). The questionnaire was completed by two biology teachers to assess the practicality, suitability, and applicability of the developed module in biology learning. Meanwhile, the student response questionnaire consisted of 24 assessment indicators covering five aspects, namely ease of use (5 indicators), attractiveness (6 indicators), readability (5 indicators), learning motivation (4 indicators), and overall response (4 indicators). The questionnaire was administered to 16 Grade X students after they completed the learning activities using the developed module. All instruments used a four point rating scale. The assessment indicators were formulated and adapted to the research objectives, Plantae learning content, assessment aspects, and characteristics of the Nature Exploration based biology learning module.

Instrument Validity and Reliability

Before being used for data collection, the research instruments were examined for content validity through expert judgment. The validity assessment focused on the relevance, clarity, representativeness, and suitability of each assessment item to the research objectives and the intended assessment aspects. The material and media validation instruments were reviewed by the appointed experts, and their

suggestions and comments were used to revise unclear, inappropriate, or less relevant items before the instruments were used in the study. This procedure was conducted to ensure that the assessment indicators adequately represented the aspects being measured. The reliability of the expert validation assessment was examined using the Percentage of Agreement (PA) method proposed by Borich (1994). The analysis was used to determine the consistency of the assessments provided by the two validators. The Percentage of Agreement was calculated using the following formula:

$$PA = \left(1 - \frac{A - B}{A + B}\right) \times 100\%$$

Where:
PA : Percentage of Agreement
A : The higher score given by one validator
B : The lower score given by the other validator

According to Borich (1994), a Percentage of Agreement value of at least 75% indicates an acceptable level of agreement between validators.The Percentage of Agreement analysis was conducted to examine the consistency between the validator assessments before the feasibility scores were interpreted. The results of the content validity review and Percentage of Agreement analysis were used to support the quality and credibility of the validation process. Thus, expert judgment was used to examine the content validity of the assessment instruments, while Percentage of Agreement was used to determine the consistency of the expert assessments.

Develop Stage

The Develop stage focused on evaluating and refining the initial module through expert validation and limited field testing. The initial draft was first validated by two material expert lecturers and two media expert lecturers. The comments and suggestions obtained from the validators were used to revise the module, including improving scientific terminology, refining the presentation of learning materials, improving illustrations, adding Plantae classification diagrams, and improving layout consistency. After the revision process, a limited field trial was conducted involving two biology teachers and sixteen Grade X students of SMAN 1 Pademawu. The trial was implemented during two learning meetings, each lasting approximately 90 minutes. During the first meeting, students studied the Plantae material using the developed module and activities based on the Nature Exploration approach. During the second meeting, students conducted direct observations of Family Medicinal Plants available in the school and home environments, identified plant morphological characteristics, classified the observed plants, recorded the findings in the provided worksheets, and discussed the results with the teacher. After completing all learning activities, the students completed the student response questionnaire, while the biology teachers completed the teacher response

questionnaire to evaluate the practicality and applicability of the module in classroom instruction.

Disseminate Stage

The Disseminate stage was conducted on a limited scale by reproducing and distributing the revised module to biology teachers at SMAN 1 Pademawu. The final module was introduced as an alternative contextual teaching material to support the implementation of the Merdeka Curriculum through biology learning integrated with local wisdom. Since this study focused on product feasibility, dissemination was limited to SMAN 1 Pademawu and did not include wider implementation in other schools (Najuah 2020).

Data Analysis

The quantitative data obtained from expert validation, biology teacher responses, and student responses were analyzed using descriptive percentage analysis. The feasibility percentage was calculated using the following formula:

$$P=\frac{\sum x}{\sum xi}\ x\ 100\%$$

where P is the feasibility percentage, ∑x is the total score obtained from all respondents, and ∑xi is the maximum possible score. In addition, the Percentage of Agreement values obtained from the expert validators were used to determine the consistency of the validator assessments before the feasibility scores were interpreted. The accumulated feasibility percentage was interpreted according to the product evaluation criteria proposed by Akbar (2013). Products obtaining scores above 80% were categorized as "Highly Feasible", scores between 61% and 80% as "Feasible", scores between 41% and 60% as "Moderately Feasible", whereas scores below 40% indicated that the product required substantial revision before implementation.

3. Results and Discussion

Results of the Define Phase

The Define phase was conducted to identify the instructional problems, learner needs, curriculum requirements, and local environmental potential that would become the basis for developing the biology learning module. Data were collected through classroom observations, interviews with biology teachers, and analysis of the Kurikulum Merdeka learning outcomes for the Plantae topic. The results of the preliminary study revealed that biology learning at SMAN 1 Pademawu was still dominated by teacher-centered instruction using textbooks and student worksheets. Consequently, students tended to memorize scientific concepts and plant nomenclature without directly observing plant characteristics in their surrounding

environment. This condition reduced students' learning motivation and limited their understanding of the relationships between biological concepts and everyday life.

Curriculum analysis indicated that the learning outcomes of the Merdeka Curriculum emphasize contextual learning experiences that encourage students to investigate biological phenomena through direct observation. Therefore, the developed module was designed to integrate the Nature Exploration approach with the utilization of family medicinal plants as authentic learning resources. The concept analysis identified 15 commonly cultivated medicinal plant species found in the Madurese community, including ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), Javanese ginger (*Curcuma xanthorrhiza*), aromatic ginger (*Kaempferia galanga*), lemongrass (*Cymbopogon citratus*), Andrographis paniculata, and several other locally available medicinal plants. These species were selected because they are easily accessible to students and represent examples that support the learning objectives of the Plantae topic.

Based on the results of the needs assessment, the developed module covers Plantae classification, plant morphology, identification of vegetative and reproductive organs, characteristics of major plant divisions, and the biological functions of medicinal plants. In addition, the module introduces secondary metabolites, including alkaloids, flavonoids, tannins, and saponins, together with their medicinal properties supported by previous scientific findings (Husna et al., 2022). These materials were integrated with field observation activities so that students could directly identify medicinal plants in their home or school environments. The findings obtained during the Define phase confirmed the necessity of developing a contextual biology learning module that connects scientific concepts with students' local environments. The identified instructional needs subsequently became the foundation for designing a Nature Exploration based biology module utilizing Family Medicinal Plants in the next development stage.

Results of the Design Phase

The Design phase focused on developing the initial prototype of the based biology learning module based on the instructional needs identified during the Define stage. The module was systematically designed to support the achievement of the Merdeka Curriculum learning outcomes while integrating local environmental resources, particularly family medicinal plants, into Plantae learning. The preparation of the module began by organizing the learning objectives, learning activities, and assessment strategies according to the principles of contextual learning. Subsequently, the instructional materials were arranged following the scientific structure of the Plantae topic, including plant classification, morphological characteristics, plant reproduction, ecological roles, and the utilization of medicinal plants in everyday life. These concepts were enriched with authentic photographs of medicinal plants collected from the surrounding environment to provide students with concrete learning experiences.

The developed module consisted of several components, including the front cover, preface, table of contents, concept map, learning objectives, learning materials,

student worksheets, observation guidelines, formative evaluation questions, glossary, answer key, and references. Each learning activity was designed according to the Nature Exploration approach by encouraging students to conduct direct observations, identify plant characteristics, classify medicinal plants, and discuss the biological functions of the observed species. To facilitate students' learning, the module also incorporated observation sheets, reflection activities, discussion questions, and independent evaluation tasks. These learning components were expected to promote active learning, scientific inquiry, and independent study while strengthening students' understanding of the Plantae concepts through direct interaction with biological objects found in their surrounding environment. The overall development process of the biology learning module followed the four stages of the 4-D development model. The implementation of each development stage is illustrated in Figure 1.

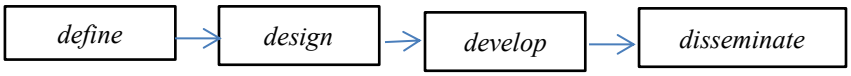

Figure 1. Development Process Flow

As shown in Figure 1, the Design phase produced the first prototype of the biology learning module, which subsequently underwent expert validation during the Develop stage. The initial draft served as the basis for evaluating the module's content quality, visual appearance, language clarity, and instructional practicality before it was implemented in classroom learning.

Results of the Develop Phase

Material Expert Validation

The Develop phase began with expert validation to evaluate the quality and feasibility of the initial module prototype before it was implemented in classroom learning. Material validation was conducted by two biology education lecturers who possessed expertise in biology content and instructional material development. The evaluation aimed to determine the appropriateness of the module in terms of scientific accuracy, language clarity, presentation, and its potential to motivate students during learning. The quantitative results of the material expert validation are presented in Table 1.

Table 1. Feasibility Assessment Results by Material Experts

No	Feasibility Component	Score Material Expert 1	Score Material Expert 2
1	Content/Material	52	49
2	Language	34	31
3	Visual and Presentation	41	39
4	Motivation	23	22
Total	Total Score (Σx)	150	141
Percentage	P=(Σx/Σxi)×100%	87.20%	81.97%
Average	Average Feasibility Percentage	-	84.58% (Highly Feasible)

As shown in Table 1, the first material expert awarded a feasibility score of 87.20%, while the second material expert awarded 81.97%. The average feasibility score obtained from both validators was 84.58%, indicating that the developed biology module falls within the Highly Feasible category according to the feasibility criteria proposed by Akbar (2013). These findings indicate that the module has met the fundamental requirements of content validity and is suitable for implementation after minor revisions. The validation results also demonstrated that each assessment aspect achieved satisfactory scores. The content feasibility aspect received a high evaluation because the learning materials were consistent with the learning outcomes of the Kurikulum Merdeka and adequately represented the essential concepts of the Plantae topic. The language aspect was considered appropriate because the explanations were scientifically accurate and understandable for senior high school students. Likewise, the presentation aspect received positive evaluations due to the systematic organization of learning materials, illustrations, and learning activities. Furthermore, the motivational aspect indicated that the module has the potential to encourage students to actively participate in learning through direct observation of family medicinal plants using the Nature Exploration approach.

Among the evaluated aspects, the content feasibility aspect obtained the highest score because the learning materials were highly consistent with the learning outcomes of the Merdeka Curriculum and accurately represented the concepts of Plantae. Meanwhile, the language aspect obtained a relatively lower score compared with the other aspects, indicating the need for improvements in sentence effectiveness, terminology consistency, and scientific writing conventions, particularly in the use of binomial nomenclature. Although the overall feasibility category was classified as Highly Feasible, both material experts provided several constructive suggestions to further improve the quality of the module. The recommendations included standardizing the writing of scientific names according to binomial nomenclature rules, adding a classification diagram illustrating the three major divisions of Kingdom Plantae (Bryophyta, Pteridophyta, and Spermatophyta), including the local Madurese names of each medicinal plant to strengthen the contextual learning approach, and simplifying the explanation of the ecological and economic roles of Plantae into concise bullet points to improve readability. These suggestions were carefully accommodated during the revision process before proceeding to the next stage of product evaluation.

The implementation of these revisions improved both the scientific accuracy and instructional quality of the developed module. The inclusion of classification diagrams provided clearer conceptual relationships among plant groups, whereas the addition of local plant names strengthened the integration of local wisdom into biology learning. Moreover, simplifying several explanations into bullet points enhanced students' reading efficiency and facilitated independent learning, which is one of the primary characteristics of an effective learning module. The results of the revision process revealed several differences between the initial product development and the improved version. These differences were identified based on feedback from media experts, biology teachers, and student trials, particularly in terms of visual design, content accuracy, layout structure, and overall usability. The

improvements made were aimed at enhancing the quality and feasibility of the learning media for classroom implementation. The comparison of these changes is presented in the following table.

Table 2. Differences Between Initial Development and Revision

Initial Design	After Revision	Remarks
		The classification of the Kingdom Plantae has been added.
		The role of Plantae in life is highlighted as a key point.
		

Based on the comparison between the initial design and the revised version, several improvements were made to enhance the clarity and completeness of the learning media. In the revised design, the classification of Kingdom Plantae was added to provide more structured biological content and to support students' conceptual understanding. In addition, the roles of Plantae in daily life were emphasized and presented in point form to make the information easier to read and more accessible for learners. These revisions aimed to improve content organization, increase readability, and strengthen the instructional value of the material

Media Expert Validation

The media validation was conducted by two media expert lecturers to evaluate the quality of the developed module in terms of graphical appearance, presentation, and

technical feasibility. The assessment focused on the visual design of the module, page layout, typography, image quality, consistency of formatting, and overall usability. The quantitative results of the media expert validation are presented in Table 3.

Table 3. Feasibility Assessment Results by Media Experts

No	Feasibility Component	Score Media Expert 1	Score Media Expert 2
1	Appearance and Graphics	38	49
2	Presentation	60	31
3	Feasibility/Implementation	8	39
Total	Total Score (Σx)	106	141
Percentage	P=(Σx/Σxi)×100%	98.19%	87.03%
Average	Average Feasibility Percentage		92.61% (Highly Feasible)

As shown in Table 3, the first media expert awarded a feasibility score of 98.19%, while the second media expert awarded 87.03%. The average feasibility percentage obtained from both validators was 92.61%, indicating that the developed biology module belongs to the Highly Feasible category according to the feasibility criteria proposed by Akbar (2013). These findings demonstrate that the module possesses an appropriate visual appearance and can effectively support biology learning. The validation results also indicated that each assessment aspect received positive evaluations. The appearance and graphics aspect obtained a high score because the module employed an attractive cover design, relevant illustrations, and appropriate color combinations that enhanced students' interest in learning. The presentation aspect was considered systematic because the learning materials, activities, and supporting components were arranged in a logical sequence, making the module easier to follow. Furthermore, the technical feasibility aspect showed that the typography, page layout, image placement, and overall organization of the module supported readability and facilitated independent learning.

Although the module was categorized as Highly Feasible, the media experts provided several suggestions for improvement. These included improving the consistency of page layouts, refining the placement and proportion of several illustrations, adjusting font sizes to improve readability, and enhancing the organization of several learning components. All recommendations were implemented during the revision process to improve the visual quality and instructional effectiveness of the module before it was used in the limited field trial. The implementation of these revisions resulted in a more organized module with improved visual consistency and readability. The revised layout enabled students to follow the learning materials more easily, while the improved illustrations strengthened the connection between biological concepts and the surrounding environment. Consequently, the revised module became more attractive, user-friendly, and suitable for supporting contextual biology learning based on the Nature Exploration approach. The graphical appearance aspect achieved the highest score due to the attractive cover design, relevant illustrations, and appropriate color combinations. In contrast, the technical feasibility aspect obtained comparatively

lower scores because several improvements were required regarding layout consistency, image proportion, and typography readability.

Biology Teacher Response Assessmen

The practicality of the developed biology module was further evaluated through responses from two biology teachers at SMAN 1 Pademawu. The teacher response assessment aimed to determine the suitability of the module for classroom implementation in terms of content accuracy, instructional presentation, language, visual appearance, and overall usability. The quantitative results of the biology teacher response assessment are presented in Table 4.

Table 4. Results of Biology Teachers' Response Test to the Product

No.	Assessment aspect	Score
1	Logical flow of concepts	3
2	Alignment of illustrations with the material	3
3	Presentation of text, images, and reference sources	3
4	Table of contents	3
5	Concept map	3
6	Content/Material	3
7	Summary	3
8	Bibliography	3
9	Breadth of material	4
10	Relevance of material	4
11	Accuracy of facts and concepts	3
12	Correctness of scientific name formatting	3
13	Accuracy of illustrations and learning resources	3
14	Suitability of examples and references	3
15	Contextual relevance	3
16	Connection between content explanation and examples	3
17	Alignment with students' cognitive development level	3
18	Language style that encourages communicative thinking	3
19	Appropriate use of communicative sentences	4
20	Clarity of sentences	4
21	Correct use of punctuation	3
22	Engaging language style	3
23	Correct sentence structure	3
24	Correct use of terminology	3
25	Consistency in terminology usage	3
26	Suitability of cover design	3
27	Title color contrasts with the background	3
28	Appropriateness of font, illustrations, format, and images	3
29	Ability of images to convey the meaning of the subject	3
30	Accurate and proportional shapes reflecting reality	3
30	Harmonious presentation of illustrations	3
31	Creative and dynamic	3
	Total Score (Σx)	98
	P = (Σx/Σxi) × 100%	100%

As shown in Table 4, the developed module obtained a 100% feasibility score, indicating that it was categorized as Highly Feasible according to the feasibility criteria proposed by Akbar (2013). This result demonstrates that the module is

appropriate for classroom implementation without requiring major revisions. The assessment showed that the module performed well across all evaluated aspects. High scores were obtained for the organization of concepts, suitability of illustrations, presentation of learning materials, concept maps, summaries, and reference lists, indicating that the module effectively supports students in understanding the Plantae topic. In addition, the teachers provided the highest scores for the breadth and accuracy of the learning materials, the use of communicative language, and the clarity of sentence construction, suggesting that the module is appropriate for the cognitive level of senior high school students.

The visual aspects of the module also received positive evaluations. The cover design, typography, image quality, color selection, and overall layout were considered attractive and capable of supporting students' interest in learning. Furthermore, the contextual presentation of family medicinal plants through the Nature Exploration approach was regarded as relevant to students' daily experiences, enabling them to connect biological concepts with their surrounding environment. In addition to the quantitative assessment, the biology teachers provided positive qualitative feedback regarding the developed module. They stated that the module was attractive, communicative, innovative, and practical for classroom use. The outdoor observation activities integrated into the module were considered effective in encouraging students to learn independently while improving their observation skills and active participation during biology learning. Overall, the teacher responses indicate that the developed module has high instructional practicality and is suitable for supporting the implementation of the Merdeka Curriculum through contextual biology learning based on local wisdom.

Student Response Trial

A limited field trial was conducted involving 16 Grade X students at SMAN 1 Pademawu to evaluate the practicality, readability, attractiveness, and usability of the developed biology module. The trial was carried out during two learning sessions, in which students used the module to study the Plantae topic through the Nature Exploration approach. During the learning activities, students observed family medicinal plants found in the school and home environments, identified their morphological characteristics, classified the observed plants, completed the observation worksheets provided in the module, and discussed their findings with the teacher. After completing all learning activities, each student independently completed the response questionnaire. The quantitative results of the student response trial are presented in Table 5.

Table 5 . Student Response Scores for the Product

No.	Quantity	Percentage	Category
1	91	91%	Highly Suitable
2	96	96%	Highly Suitable
3	93	93%	Highly Suitable
4	96	96%	Highly Suitable
5	94	94%	Highly Suitable
6	82	82%	Highly Suitable

7	81	81%	Highly Suitable
8	75	75%	Suitable
9	94	94%	Highly Suitable
10	93	93%	Highly Suitable
11	90	90%	Highly Suitable
12	90	90%	Highly Suitable
13	90	90%	Highly Suitable
14	95	95%	Highly Suitable
15	87	86%	Highly Suitable
16	76	76%	Suitable
	Average Percentage	**89,36%**	Highly Suitable

As shown in Table 4, the individual student response scores ranged from 75% to 96%**,** with an average feasibility percentage of 89.36%**,** indicating that the developed module was categorized as Highly Feasible according to the feasibility criteria proposed by Akbar (2013). Most students gave very positive responses, while only two students rated the module in the Feasible category. Overall, these findings indicate that the module was well accepted by students and could be effectively used as a contextual teaching material in biology learning. The high response scores suggest that the developed module successfully met students' learning needs. Students considered the module easy to understand because it presented learning materials systematically using communicative language supported by relevant illustrations and authentic photographs of family medicinal plants. The integration of the Nature Exploration approach also enabled students to directly observe biological objects in their surrounding environment, making the learning process more meaningful and engaging than conventional classroom instruction.

The qualitative responses further supported the quantitative findings. Most students reported that the module increased their motivation to learn because it connected the concepts of Plantae with medicinal plants that they frequently encountered in their home gardens. They also stated that the observation activities helped them better understand plant classification, morphological characteristics, and the biological functions of medicinal plants through direct experience rather than memorizing theoretical concepts alone. These findings indicate that the developed module possesses high practicality and has the potential to facilitate meaningful biology learning based on local environmental resources.

Discussion

The findings of this study demonstrate that the developed biology learning module utilizing family medicinal plants through the Nature Exploration approach is highly feasible for implementation in senior high school biology learning. The consistently high feasibility scores obtained from material experts, media experts, biology teachers, and students indicate that the module satisfies the essential characteristics of effective teaching materials, including content validity, visual quality, practicality, and readability. According to Khasanah (2021) an effective learning module should fulfill the principles of self-instruction, selfcontained, stand-alone, adaptive, and user-friendly teaching materials. The developed module fulfills these

characteristics by providing complete learning content, systematic learning activities, clear learning objectives, contextual examples, and evaluation activities that enable students to learn independently (Tarigan et al., 2026).

One of the major contributions of this study is the integration of the Nature Explorationapproach with the utilization of family medicinal plants as contextual learning resources for the Plantae topic. Unlike conventional biology instruction, which often emphasizes memorization of scientific names and plant classification, the developed module encourages students to directly observe, identify, classify, and analyze medicinal plants available in their surrounding environment. Through these authentic learning experiences, students are able to relate abstract biological concepts to real biological objects encountered in everyday life. Direct observation of medicinal plants also helps students recognize morphological characteristics, distinguish plant divisions, understand plant functions, and appreciate the importance of local biodiversity. Therefore, the approach not only improves conceptual understanding but also strengthens students' environmental awareness and appreciation of local wisdom (Wulandari et al., 2025).

These findings are consistent with previous studies conducted by Herayana (2020) and Ule (2021) which reported that based biology learning increases students' motivation, learning participation, and learning outcomes. However, the present study extends these findings by demonstrating that the approach can also be effectively implemented through the exploration of family medicinal plants, a learning resource that has received relatively limited attention in previous biology education research. Consequently, this study contributes to expanding the application of beyond biodiversity and ecosystem topics toward contextual learning of the Plantae concept. The utilization of family medicinal plants as learning resources also supports contextual and meaningful learning. Students do not merely study plant classification from textbooks but directly investigate medicinal plants cultivated in their home gardens and school environments. This learning process enables students to connect scientific knowledge with local community practices regarding the use of medicinal plants. Similar findings have been reported by Afrianto, 2025; Halhaji & Suryadarma, 2022; Nayaka et al. (2023) who concluded that local biodiversity possesses considerable potential as a contextual learning resource capable of strengthening biology learning and preserving local knowledge.

The observation activities integrated into the module also contribute to the development of students' scientific literacy and science process skills. Through direct observation, recording of field data, classification of plant specimens, and group discussions, students actively construct biological knowledge based on empirical evidence rather than relying solely on memorization (Alfian. 2022). This finding supports the results reported by Lestari (2025), who found that learning activities involving authentic environmental problems significantly improve students' scientific literacy. (Aly, 2022; Ilhamdi et al., 2022) eported that outdoor learning activities facilitate deeper conceptual understanding because students directly interact with biological objects and phenomena.

Furthermore, the collaborative observation activities implemented during the field exploration encouraged students to communicate scientific findings, exchange ideas, and solve problems cooperatively. These learning experiences are consistent with the findings of (Lestari & Irsadi, 2025) and (Rahimanisa et al., 2025) who reported that the JAS approach promotes collaboration, communication skills, and science process skills through direct environmental exploration. Therefore, the developed module not only supports cognitive learning outcomes but also facilitates the development of essential twenty first entury skills required in biology education (Aritonang et al. 2024;Harefa et al 2024).

Despite the positive findings, this study has several limitations. First, the implementation of the module was limited to one senior high school with a relatively small number of participants; therefore, the generalizability of the findings should be interpreted cautiously. Second, the availability and diversity of family medicinal plants may differ across regions. This variation may affect the types of plants that students can observe and identify during the Nature Exploration activities. Consequently, teachers may need to adjust the observation activities and examples in the module according to the medicinal plants available in the local environment without changing the main learning objectives. Third, the successful implementation of the Nature Exploration approach requires teachers to be adequately prepared to organize outdoor learning activities, manage students during environmental exploration, and guide them in observing and identifying plant characteristics. Limited teacher preparation may reduce the effectiveness of these activities and restrict students' opportunities to engage in direct exploration. In addition, schools with limited access to green spaces, school gardens, or local medicinal plant resources may face practical constraints when implementing the observation activities. Differences in environmental conditions, availability of learning resources, and school facilities may therefore require adaptation of the learning activities to suit the local context. These limitations indicate that the broader implementation of the module should consider regional biodiversity, teacher readiness, school facilities, and environmental conditions to ensure that the Nature Exploration activities remain relevant and feasible in different educational settings.

The findings of this study also have important practical implications for biology education. The developed module may serve as an alternative contextual teaching material to support the implementation of the Merdeka Curriculum, particularly in promoting student-centered learning, contextual learning, and the integration of local wisdom into biology instruction. The module can be adapted to the availability of family medicinal plants and environmental conditions in different schools, allowing teachers to connect Plantae concepts with locally relevant biological resources. Future studies are recommended to examine the effectiveness of the module in improving students' learning outcomes, scientific literacy, science process skills, critical thinking skills, and environmental attitudes through broader implementation involving different schools and learning environments.

4. Conclusion

This study successfully developed a Nature Exploration based biology learning module utilizing family medicinal plants for the Plantae topic through the systematic implementation of the 4-D development model. The findings indicate that the developed module fulfills the criteria of a valid and highly feasible teaching material for senior high school biology learning based on evaluations from material experts, media experts, biology teachers, and students. Practically, the developed module can be used as an alternative contextual teaching material to support the implementation of the Merdeka Curriculum in senior high schools by integrating local environmental resources and local wisdom into biology instruction. The module provides opportunities for students to engage in student-centered learning through direct exploration of family medicinal plants in their surrounding environment. This learning approach enables students to develop a more meaningful understanding of plant classification, morphology, and biological functions while fostering environmental awareness and appreciation of local biodiversity and local wisdom. Since this study focused primarily on evaluating the feasibility of the developed product, future research is recommended to examine the effectiveness of the module in improving students' learning outcomes, science process skills, scientific literacy, critical thinking skills, and environmental attitudes through experimental studies involving larger samples, different schools, and diverse environmental contexts. Such studies are expected to provide stronger empirical evidence regarding the educational impact and broader applicability of the developed module.

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References

Afrianto, W. F. (2025). Ethnobotanical Documentation of Home Gardens in Relation to Javanese Basic Life Needs in Kediri District, East Java, Indonesia. Asian Journal of Ethnobiology. *Asian Journal of Ethnobiology*, *8*(1), 79–91. https://doi.org/10.13057/asianjethnobiol/y080107

Agustina, N., Hutauruk, T. J. W., Sulistyaningrum, N., Yudhanto, S. M., Liza, N., Kusumaningrum, L., Sugiyarto, Yasa, A., Saensouk, S., Naim, D. M., & Setyawan, A. D. (2022). Diversity of the Medicinal Plant in Homegarden of Local Communities in the Coastal Area of Prigi Bay, Trenggalek, East Java, Indonesia. *Biodiversitas*, *23*(12), 6302–6312. https://doi.org/10.13057/biodiv/d231226

Alfian, M. (2022). Penerapan Augmented Reality (Tanaman Obat Keluarga) TOGA sebagai Media Pembelajaran Berbasis Android dengan Metode Marker. *Jurnal Informatika Dan Rekayasa Perangkat Lunak*, *3*(1), 77–85. https://doi.org/10.33365/jatika.v3i1.1863

Aly, I. B. (2022). Pengaruh Model Pembelajaran Jelajah Alam Sekitar (JAS) terhadap Penguasaan Konsep Siswa Kelas VIII MTs-Al-Farabi Wasilei Selatan Kabupaten Halmahera Timur. *JBES: Journal of Biology Education and Science*, *2*(1), 25–35. https://jurnal.isdikkieraha.ac.id/index.php/jbes/article/view/297

Aria, R., Liani, N. S., & Rahmi, R. (2026). Pengembangan Bahan Ajar Interaktif Flipbook Berbasis Literasi Sains untuk Melatih Keterampilan Berpikir Kritis Siswa pada Kurikulum Merdeka. *Panthera: Jurnal Ilmiah Pendidikan Sains Dan Terapan*, *6*(2), 869–879. https://doi.org/10.36312/panthera.v6i2.1098

Aritonang, U. D., Nusantari, E., Hamidun, M. S., Husain, I., & Usman, N. F. (2024). Pengembangan E-Modul Biologi Metode Jelajah Alam Sekitar (JAS) Berbantuan Flipbook Maker pada Materi Perubahan Lingkungan di Sekolah Menengah Atas. *Didaktika: Jurnal Kependidikan*, *13*(4), 4803–4814. https://doi.org/10.58230/27454312.1252

Famulaqih, S., & Lukman, A. (2024). Pengembangan Bahan Ajar Modul Pembelajaran. *Jurnal Riset Ilmu Pendididkan Islam*, *1*(2), 01–12. https://ejournal.aripafi.or.id/index.php/Karakter/article/view/156

Halhaji, P. N., & Suryadarma, I. G. P. (2022). Ethnobotanical Investigation of Medicinal Plants of Serawai Tribe in Bengkulu as a Potential of Biology Teaching Materials. *Biosfer: Jurnal Pendidikan Biologi*, *1*(15), 62–75. https://doi.org/10.21009/biosferjpb.22462

Harefa, M. S., Arbiansyah, A., Fazera, D., Siboro, L. P. P., Fadilah, R., Nasution, T. W., & Utami, W. A. (2024). Identifikasi Faktor-Faktor Penyebab Kerusakan Wilayah Pengembangan Konservasi Mangrove di Wilayah Pesisir Paluh Merbau. *Jurnal Manajemen Pesisir Dan Laut*, *2*(1), 35–43. https://doi.org/10.36841/mapel.v2i01.4515

Herayana, H., Hadi, K., & Syamsu, F. D. (2020). Pengembangan Modul Biologi Berbasis Pendekatan Jelajah Alam Sekitar (JAS) untuk Meningkatkan Hasil Belajar Siswa pada Materi Keanekaragaman Hayati di Kelas X SMA Negeri 1 Kaway XVI. *Bionatural*, *7*(1), 61–74. https://ejournal.uncm.ac.id/index.php/bio/article/view/775

Huda, N., & Hermina, D. (2024). Pengolahan Hasil Non-Test Angket, Observasi, Wawancara dan Dokumenter. *Student Research Journal*, *2*(3), 259–273. https://doi.org/10.55606/srjyappi.v2i3.1343

Husna, P. A. U., Kairupan, C. F., & Lintong, P. M. (2022). Tinjauan Mengenai Manfaat Flavonoid pada Tumbuhan Obat sebagai Antioksidan dan Antiinflamasi. *EBiomedik*, *10*(1), 76–83. https://doi.org/10.35790/ebm.v10i1.38637

Ilhamdi, M. L., Hasanah, N., & Syazali, M. (2022). Penerapan Pendekatan Jelajah Alam Sekitar untuk Meningkatkan Penguasaan Konsep Ekosistem Siswa. *Jurnal Pengabdian Magister Pendidikan IPA*, *5*(3), 252–258. https://doi.org/10.29303/jpmpi.v5i3.2165

Khasanah, I., & Nurmawati, I. (2021). Pengembangan Modul Digital sebagai Bahan

Ajar Biologi untuk Siswa Kelas XI IPA. *Indonesian Journal of Mathematics and Natural Science Education*, *2*(1), 34–44. https://doi.org/10.35719/mass.v2i1.57

Lestari, J. I., & Irsadi, A. (2025). Penerapan Pendekatan Jelajah Alam Sekitar untuk Meningkatkan Keterampilan Kolaborasi Siswa Kelas VII E SMP Negeri 21 Semarang. In *Seminar Nasional Pendidikan dan Penelitian Tindakan Kelas*. https://proceedings.unnes.ac.id/snpptk/article/view/3219

Muryanto, B. S., Hidayat, S., Yasa, A., & Setyawan, A. D. (2023). Ethnobotany of Medicinal Plants in Homegarden of Menoreh Karst Area, Purworejo District, Indonesia. *Asian Journal of Ethnobiology*, *6*(15), 174–184. https://doi.org/10.13057/asianjethnobiol%2Fy060208

Najuah, N., Lukitoyo, P. S., & Wirianti, W. (2020). Modul Elektronik: prosedur penyusunan dan aplikasinya. In *Modul Elektronik: Prosedur Penyusunan dan Aplikasinya*. https://digilib.unimed.ac.id/id/eprint/49006/

Nayaka, N. M. D. W., Kusuma Yuda, P. E. S., Sanjaya, D. A., Ernawati, D. K., & Cahyaningsih, E. (2023). Ethnobotanical Study of Medicinal Plant Usage during COVID-19 Pandemic: A Community-Based Survey in Indonesia. *Biotropia*, *2*(30), 1784. https://doi.org/10.11598/btb.2023.30.2.1784

Prayudi, A., Supriyaddin, S., Burhanuddin, B., Akhirwan, A., & Rasul, A. (2025). Development of Learning Object Materials for Multimedia Learning Integrated with Dompu Local Wisdom for Students. *Journal of Educational Sciences*, *9*(5), 3922–3934. https://doi.org/10.31258/jes.9.5.p.3922-3934

Puspitasari, I., Nurfiana, G., Sari, F., & Indrayati, A. (2021). Pemanfaatan Tanaman Obat Keluarga (TOGA) sebagai Alternatif Pengobatan Mandiri. *Jurnal Warta LPM*, *24*(3), 456–465. http://journals.ums.ac.id/index.php/warta

Putra, S. H. J. (2021). Pendekatan Jelajah Alam Sekitar (JAS): Dampaknya terhadap Aktivitas dan Hasil Belajar Kognitif Siswa SMP. *Journal of Natural Science and Integration*, *4*(2), 204. https://doi.org/10.24014/jnsi.v4i2.10030

Rahimanisa, F., Khalil, M., & Artikel, I. (2025). Implementasi Pendekatan Jelajah Alam Sekitar Terintegrasi Project-Based Learning untuk Meningkatkan Keterampilan Proses Sains Biologi. *Biodik: Jurnal Ilmiah Pendidikan Biologi*, *11*(2), 341–350. https://online-journal.unja.ac.id/biodik

Royani, I., Imran, A., & Dharmawibawa, I. D. (2023). Pengembangan Bahan Ajar Biologi Berbasis Jelajah Alam Sekitar (JAS) Berorientasi pada Keterampilan Proses Sains Siswa dan Hasil Belajar Siswa Kelas X SMA. *Bioscientist : Jurnal Ilmiah Biologi*, *11*(2), 1903. https://doi.org/10.33394/bioscientist.v11i2.9713

Sabilla, A. L., & Prayitno, H. J. (2026). Exploring Meaningful Learning Experiences Through the Use of Digital Technology in Indonesian Language Learning in Grade IV of Muhammadiyah 1 Elementary School in Surakarta. *Journal of Educational Sciences*, *10*(2), 2990–3008. https://doi.org/10.31258/jes.10.2.p.2990-3008

Sukmanasa, E., Novita, L., Suhardi, E., Prawira, A. Y., & Maesya, A. (2025). Management of Teaching Modules Based on Culturally Responsive Teaching Toward Education for Sustainable Development. *Journal of Biology Education, Science & Technology*, *8*(1), 11–28. https://jtlee.ejournal.unri.ac.id/index.php/JTLEE/article/view/43

Tarigan, A. T. S. B., Siswanto, S., Silaban, R., & Sutiani, A. (2026). Needs Analysis for Developing Ethnoscience-Integrated Project-Based Learning Chemistry Teaching Materials Supported by Digital Video on Macromolecule Topics in Senior High School. *Journal of Educational Sciences*, *10*(6), 338–350. https://doi.org/10.31258/jes.10.6.p.338-350

Ule, K. N., Bunga, Y. N., & Bare, Y. (2021). Pengembangan Modul Pembelajaran Biologi Berbasis Jelajah Alam Sekitar (JAS) Materi Ekosistem Taman Nasional Kelimutu (TNK) SMA Kelas X. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, *5*(2), 147–156. https://doi.org/10.33369/diklabio.5.2.147-156

Waluyo, E. H., & Wibowo, U. B. (2026). Evaluation of the Implementation of the Pancasila Student Profile Strengthening Project at SMK Negeri 2 Yogyakarta, SMK 5 Negeri Yogyakarta, and SMK Negeri 6 Yogyakarta. *Journal of Educational Sciences*, *10*(2), 2671–2695. https://doi.org/10.31258/jes.10.2.p.2671-2695s

Waruwu, M. (2024). Metode Penelitian dan Pengembangan (R&D): Konsep, Jenis, Tahapan dan Kelebihan. *Jurnal Ilmiah Profesi Pendidikan*, *9*(2), 1220–1230. https://doi.org/10.29303/jipp.v9i2.2141

Wikanta, Asy'ari, & Juniawan. (2021). Study of 21st-Century Skill Improvement for Prospective Biology Teacher Students Through the Lesson Study (LS) Model. *Jurnal Pendidikan Biologi*, *12*(3), 146–157. http://jurnal.unimed.ac.id/2012/index.php/JPB

Wulandari, S., Suwondo, S., & Husna, R. A. (2025). Implementation of an Education for Sustainable Development (ESD)-Based Electronic Module to Improve Critical Thinking Skills and Environmental Awareness Among Students in the Wetland Ecology Course. *Journal of Educational Sciences*, *9*(6), 5192–5205. https://doi.org/10.31258/jes.9.6.p.5192-5205

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