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Development of a Gastropod Diversity Booklet from Lagundri Beach, South Nias, as a Biology Learning Resource for Senior High School on the Topic of Biodiversity

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Abstract. This study aimed to identify the diversity of gastropods at Lagundri Beach, South Nias, and to develop and evaluate the feasibility, practicality, and effectiveness of a booklet as a biology learning resource for senior high school students on the topic of biodiversity. This research employed a Research and Development (R&D) approach using the 4D model (define, design, develop, disseminate). The research subjects consisted of five validators, two teachers, and 31 students. Data were analyzed quantitatively and qualitatively through validity, practicality, and effectiveness tests, with effectiveness assessed using normality, homogeneity, t-test, and N-gain analyses. The results showed that the gastropod diversity index was 3.31, which falls into the high category. The developed booklet was classified as highly feasible (average >88%), highly practical (≥91%), and moderately effective, with an N-gain value of 63.13%. The t-test indicated a significant difference between the experimental and control classes ($t = 4.80$; $p < 0.05$). Therefore, this booklet based on local potential is suitable for use as a supplementary learning resource to improve students' conceptual understanding and biodiversity literacy.
Keywords: Booklet; gastropods; research and development; 4D model; effectiveness

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INTRODUCTION

Biodiversity encompasses all forms of life, including plants, animals, microorganisms, and the genetic material they contain. It constitutes part of a complex ecosystem in which interactions at the genetic, species, and community levels collectively maintain environmental balance (Primack, 2014; Odum & Barrett, 2005). According to Muhammad et al. (2022), species diversity is an important indicator of biological richness and can be measured through the relative abundance of species within a given area. A high level of species variation combined with an even distribution of abundance reflects a stable ecosystem with high ecological value (Magurran, 2004).

One group of organisms that represents high species diversity is Gastropoda. As the largest class within the phylum Mollusca, Gastropoda comprises more than 60,000 species distributed across a wide range of habitats, including marine, freshwater, and terrestrial environments (Bouchet et al., 2017). Wahyuni et al. (2017) emphasized that gastropods play significant ecological roles in maintaining ecosystem balance, functioning as detritivores, herbivores, and components of food webs, while also possessing economic value as sources of food and industrial raw materials. Their morphological diversity and ability to adapt to various substrates make gastropods a highly relevant subject for biology education, particularly in the study of biodiversity.

Despite this potential, biodiversity studies on gastropods remain largely dominated by inventory-based research focused primarily on ecological aspects and have not been widely integrated into educational contexts. This condition indicates a

research gap between scientific biodiversity data and its pedagogical implementation in schools (Situmorang, 2016). As a result, the teaching materials currently used tend to be conceptual and theoretical in nature, lack contextual relevance, and make limited use of local potential as a learning resource. In fact, learning based on local potential or local wisdom has been shown to enhance the relevance and meaningfulness of learning for students (Sudarisman, 2015).

One area with considerable biodiversity potential is the coastal zone, including Lagundri Beach in South Nias, which is rich in gastropod species. However, this potential has not yet been optimally utilized as a biology learning resource. Therefore, innovation is needed in the development of teaching materials that can integrate biodiversity research findings into contextual learning rooted in students' surrounding environment.

As a practical solution, biodiversity research findings can be used as learning resources through the development of instructional media in the form of a booklet. A booklet was selected because it can present material concisely and systematically while incorporating visual images of actual specimens, thereby facilitating students' understanding. The use of booklets as instructional media is supported by Mayer's multimedia learning theory, which states that the appropriate integration of text and visuals can enhance understanding and reduce students' cognitive load in processing information (Richard E. Mayer, 2009).

Empirically, this is consistent with the findings of Arisandi et al. (2018) and Pralisaputri et al. (2016), who reported that booklet-based media are effective in improving students' cognitive learning outcomes and independent learning. In addition, Salsabila et al. (2020) stated that the presentation of concise material accompanied by engaging images can help students better understand the concepts of morphology, identification, and classification of living organisms. This is further supported by Intika (2018), who showed that the use of booklets can optimally improve students' learning mastery.

Based on the foregoing, this study aims to develop a gastropod diversity booklet based on the local potential of Lagundri Beach, South Nias, as a biology learning resource for senior high school students in the topic of biodiversity that is valid, practical, and effective in improving students' conceptual understanding.

METHOD

Research Type and Design

This study employed a Research and Development (R&D) approach. The development model used was the 4D model—Define, Design, Develop, and Disseminate—adapted from Thiagarajan (1974). To test effectiveness, the study used a Pretest–Posttest Control Group Design to compare improvements in learning outcomes between the control class and the experimental class.

Research Subjects

The subjects in this study consisted of validators, teachers, and students as product users. The validators included a subject-matter expert, an instructional design expert, and a graphic design expert. The teacher participants consisted of two Biology teachers. The student participants were Grade X students of SMA Negeri 1 Aramo who were studying the topic of Biodiversity.

The sampling technique used was purposive sampling, in which subjects were selected based on specific criteria to meet the needs of the trial stages, namely individual trials (3 students), small-group trials (9 students), and field trials (21 students).

Research Object

The main object of this study was a Gastropod Diversity Booklet Learning Media developed based on the results of biodiversity research conducted at Lagundri Beach. This object included the aspects of feasibility (validity), practicality, and effectiveness as a Biology learning resource.

Research Procedure (4D Stages)

The study was conducted through four main stages:

1. **Define Stage:** This stage involved front-end analysis, learner analysis, task analysis, concept analysis, and the formulation of learning objectives.
2. **Design Stage:** This stage included the preparation of criterion-referenced tests, the selection of appropriate media (booklet), the selection of format, and the preparation of the initial design.
3. **Develop Stage:** This stage included expert validation (expert appraisa**l**) and developmental testing involving teachers and students in order to revise the product until it was declared feasible and practical.
4. **Disseminate Stage:** This stage involved limited-scale product dissemination within the school environment (SMA Negeri 1 Aramo).

Data Collection Techniques

Data were collected using validated instruments, namely:

1. **Expert Validation Sheets**: These used a Likert scale (1–5) to assess the feasibility of the material, instructional design, and graphic design.
2. **Teacher and Student Response Questionnaires**: These were used to measure the practicality of using the booklet in the learning process.
3. **Learning Outcome Tests**: These consisted of pre-test and post-test instruments used to measure students' conceptual mastery before and after the use of the learning media.

Data Analysis Techniques

The biodiversity data on gastropod diversity were analyzed using the Shannon–Wiener Diversity Index (H'), with the formula:

$$H' = -\sum Pi \ln Pi$$

Validity analysis was calculated using a percentage formula, as presented in Table 1.

Table 1. Feasibility assessment score criteria for the booklet

Percentage Score (%)	Interpretation
81%-100%	Highly Feasible
61%-80%	Feasible
41%-60%	Moderately Feasible
21%-40%	Not Feasible
0%-20	Highly Not Feasible

(Source: Mardianti et al., 2020)

The practicality of the booklet was analyzed using questionnaire data and a percentage formula, as presented in Table 2.

Table 2. Practicality assessment score criteria for the booklet

Percentage Score (%)	Interpretation
81%-100%	Highly Practical
61%-80%	Practical

Percentage Score (%)	Interpretation
41%-60%	Moderately Practical
21%-40%	Less Practical
0%-20	Highly Impractical

(Source: Riduwan, 2012)

Effectiveness Analysis (Prerequisite and Hypothesis Testing)

Effectiveness analysis included prerequisite testing and hypothesis testing, as follows:

1. Normality and Homogeneity Tests were conducted as statistical prerequisites, with the criterion of Sig. > 0.05.
2. Independent Sample t-test was used to determine whether there was a significant difference in post-test results between the experimental and control classes. The null hypothesis (H0) was rejected if p-value < 0.05.
3. Normalized Gain (N-Gain) was used to measure the magnitude of improvement in learning outcomes. The criteria were categorized as high if g > 0.7, moderate if 0.3 ≤ g ≤ 0.7, and low if g < 0.3. Final effectiveness referred to the classification proposed by Hake (1999), as presented in Table 3.

Table 3. Classification of normalized Gain (N-Gain score)

No.	Percentage (%)	Category
1	< 40	Ineffective
2	40-55	Less Effective
3	56-75	Moderately Effective
4	>76	Effective

RESULTS AND DISCUSSION

Gastropod Diversity at Lagundri Beach

Exploration of the intertidal zone at Lagundri Beach revealed 33 gastropod species belonging to 6 orders, 16 families, and 22 genera. These findings indicate that Lagundri Beach has relatively high gastropod species richness and therefore has strong potential as a contextual learning resource for biodiversity-related topics. The taxonomic data obtained in this study are presented in Table 4.

Table 4. Classification of gastropods found at Lagundri Beach

No.	Order	Family	Genus	Species
1	Littorinimorpha	Littorinidae	*Littoraria*	*Littoraria angulifera*
2	Littorinimorpha	Littorinidae	*Littoraria*	*Littoraria scabra*
3	Littorinimorpha	Cypraeidae	*Cypraea*	*Cypraea moneta*
4	Littorinimorpha	Cypraeidae	*Mauritia*	*Mauritia arabica*
5	Littorinimorpha	Cypraeidae	*Luria*	*Luria cinerea*
6	Littorinimorpha	Cypraeidae	*Cypraea*	*Cypraea isabella*
7	Littorinimorpha	Cypraeidae	*Cypraea*	*Cypraea tigris*
8	Littorinimorpha	Strombidae	*Strombus*	*Strombus alatus*
9	Littorinimorpha	Naticidae	*Polinices*	*Polinices mammilla*
10	Littorinimorpha	Ranellidae	*Monoplex*	*Monoplex nicobaricus*
11	Littorinimorpha	Ranellidae	*Ranella*	*Ranella olearium*
12	Neogastropoda	Conidae	*Conus*	*Conus marmoreus*

No.	Order	Family	Genus	Species
13	Neogastropoda	Conidae	*Conus*	*Conus flavidus*
14	Neogastropoda	Conidae	*Conus*	*Conus ebraeus*
15	Neogastropoda	Conidae	*Conus*	*Conus betulinus*
16	Neogastropoda	Conidae	*Conus*	*Conus frigidius*
17	Neogastropoda	Conidae	*Conus*	*Conus coronatus*
18	Neogastropoda	Buccinidae	*Cominella*	*Cominella glandiformis*
19	Neogastropoda	Muricidae	*Drupa*	*Drupa morum*
20	Neogastropoda	Muricidae	*Morula*	*Morula granulata*
21	Neogastropoda	Cerithiidae	*Clypeomorus*	*Clypeomorus petrosa*
22	Trochida	Trochidae	*Tectus*	*Tectus fenestratus*
23	Trochida	Trochidae	*Trochus*	*Trochus hanleyanus*
24	Trochida	Trochidae	*Monodonta*	*Monodonta labio*
25	Trochida	Trochidae	*Monodonta*	*Monodonta canalifera*
26	Trochida	Tegulidae	*Tegula*	*Tegula globulus*
27	Vetigastropoda	Angariidae	*Angaria*	*Angaria delphinus*
28	Vetigastropoda	Turbinidae	*Turbo*	*Turbo argyrostoma*
29	Cycloneritida	Neritidae	*Nerita*	*Nerita polita*
30	Cycloneritida	Neritidae	*Nerita*	*Nerita albicilla*
31	Cycloneritida	Neritidae	*Nerita*	*Nerita fulgurans*
32	Cycloneritida	Neritidae	*Nerita*	*Nerita plicata*
33	Ellobiida	Ellobiidae	*Pythia*	*Pythia scarabaeus*

Based on the inventory results, gastropod species richness at Lagundri Beach can be considered high. Compared with previous studies reporting only 22 species in similar intertidal ecosystems, the identification of 33 species at this site suggests greater biodiversity potential. The species composition, which includes herbivorous, detritivorous, and carnivorous taxa, also indicates that the gastropod community at Lagundri Beach is relatively complex. From an ecological perspective, such community complexity may reflect habitat conditions that are sufficiently supportive of multiple trophic niches.

The relatively high richness recorded in this study may be associated with the ecological heterogeneity of the intertidal habitat. Intertidal gastropods are strongly influenced by microhabitat conditions, including substrate characteristics, thermal exposure, and local habitat complexity. Gastropod body temperature is closely linked to substrate temperature, and microhabitat selection may therefore determine species persistence and distribution across the shore (Moisez et al., 2020). In addition, habitat heterogeneity has been shown to shape the abundance, diversity, and structural properties of intertidal gastropod assemblages, indicating that more varied habitats tend to support more complex communities (Pandey et al., 2018).

The composition of the gastropod assemblage at Lagundri Beach, which includes taxa with different feeding roles, also suggests the presence of a relatively well-structured intertidal food web. The coexistence of herbivores, detritivores, and carnivores implies that ecological interactions in this habitat are not limited to a single trophic function, but instead reflect broader functional diversity. Such diversity is

important because it contributes to ecosystem stability and indicates that the habitat may still be capable of supporting multiple ecological niches (Pandey et al., 2018).

The presence of gastropods at Lagundri Beach is likely influenced by a combination of environmental factors, including substrate type, temperature, salinity, and pH. The manuscript states that Lagundri Beach is dominated by sandy substrate, which may provide living space and attachment surfaces for several gastropod species. Although sandy habitats are often less structurally complex than rocky substrates, local variation in sediment structure, moisture retention, and associated microhabitats may still support diverse gastropod assemblages. Therefore, variation in coastal habitat conditions likely contributes to the high species diversity observed at the study site (Moisez et al., 2020; Pandey et al., 2018).

These findings also strengthen the argument that local biodiversity can be transformed into meaningful learning resources. Because the species documented in this study originate directly from the students' surrounding environment, the biodiversity content becomes more concrete, contextual, and easier to relate to daily experience. Learning resources based on local potential have been reported to improve learning quality, strengthen environmental awareness, and positively influence student learning outcomes, making them particularly relevant for biodiversity education (Fajeriadi et al., 2025).

The booklet product developed in this study is presented through its cover and table of contents. In the original manuscript, there is an inconsistency in figure numbering: the text refers to Figure 1, whereas the caption appears as Figure 2. This should be standardized to a single figure number, for example:

Figure 1. Cover and table of contents of the gastropod diversity booklet from Lagundri Beach, South Nias

Booklet Validity

Based on the material expert validation results, the gastropod diversity booklet obtained an average score of 89.125%, categorized as highly valid. The material aspect received the highest score (100%), followed by presentation support (90%), presentation feasibility (86.5%), and language feasibility (80%). These results indicate that, in terms of content, the booklet is well aligned with the learning material, although

the language aspect still requires simplification to make the text more communicative for students.

Table 5. Results of booklet validation by material experts

No.	Assessment aspect	Percentage	Category
1	Material	100%	Highly valid
2	Presentation feasibility	86.5%	Highly valid
3	Presentation support	90%	Highly valid
4	Language feasibility	80%	Valid
	Average	**89.125%**	**Highly valid**

Validation by instructional design experts showed an average score of 88.6%, also categorized as highly valid. The product assessment aspect achieved the highest score (95%), whereas material suitability received the lowest score (80%), although it still remained within the valid category. These findings indicate that the booklet is appropriate for use as a learning medium in terms of content, presentation, and its contribution to the learning process.

Table 6. Results of booklet validation by instructional design experts

No.	Assessment aspect	Percentage	Category
1	Material suitability	80%	Valid
2	Presentation feasibility	88%	Highly valid
3	Language feasibility	90%	Highly valid
4	Feasibility in supporting learning	90%	Highly valid
5	Product assessment feasibility	95%	Highly valid
	Average	**88.6%**	**Highly valid**

The graphic design expert validation yielded an average score of 91.32%, which falls into the highly valid category. Booklet size received the highest score (100%), followed by image/illustration presentation (95%), typography (90%), layout (86.6%), and cover design (85%). These data indicate that the booklet has good visual quality and supports student readability.

Table 7. Results of booklet validation by graphic design experts

No.	Assessment aspect	Percentage	Category
1	Booklet size feasibility	100%	Highly valid
2	Cover design feasibility	85%	Highly valid
3	Layout feasibility	86.6%	Highly valid
4	Typography feasibility	90%	Highly valid
5	Image/illustration presentation feasibility	95%	Highly valid
	Average	**91.32%**	**Highly valid**

Overall, the three validation results indicate that the developed booklet meets the criteria of being highly valid. This finding is in line with previous studies reporting that booklet-based learning media can achieve high validity when the materials are systematically developed in terms of content accuracy, language, design, and learning

feasibility. For example, Halifa and Fauziah (2025) found that a discovery learning-based booklet fulfilled the criteria of content, design, and instructional validity, while Azmi et al. (2023) reported that biodiversity teaching materials based on local potential showed very high validity and readability. Thus, the strong validation scores obtained in this study suggest that the developed booklet is pedagogically sound and suitable for further implementation.

In addition, the high validity of the present booklet may be closely related to its contextual basis. The content was not compiled solely from secondary sources, but was built from actual research findings on gastropod diversity at Lagundri Beach. This research-based contextualization is important because biodiversity learning is generally more meaningful when students encounter examples derived from real organisms and ecosystems in their own environment. Accordingly, the booklet does not merely function as an information source, but also as a bridge between field-based biological data and classroom learning (Fajeriadi et al., 2025; Azmi et al., 2023).

Booklet Practicality

Based on the responses of biology teachers, the booklet obtained an average score of 91%, categorized as highly practical. The highest scores were recorded for visual readability, the presence of captions on each image, and the booklet's contribution as an additional learning resource, each receiving 100%. Meanwhile, the accuracy of the material content and the writing of Latin names each received 80%, although both remained within the practical category. These results indicate that the booklet is easy to use in learning, although refinement of scientific terminology and wording is still needed.

Table 8. Biology teachers' responses to the gastropod booklet

No.	Assessment aspect	Percentage	Category
1	Booklet appearance	90%	Highly practical
2	The content display, font size, and images are clearly visible	100%	Highly practical
3	Provides understanding of gastropods	90%	Highly practical
4	Accuracy of content and completeness of the material	80%	Practical
5	Captions are provided for each image presented	100%	Highly practical
6	The sentences used in the booklet are easy to understand	90%	Highly practical
7	Scientific names are written according to nomenclature rules	80%	Practical
8	The images provided are attractive and facilitate comprehension of the content	90%	Highly practical
9	The material presented is aligned with the learning objectives	90%	Highly practical
10	The booklet can serve as an additional learning resource for students	100%	Highly practical
	Average	**91%**	**Highly practical**

In the individual trial, the booklet obtained an average score of 92.06%, categorized as highly practical. This result indicates that the booklet generated a positive initial impression among students in terms of appearance, usefulness, and ease of understanding the material.

Table 9. Results of the individual trial

No.	Assessment aspect	Percentage	Category
1	The physical appearance and content of the booklet are attractive	93.3%	Highly practical
2	Provides a general overview of gastropods	93.3%	Highly practical
3	The image layout is attractive and each image includes a caption	93.3%	Highly practical
4	Helps readers conduct field practice	86.6%	Highly practical
5	The images are attractive and easy to distinguish	100%	Highly practical

No.	Assessment aspect	Percentage	Category
6	The booklet content is integrated with the research findings	93.3%	Highly practical
7	The booklet is useful in everyday life	100%	Highly practical
8	Ease of understanding the sentences/material in the booklet	80%	Highly practical
9	Font size and type are easy to read	86.6%	Highly practical
10	The booklet broadens readers' knowledge	100%	Highly practical
	Average	**92.06%**	**Highly practical**

In the small-group trial, the average practicality score increased to 96.1%, which also falls into the highly practical category. This result further confirms that the booklet can be used more broadly and is very well received by students.

Table 10. Results of the small-group trial

No.	Assessment aspect	Percentage	Category
1	The physical appearance and content of the booklet are attractive	97.7%	Highly practical
2	Provides a general overview of gastropods	95.5%	Highly practical
3	The image layout is attractive and each image includes a caption	95.5%	Highly practical
4	Helps readers conduct field practice	97.7%	Highly practical
5	The images are attractive and easy to distinguish	93.3%	Highly practical
6	The booklet content is integrated with the research findings	97.7%	Highly practical
7	The booklet is useful in everyday life	97.7%	Highly practical
8	Ease of understanding the sentences/material in the booklet	93.3%	Highly practical
9	Font size and type are easy to read	95.5%	Highly practical
10	The booklet broadens readers' knowledge	95.5%	Highly practical
	Average	**96.1%**	**Highly practical**

The limited-group trial also produced an average score of 96.09%, categorized as highly practical. Thus, the booklet is not only valid in terms of content and design, but is also easy to use and well liked by students on a larger user scale. In the original manuscript, the term *university students* was used; if the research subjects were senior high school students, this term should be revised for consistency.

Table 11. Results of the limited-group trial

No.	Assessment aspect	Percentage	Category
1	The physical appearance and content of the booklet are attractive	97.14%	Highly practical
2	Provides a general overview of gastropods	94.28%	Highly practical
3	The image layout is attractive and each image includes a caption	94.28%	Highly practical
4	Helps readers conduct field practice	97.14%	Highly practical
5	The images are attractive and easy to distinguish	97.14%	Highly practical
6	The booklet content is integrated with the research findings	97.14%	Highly practical
7	The booklet is useful in everyday life	99.04%	Highly practical
8	Ease of understanding the sentences/material in the booklet	94.28%	Highly practical
9	Font size and type are easy to read	97.14%	Highly practical
10	The booklet broadens readers' knowledge	94.28%	Highly practical
11	The attractiveness of the booklet in learning	95.23%	Highly practical
	Average	**96.09%**	**Highly practical**

The consistently high practicality scores from teachers and students indicate that the booklet can be implemented efficiently in actual learning situations. This is important because biodiversity material often contains dense information, hierarchical classification, and many unfamiliar scientific names. A booklet that presents concise explanations, relevant images, and clear captions can reduce the cognitive burden on students and support more independent learning. Similar findings were reported by Halifa and Fauziah (2025), who showed that booklet media were perceived as easy to use, engaging, and well received by both teachers and students.

The practicality of this booklet may also derive from its visual and contextual characteristics. In biodiversity learning, visual support is essential because students are often required to distinguish organisms based on morphological features and taxonomic characteristics. The presence of species photographs and captions in the booklet likely helped students connect names, forms, and ecological context more effectively. Moreover, because the booklet was based on local gastropod diversity, students were not learning through abstract examples alone, but through biological objects closely related to their own coastal environment. This contextual relevance is consistent with evidence that local potential-based learning resources can strengthen both understanding and student engagement (Fajeriadi et al., 2025).

Effectiveness of the Booklet on Learning Outcomes

The normality test results showed that all pretest and posttest data, in both the control and experimental classes, had significance values greater than 0.05, indicating that the data were normally distributed. Therefore, further analysis using parametric tests was appropriate. In the original manuscript, there is a statement indicating that “linear regression was then performed”; however, the subsequent tables and analyses show the use of a homogeneity test, an independent-samples *t*-test, and N-gain analysis. This sentence should therefore be deleted to ensure consistency with the actual analytical procedures.

Table 12. Results of the normality test

Class	Kolmogorov-Smirnov Sig.	Shapiro-Wilk Sig.	Interpretation
Pretest control class	0.055	0.197	Normal
Posttest control class	0.200	0.548	Normal
Pretest experimental class	0.178	0.285	Normal
Posttest experimental class	0.062	0.147	Normal

The homogeneity test yielded a significance value of 0.385 based on the mean. Because this value is greater than 0.05, the variance in biology learning outcomes between the experimental and control classes can be considered homogeneous.

Table 13. Results of the homogeneity test

Variable	Levene Statistic	df1	df2	Sig.	Interpretation
Biology learning outcomes	0.765	1	62	0.385	Homogeneous

The t-test results showed that *t*count = 4.80 and *t*table = 1.751, indicating that $t_{count} > t_{table}$. Thus, there was a significant difference in learning outcomes between students in the experimental class and those in the control class. These findings indicate that the use of the booklet contributed to improved student learning outcomes.

Table 14. Results of the t-test

Test	t_{count}	t_{table}	Criterion
Independent-samples t-test	4.80	1.751	There is a difference in learning outcomes between the experimental and control classes

Based on the N-gain analysis, the experimental class achieved a mean score of 63.13%, whereas the control class obtained a mean score of 13.98%. These findings indicate that the use of the booklet was moderately effective in improving student learning outcomes on the topic of gastropods. The substantial difference between the experimental and control classes suggests that a booklet based on local potential is more effective in helping students understand the material than instruction delivered without such media.

Table 15. Summary of N-gain test results

Class	Mean N-gain (%)	SD	Minimum	Maximum	Category
Experimental	63.13	12.812	39	86	Moderately effective
Control	13.98	18.384	-36	50	Less effective

Overall, the effectiveness of the gastropod diversity booklet as a biology learning resource was demonstrated by two main indicators: a significant difference in learning outcomes based on the *t*-test and an increase in N-gain scores in the experimental class. This result is consistent with previous studies showing that booklet-based media can improve student learning outcomes when the content is organized clearly and aligned with learning needs. Adriana et al. (2024) reported that local potential-based biodiversity booklets were effective in improving student achievement, while Azmi et al. (2023) found that biodiversity teaching materials based on local potential were feasible and effective for strengthening scientific literacy.

The effectiveness of the booklet in this study is likely related to its ability to transform biodiversity material into a more concrete and contextual learning experience. Biodiversity is often difficult for students because it involves abstract classification systems, numerous scientific terms, and limited direct observation opportunities. By presenting species actually found in the local environment, the booklet may have helped students connect scientific concepts with observable biological reality. This interpretation is supported by broader evidence that local potential-based biology learning resources contribute positively to students' attitudes and cognitive learning outcomes (Fajeriadi et al., 2025).

An N-gain value of 63.13% indicates that the booklet functioned as an instructional medium that supported the transition of students' understanding from their initial condition to a better level of comprehension after instruction. At the same time, the result remained within the moderately effective category, suggesting that the booklet should be regarded as effective but still open to improvement. One possible explanation is that gastropod material contains dense taxonomic information and many Latin scientific names, which may still present challenges for students even when supported by visual media. Similar issues are common in biodiversity learning, where students are often required not only to memorize terms but also to interpret relationships among taxa and organismal characteristics (Azmi et al., 2023; Fajeriadi et al., 2025).

Nevertheless, the current findings confirm that the booklet has substantial value as a locally grounded biology learning resource. Its main strength lies in the integration of authentic field research results with instructional media design, allowing students to

learn biodiversity through examples that are empirically documented and directly relevant to their environment. In this sense, the booklet is not merely supplementary reading material, but a contextual learning medium capable of linking ecological reality, visual representation, and conceptual understanding in biology learning (Adriana et al., 2024; Fajeriadi et al., 2025).

Despite these positive findings, the booklet's effectiveness, which remained within the moderately effective category, indicates that further refinement is still needed. Future development may focus on simplifying the language, adding a glossary of scientific terms, and integrating more structured species-identification activities so that students can engage more actively with the material. Such improvements may help optimize the role of the booklet not only as a source of information, but also as a guide for observation, classification, and contextual scientific reasoning in biodiversity learning (Azmi et al., 2023; Halifa & Fauziah, 2025).

CONCLUSION

This study demonstrated that the intertidal zone of Lagundri Beach possesses relatively high gastropod diversity, with 33 species identified across 6 orders, 16 families, and 22 genera. This richness indicates that the coastal area has substantial biodiversity value and can serve as a relevant local resource for biology learning, particularly in biodiversity-related topics. The diversity of trophic groups identified also suggests that the gastropod community at the study site is ecologically complex and supported by suitable habitat conditions.

The gastropod diversity booklet developed from these research findings was shown to be highly feasible based on expert validation in terms of material, instructional design, and graphic design. In addition, the booklet demonstrated very high practicality based on responses from teachers and students in individual, small-group, and limited-group trials. These findings indicate that the booklet is not only valid in content and design, but also easy to use and well accepted as a biology learning medium.

The effectiveness test further showed that the booklet contributed positively to student learning outcomes. Significant differences between the experimental and control classes, supported by a higher N-gain score in the experimental class, indicate that the booklet was moderately effective in improving student understanding of gastropod material. Overall, this study confirms that a booklet based on local biodiversity potential can function as a contextual, practical, and effective biology learning resource. Further development is recommended through language simplification, the addition of a scientific glossary, and more structured species-identification activities to optimize its educational impact.

RECOMMENDATION

Based on the findings and discussion of this study, several recommendations can be proposed. First, the gastropod diversity booklet provides accurate and engaging information that may be beneficial for teachers, lecturers, university students, and school students. Second, the gastropod diversity booklet can be used as an additional learning resource or as a supporting medium in Biology instruction at the senior high school level, particularly in learning related to gastropods.

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