Development of a Reference Book on the Charm of Macroscopic Fungi in Lubuklinggau Based on Exploration of the Surrounding Nature to Strengthen SDG-Oriented Learning

Reny Dwi Riastuti[1*], Mareta Widiya[1]

[1] Department of Biology Education, Faculty of Science and Technology, PGRI Silampari University, Lubuklinggau, Indonesia.

Abstract: The teaching of plant taxonomy in Indonesia still faces limitations in the availability of teaching materials that are relevant to local conditions, requiring the development of contextual learning resources that are appropriate to local potential and meaningful. This study addresses the scarcity of specialized, locally relevant teaching materials for the Lower Plant Taxonomy course. We developed a reference book, "The Charm of Macroscopic Fungi in Lubuklinggau," to serve as a valid, practical, and effective teaching aid. This resource uses a nature exploration approach to connect students with local biodiversity, reinforcing learning aligned with Sustainable Development Goals (SDGs), specifically targets 4 (Quality Education) and 15 (Life on Land). The research employed a Research and Development (R&D) method using the 4-D model (Define, Design, Develop, Disseminate). Expert validation confirmed the book's quality, with subject matter experts rating it "excellent" (score: 34), and media and language experts rating it "good" (scores: 39 and 34, respectively). Pilot testing on students showed the book's effectiveness in improving understanding, with normalized gain (N-gain) scores predominantly in the moderate to high categories. Our findings demonstrate that integrating local ecological potential and active learning strategies, such as nature exploration, is an effective way to improve biology education while promoting sustainability.

Keywords: Macroscopic fungi; Nature exploration; Reference books; SDGs

Introduction

Macroscopic fungi are a fundamental component of the Earth's ecosystems, playing a vital role in forest ecosystems as primary decomposers that recycle organic nutrients and maintain environmental balance (Afrita et al., 2021; Julian et al., 2024). Fungi are essential for recycling organic nutrients and maintaining environmental balance. Fungi are primary decomposers, breaking down organic matter and recycling nutrients back into (Slot, 2018). They form mycorrhizal associations with plants, enhancing nutrient uptake and supporting plant health (Niskanen et al., 2023), Fungi can detoxify contaminated environments, demonstrating their potential in environmental restoration.

These ecological functions highlight their universal scientific value, underscoring their importance in global

biogeochemical cycles. Fungi represent a vast and largely unexplored realm of biodiversity. Estimates suggest there are 2.5 million fungal species, with over 90% yet to be described (Niskanen et al., 2023). Fungal diversity is a key indicator of ecosystem health, reflecting environmental changes (Slot, 2018).

In addition to its ecological functions, the diversity of mushroom species, both edible and potentially medicinal, makes mushrooms an interesting topic for research and education. Lubuklinggau, with its abundant biodiversity, has great potential to become a natural laboratory for the exploration of macroscopic fungi, which has not been fully optimized in the context of higher education (Sepriyaningsih & Nopiyanti, 2024) Although research on the diversity of macroscopic fungi based on the surrounding nature has developed, there has been no research related to the development of a reference book specifically based on nature

exploration to strengthen SDG-oriented student learning.

Fungal species diversity serves as an important indicator of ecosystem health and offers potential for new discoveries in the fields of medicine and biotechnology. Fungi face threats from habitat loss and climate change, but conservation efforts remain limited (Mueller & Allen, 2023). Therefore, the study and conservation of fungal biodiversity are crucial for global sustainability.

The diversity of macroscopic fungi in Indonesia, particularly in the Lubuklinggau region, shows great potential as a source of local knowledge and biodiversity that needs to be preserved. Various recent studies in the last five years reveal that the types and diversity of macroscopic fungi in the Lubuklinggau region are quite high, with dozens of species found, including edible, medicinal, and poisonous fungi (Afrita et al., 2021; Sepriyaningsih & Nopiyanti, 2024). Fungi play an important role in the ecosystem as decomposers and also contribute to the local economy as food and traditional medicine (L. . Anggraini et al., 2021; Mohammad et al., 2024).

The extraordinary diversity of macroscopic fungi in areas such as Lubuklinggau, Indonesia, presents significant opportunities for scientific research and education. In regions such as Lubuklinggau, Indonesia, this fungal biodiversity is a rich source of local knowledge and has significant potential for educational applications. A study conducted by (Fitriani & Krisnawati, 2019) has identified 32 species of macroscopic fungi in 4 classes and 16 families in Lubuklinggau, conducted by (Afrita et al., 2021) identified 17 macroscopic fungal species in the Curug Embun Waterfall area of Lubuklinggau. The study (Lestari & Febrianti, 2018) in Purwodadi Regency revealed 10 species from the order Polyporales. Research (Triyanti et al., 2022) in the Pelawau waterfall tourist area identified 13 species from 4 orders, 12 families, and 12 genera.

Recent studies have revealed a large number of macroscopic fungal species in the area, including edible, medicinal, and toxic varieties. Fungi not only play a crucial ecological role but also contribute to the local economy and traditional medicine. This makes the study of fungi an interesting topic for university-level courses, such as Lower Plant Taxonomy, where students can connect theoretical knowledge with practical examples in the real world.

Despite the rich fungal biodiversity in Lubuklinggau and its potential for education, there is a significant gap in locally contextual teaching materials. Existing resources are often too general, failing to highlight the specific flora and fauna of the region, which makes it difficult for students to connect theoretical concepts with their local environment. This lack of relevant material leads to non-contextual learning, hindering students' ability to apply what they learn in the field. Furthermore, modern education must integrate the principles of the Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education) and Goal 15 (Life on Land), to foster ecological awareness and a sense of responsibility in students. There is an urgent need for innovative teaching materials that bridge the gap between theory, local biodiversity, and global sustainability goals.

Existing teaching materials are often general in nature and do not specifically address local resources, making them less relevant to biology students in the region (Sukirno et al., 2020). This lack of contextual learning often makes it difficult for students to connect theory with reality in the field (Rhyan, 2020). On the other hand, the issue of Sustainable Development Goals (SDGs), particularly point 4 s on Quality Education, point 15 on Life on Land, and point 17 on Partnerships for the Goals, demands innovation in learning that integrates environmental and sustainability aspects. The integration of SDGs in education is key to producing graduates who not only master theory but also have ecological awareness and are able to make real contributions to environmental conservation (Nurfatimah et al., 2022).

The SDGs aim to equip students with a holistic understanding of social and environmental responsibility (Haidar et al., 2024). This approach not only improves the quality of education academically, but also instills the values of diversity, 21st-century life skills, and ecological awareness that are important for facing global challenges such as climate change and environmental degradation (Puspitasari, 2025). Therefore, innovative and locally-based teaching materials are needed to bridge the gap between theory and practice and to implement SDG values in learning. Several previous studies have shown the importance of using teaching materials based on local wisdom (Arjaya et al., 2024; Febrian et al., 2024; Monica et al., 2021; Yusni et al., 2023).

Research by (Azmi et al., 2023; Fitriani & Krisnawati, 2019; Johanes J.Y.P.I et al., 2025; Santuti et al., 2025), focused on developing teaching materials based on local potential in their respective regions, but did not integrate learning in SDGs. In addition, most of the previous studies have not explicitly integrated the nature exploration approach as an active learning method to strengthen SDG-oriented learning. This approach allows students to learn directly from nature, observe and identify fungi in their natural habitat, which ultimately strengthens their conceptual understanding and taxonomic skills. Furthermore, although many studies have discussed the integration

of SDGs in learning, there has been no research that combines these three important elements as a whole: local macroscopic fungi, the nature exploration approach, and SDG orientation in one specific teaching material product, namely a reference book. The uniqueness of this research lies in its systematic effort to fill this gap by developing a reference book that combines the beauty of Lubuklinggau's macroscopic fungi with nature exploration learning, which is explicitly aimed at achieving SDG goals.

Although previous studies have explored the use of locally-based teaching materials and the integration of SDGs into education, no study has systematically combined these three important elements: the rich diversity of macroscopic fungi in Lubuklinggau, the nature exploration approach, and an explicit orientation towards SDGs. The novelty of this study lies in its unique attempt to fill this gap by developing a special reference book. The reference book is based on the results of previous research conducted by the researcher and team, as well as by other lecturers and students. This book is designed to serve as a practical tool for active learning, allowing students to directly observe, identify, and understand the ecological role of fungi in their natural habitat. This research has two main objectives: first, to develop a valid and practical reference book on the macroscopic fungi of Lubuklinggau for higher education; and second, to analyze the effectiveness of this book in improving student understanding and instilling values related to environmental conservation and sustainable resource use in line with the SDGs. This research aims to prove that integrating local ecological potential with active learning methods can significantly improve the quality of biology education.

Method

Research Time and Location

This research was conducted from November 2024 to June 2025 at PGRI Silampari University, specifically in the Biology Program. This research was carried out in Lubuklinggau, South Sumatra, which served as the research context and source of local biodiversity described in the reference book developed.

Research Type and Method

This research used a Research and Development (R&D) approach, specifically using the 4-D model by (Thiagarajan, 1974). The R&D method was chosen not only to create a valid and practical product, a reference book entitled "The Charm of Macroscopic Fungi in Lubuklinggau," but also to systematically test its effectiveness in improving student learning outcomes

and raising awareness of the Sustainable Development Goals (SDGs).

Research Stage

The development process followed the four stages of the 4-D Model, namely Define, Design, Development, and Disseminate (Thiagarajan, 1974), as follows.

1. Define Stage

This stage involves needs analysis through literature review and field observation to identify student learning needs and available local resources. This includes preliminary studies of the course and its participants to establish a clear framework for the reference book.

2. Design Stage

A preliminary design of the reference book is created. This includes the design of the book's content, proposed learning activities (nature exploration), and the development of evaluation tools (validation questionnaires and pre- and post-tests). This design is then consulted with experts.

3. Development Stage

The initial design of the reference book is created and then validated by subject matter, media, and language experts. Based on their feedback, the book is revised. Limited trials are conducted with small groups of students to refine the product before broader field testing.

4. Dissemination Stage

The finalized reference book was implemented in the "Lower Plant Taxonomy" course. Data on its effectiveness was collected through a wider field test. The final product and research findings were disseminated to biology education study programs and other relevant institutions to encourage wider use of locally-based teaching materials oriented towards the Sustainable Development Goals (SDGs).

Sample Population

The research population included all students enrolled in the Plant Taxonomy course in the Biology Study Program at PGRI Silampari University. A purposive sample of 46 students was selected for this study.

Data Analysis

Data were collected using various instruments, including direct observation, in-depth interviews,

validation questionnaires, and pre- and post-tests. Data analysis was conducted in three main parts:

1. Validity and Practicality Analysis:

Expert Validation: Data from subject matter experts, media, and language experts were analyzed to determine the validity of the book. The average score was calculated using Formula 1.

$$X = \frac{\Sigma\, x}{N} \tag{1}$$

(Lovisia & Febrianti, 2025)

Explanation:

X = average score

Σx= the sum of the scores given by each rater for a particular component

N = number of assessors

The results were then compared with the five-category Likert scale validation criteria (Table 1), which determined whether the product met the minimum classification of "adequate" (C) for feasibility.

Table 1. Mean Component Score with Criteria

Formula	Value	Criteria
$X > \overline{Xi} + 1.8 \times sbi$	A	Very good
$\overline{Xi} + 0.6 \times sbi < X \le \overline{Xi} + 1.8 \times sbi$	B	Good
$\overline{Xi} - 0.6 \times sbi < X \le \overline{Xi} + 0.6 \times sbi$	C	Simply
$\overline{Xi} - 1.8 \times sbi < X \le \overline{Xi} - 0.6 \times sbi$	D	Less
$X < \overline{Xi} - 1.8 \times sbi$	E	Very Less

(Widoyoko, 2019)

Description

$\overline{Xi}$ (Ideal average) $= \frac{1}{2}$ (ideal max score+ideal min score)

sbi (ideal standard deviation) $= \frac{1}{6}$ (ideal max score - ideal min score)

Student Responses: Student practicality responses were analyzed using a Likert scale. The response percentage was calculated using Formula 2.

$$P = \frac{f}{N} x100\% \tag{2}$$

Description:

P = Percentage of questionnaire data

f = Total score obtained

N= Maximum number of scores

The percentage is then converted to a qualitative category (Table 2), with a minimum classification of "adequate" required for the product to be considered practical.

Table 2. Student Response Assessment Score Guidelines

Negative Statement Responses	Score	Positive Statement Responses	Score
Strongly Agree	1	Strongly Agree	4
Agree	2	Agree	3
Disagree	3	Disagree	2
Strongly disagree	4	Strongly disagree	1

2. Effectiveness Analysis:

The effectiveness of reference books in improving student understanding was measured by comparing pre-test and post-test scores using the normalized gain (N-gain) formula:

$$N - \text{gain} = \frac{Posttest\,score - Pretest\,score}{Smaximum - Pretest\,score} \tag{3}$$

Description:

Pre-test Score = score before using the module

Posttest Score = score after using the module

Smaximum = maximum score

In converting the learning effectiveness score, the following guidelines are used:

Table 3. Criteria for SDG-Oriented Learning Reinforcement

N-gainvalue	Criteria
$g \ge 0.7$	High
$0.3 \le g \le 0.7$	Medium
$g \le 0.3$	Low

3. *Qualitative Data Analysis:*

Data from interviews and observations were used to provide a deeper understanding of the quantitative results and to describe the learning process and student engagement with new teaching materials.
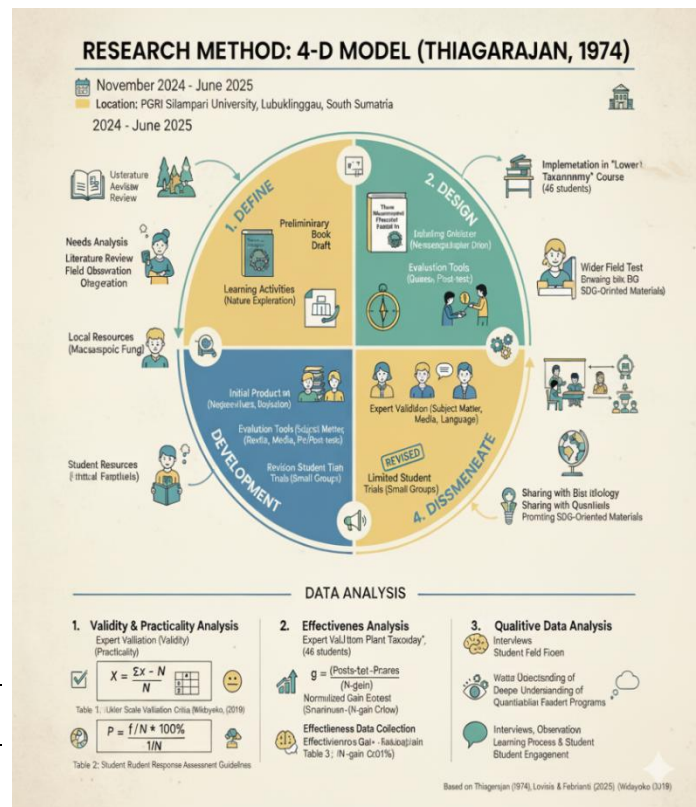

Figure 1. Research Method: 4-D Model (Thiagarajan,1974)

Results and Discussion

Subject Matter Experts

Before the Lubuklinggau macroscopic fungi reference book was used in the learning trial, initial product validation was carried out by subject matter experts. Validation by subject matter experts was conducted to assess the accuracy of concepts, depth of content, and suitability of the material in the reference book with the Semester Learning Plan (RPS) and the results of student needs analysis. This assessment was very important to ensure that the reference book developed contained accurate, relevant content that was in line with the objectives of the Lower Plant Taxonomy course, especially on the topic of macroscopic fungi. The input obtained from the subject matter expert was then used as the basis for revisions to improve the content of the book so that it would be suitable and effective for use in the learning process. The following presents the results of the subject matter expert's validation of the reference book that had been developed.

Table 4. Data on the Results of Expert Validation

Statement	Score
The content of the book is relevant to the basic competencies and learning objectives.	5
The material presented is accurate, up-to-date, and in line with scientific developments.	5
The material is presented in a systematic and coherent manner in accordance with academic standards.	3
The examples and illustrations used in the book reinforce conceptual understanding.	4
The material presents contextual information.	4
The book contains scientific references.	5
The material in the book is able to integrate learning reinforcement oriented towards the SDGs.	4
The material is comprehensive and does not leave out any key topics.	4
Σx	34
Criteria	Very Good

Based on the assessment results of the aspects listed in the subject matter expert validation sheet, the validators provided a number of suggestions for improving the Lubuklinggau Macroscopic Mushrooms reference book that had been developed. These suggestions include: the presentation of material needs to be organized systematically and coherently in accordance with applicable academic standards, and the learning orientation that integrates Sustainable Development Goals (SDGs) in the material needs to be strengthened to increase its relevance and contribution to sustainable learning.

Media Expert

Validation by media experts was carried out to evaluate the feasibility of the design, appearance, and readability of the module to meet quality standards in terms of presentation, aesthetics, and ease of use for students. The validation process was carried out in detail to ensure that the reference book could be optimally accepted by the target users. The results of this validation were then used as a basis for revisions and improvements before the book was implemented in a limited trial phase. The following presents the results of the media expert's assessment of the reference book that has been developed.

Table 5. Media Expert Validation Results Data

Statement	Score
Reference book design	4
Reference book content layout	4
Combination of text color and background color	4
Image and illustration quality	3
Combination of visual elements (graphs, tables, illustrations)	4
Information presented	5
Has visual appeal	4
Consistency in the use of layout and overall design elements	3
Instructions for using reference books	4
Book presentation media	4
Σx	39
Criteria	Good

In addition to assessing the aspects listed in the validation sheet, the media validator also provided several suggestions for improvement during the revision stage to perfect the reference book Pesona Jamur Makroskopis Lubuklinggau (The Charm of Macroscopic Mushrooms in Lubuklinggau). These suggestions include: 1) the image quality in the book should use HD resolution to ensure visual sharpness and clarity, 2) the combination of visual elements such as graphics, tables, and illustrations must be designed to support the clarity and coherence of the book's content as a whole. Improvements in these aspects are expected to strengthen the appeal and effectiveness of the reference book as an informative and easy-to-understand learning medium for students.

Language Expert

In addition to being validated by subject matter experts and media experts, this reference book also underwent a validation process by language experts who assessed linguistic aspects, including readability, clarity of sentences, appropriateness of terminology, and language structure. This validation was important to ensure that the reference book was easy for students

to understand and to avoid any multi-interpretations that could cause confusion. Input from language experts is then used as a basis for improving sentence structure and information presentation to comply with the rules of proper and correct Indonesian. The following presents the results of language expert validation of the reference book that has been developed.

Table 6. Language Expert Validation Results Data

Statement	Score
The language used in the book is in accordance with the rules of proper and correct Indonesian	3
Sentences are structured effectively and efficiently	4
Grammar and spelling in the book are consistent	3
Use of technical terms accompanied by explanations	4
Sentence structure in the book is proportional	4
Use of communicative language appropriate for students	4
There is consistency between the language style and the purpose and characteristics of the scientific reference book	4
Clear and unambiguous communication of information	4
Use of punctuation in the book	4
Σx	34
Criteria	Good

In addition to the aspects assessed in the questionnaire, the language validator also provided a number of suggestions to improve the quality of the Pesona Jamur Makroskopis Lubuklinggau reference book through the revision process. Some of the suggestions included: thoroughly reviewing each sentence because there were still instances of capital letters in the middle of sentences, words that were cut off without spaces, sentences that did not end with a period, and scientific terms that should have been italicized but were not consistently applied.

Development Trial

After the Pesona Jamur Makroskopis Lubuklinggau reference book was declared suitable as a learning medium based on the validity test results from experts, the next stage was to conduct a development trial. This trial aimed to refine the reference book that had been developed to make it easier for users to use. This trial was categorized into three levels of ability, namely high, medium, and low. Students were asked to fill out a suggestion sheet provided in each sub-chapter of the macroscopic mushroom material taught. The following are suggestions provided by students based on their ability category: 1) Students with high ability suggested increasing the depth of explanation and providing examples of real applications in the local context; 2) Students with medium ability provided

feedback on the need to add supporting images and simpler language; 3) Students with low proficiency suggested improvements to the layout to make it neater and the addition of a glossary of terms to facilitate understanding.

Testing of the developed reference book.

The testing was carried out by involving two groups, namely a small group and a large group. The small group consisted of 9 students who had taken the Lower Plant Taxonomy course. The selection criteria for this small group took into account a variety of abilities, namely 3 students with high abilities, 3 students with moderate abilities, and 3 students with low abilities. The trial on the small group was conducted first as an initial stage before continuing to the trial on the large group. Meanwhile, the large group consisted of 46 students majoring in Biology Education at PGRI Silampari University who were currently taking the Low Plant Taxonomy course.

Small Group Trial.

The small group trial involved 9 students with varying levels of ability, namely high, moderate, and low. The selection of student samples was based on their grades in the Lower Plant Taxonomy course to ensure representation of the variation in ability. The selected students were then asked to read, study, and understand the contents of the reference book Pesona Jamur Makroskopis Lubuklinggau (The Charm of Macroscopic Fungi in Lubuklinggau) thoroughly. During this process, they were also asked to provide feedback on the suitability and ease of use of the book as learning material.

Based on the presentations from the nine students with different abilities, there were various suggestions and responses to the reference book that had been studied, including: 1) High-ability students suggested that the material in the reference book be deepened with more detailed explanations and the addition of case studies relevant to the local context; 2) Students with moderate abilities suggested simplifying the language used to make it easier to understand and adding illustrations to support conceptual understanding; 3) Students with low abilities suggested that the layout of the book be made neater, with the addition of a glossary of important terms to reinforce understanding. All suggestions and feedback from students regarding the reference book were systematically recorded on a provided instrument sheet as evaluation material for improving the book.

The purpose of providing suggestions on the developed reference book is to refine and improve the product so that it can be used in accordance with the

needs and expectations of students, taking into account input from several experts before the product is implemented in large groups. The small group trial phase provided constructive suggestions regarding the presentation of material, language appropriateness, and more attractive and easy-to-understand visualizations. Therefore, the developed product received positive responses and was declared suitable for use and further testing in large groups.

Large Group Trial

The large group trial phase was conducted on 46 Biology Education students who were taking the Low Plant Taxonomy course. After the reference book was declared feasible based on validation from experts and trials in small groups, the product was then trialed in large groups. This large group trial aimed to measure the practicality of the learning module that had been developed in the context of real use in the classroom.

Sustainable Development Goals (SDGs) Values

After the Pesona Jamur Makroskopis Lubuklinggau reference book was applied in the learning process, student learning outcomes were measured through a pretest and posttest. This measurement aimed to assess the effectiveness of the

reference book in improving learning reinforcement oriented towards Sustainable Development Goals (SDGs). The learning outcome data was then analyzed and presented in graph form to facilitate the interpretation of the improvements that occurred. The following is a graph of the N-gain of using reference books in supporting SDG-oriented learning reinforcement on Macroscopic Fungi material.
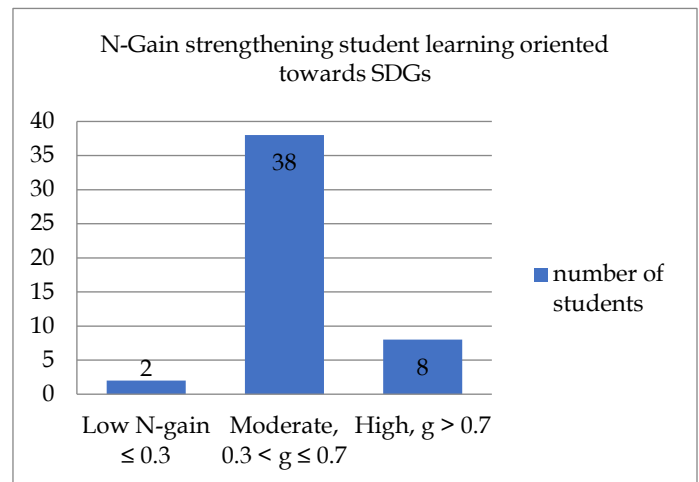

Figure 2. Strengthening SDG-oriented learning

Figure 3. The developed reference book

The graph (Figure 2) shows the distribution of students based on their "N-gain" scores, which are categorized into three levels: low, medium, and high. Overall, this graph can be interpreted to mean that the reference book is effective because most students show good improvement (in the medium and high categories), with only a small portion experiencing minimal improvement. Figure 3 is a preview of the revised reference book.

Discussion

Based on the validation results, the reference book "Pesona Jamur Makroskopis Lubuklinggau" has excellent feasibility. Assessments from experts in the fields of material, media, and language have evaluated this book and given strong approval, meaning that this reference book is suitable for use.

Subject Matter Experts

Specifically, based on the calculation of the assessment results by subject matter experts, it can be seen that the X score is 34 which is converted to an achievement level in the range of X > 33.54 with a very good criterion. Therefore, the validation results for the Lubuklinggau Macroscopic Mushroom Charm reference book received a "very good" rating. The material expert validation shows that the book's content is highly relevant to basic competencies, aligned with current scientific developments, and supports learning oriented toward the Sustainable Development Goals (SDGs), particularly Quality Education (Goal 4) and Life on Land (Goal 15).

This is in line with the findings (Faturrahman et al., 2024; Farihah et al., 2023; Sufaati et al., 2024; Sary et al., 2023). Overall, these findings confirm that the potential of this fungus as a source of contextual teaching material is also very large, especially in supporting sustainable education, because in addition to its ecological value, fungi are also useful in the pharmaceutical and food sectors.

Media Expert

Validation by media experts gave a value of X equal to 39. When converted to an achievement level in the range of $34.02 < X \leq 42.06$, it received a "good" rating. Thus, the results of the media expert validation of the Lubuklinggau macroscopic mushroom reference book received a "good" rating. The media expert also provided important input to improve the visual aspects. These improvements include increasing the image resolution and adjusting the layout to be more consistent, which ultimately enhances the effectiveness of the book as an attractive and easy-to-understand learning medium in accordance with the principles of developing teaching materials based on local wisdom.

This validation has a significant impact on the effectiveness of reference books as learning media that can reinforce SDG-oriented learning for students, in accordance with the principles of developing teaching materials that prioritize local values and education and sustainable development. Various studies show that after revisions based on expert input, the quality of local wisdom-based learning media has improved significantly, both visually and linguistically, making the material more communicative and supporting a fun and meaningful learning process in the classroom, (Aditya & Handayani, 2024; Cahya, 2023; Dwinando et al., 2020; Ekowati et al., 2025); Sonia et al., 2024).

Language Experts

Language experts assess linguistic aspects including readability, sentence clarity, appropriate use of terminology, and language structure. This validation aims to ensure that the book's content can be easily understood by students without causing confusing multiple interpretations.

Validation by language experts gave a score of 34. When converted to a achievement level in the range of $30.6 < X \leq 37.8$, it received a "good" rating. Therefore, the results of the linguistic validation of the Lubuklinggau Macroscopic Mushroom Reference Book meet the criteria for "good." The validator also provided important suggestions for improving several shortcomings, such as checking capital letters in the middle of words, words that are cut off in sentences without spaces, sentences that do not end with a period, and consistency in the writing of scientific terms with italics. This input became the basis for the author to make revisions so that the reference book not only meets linguistic standards but also conveys information clearly and accurately in accordance with the rules of good and correct Indonesian, thereby improving the quality and professionalism of the book as open material.

Linguistic validation is very important in the development of teaching materials. This is especially important to ensure the quality of the language, so that the material is easy to read and understand, and there is consistency in the use of technical terms (Arsya Ramadhani et al., 2024; Mechwafanitiara Cantika et al., 2024; Roman-Acosta, 2024; Surip et al., 2023; Devaki, 2024)

Reference Book Testing

After the reference book "The Charm of Macroscopic Fungi in Lubuklinggau" was validated by experts, a product trial was conducted to ensure that the book was easy to use by students with varying levels of ability. Based on the trial results, students

were grouped into three categories: high, medium, and low ability.

High-ability students suggested that the material be expanded with more in-depth explanations and the addition of real-world examples, such as mushroom identification in a local context. On the other hand, medium-ability students suggested simplifying the language and adding illustrations to facilitate understanding. Meanwhile, low-ability students proposed improving the layout to make it neater and adding a glossary of important terms to make it easier to understand.

The reference book was tested in two stages, namely a small group test (9 students) and a large group test (46 students). The small group test aimed to obtain initial constructive feedback on the suitability of the material, language, and visuals of the book. This feedback was very important as a basis for improvement before the book was tested on a larger scale,(Annisa et al., 2024; Husin et al., 2024; Kocovic Pajevic, 2024). The large-group trial was then conducted to measure the practicality and effectiveness of using the book in the actual learning process, (Arrosyad et al., 2024; Mailool et al., 2025; Tlili et al., 2022).

Based on the results of effectiveness measurements using N-gain, this reference book has been proven effective in improving students' understanding of macroscopic fungi, as well as successfully integrating the values of Sustainable Development Goals (SDGs) into learning. The N-gain category obtained, which is moderate to high, indicates a significant increase in student learning outcomes after using the book. These results reinforce the argument that the development of teaching materials that utilize local potential and apply an approach of exploring the surrounding nature plays an important role in improving the quality of biology education oriented towards sustainability.

The development of teaching materials that utilize local potential and combine active learning approaches is essential to improve sustainability-oriented biology education. Recent studies emphasize the importance of utilizing local resources and involving students in their natural environment to foster a deeper understanding of ecological concepts. The following section outlines the main findings from recent research,(Imtihana & Djukri, 2020; Handayani et al., 2021; Nurhidayati, 2024; Royani et al., 2023; Saro et al., 2023).

The integration of an approach that explores nature in learning provides an active learning experience that allows students to observe macroscopic fungi and their diversity directly in their natural habitat, thereby improving their taxonomic skills and ecological understanding, (Agustina et al., 2022; Jimenez M., 2020; Fitriana et al., 2024; Winsett et al., 2022).

Thus, the development of this reference book not only fulfills academic aspects but also accommodates contextual learning needs that support the sustainable development agenda. This book serves as a model for SDG-oriented learning that can be replicated for other teaching materials, particularly in the fields of biology, conservation, and environmental education.

Conclusion

The reference book "The Charm of Macroscopic Fungi in Lubuklinggau" has been proven to be valid, practical, and effective as teaching material to support the Low Plant Taxonomy course. The validation results from subject matter experts received a rating of very good. The material presented is relevant, accurate, and supports SDG-oriented learning (Quality Education and Life on Land). The validation from media and language experts both received a "good" rating. Trials were conducted on a small group (9 students) and a large group (46 students). Feedback from students with various levels of ability (high, medium, low) indicated the need for improvements such as deepening the material, simplifying the language, adding illustrations, and a glossary. The effectiveness measurement using the N-gain value showed a significant increase in student understanding. The majority of N-gain categories obtained were at a moderate to high level. This confirms that this reference book is effective in improving students' understanding of macroscopic fungi and reinforcing the integration of SDG values.

Author Contributions
Conceptualization, RDR; methodology, MW; validation, S. LC. DL; formal analysis, RDR. MW; investigation, RDR. MW; resources, SD; data curation: RDR. MW; original draft writing: RDR; review and editing: MW; visualization: RDR. All authors have read and approved the published version of the manuscript.

Conflicts of Interest

This study was conducted by researchers on behalf of the institution, with a primary focus on developing resources for lecturers and students at PGRI Silampari University, Indonesia.

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