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Development of Handout on Biodiversity Material Based on Gastropod Diversity in The Mangrove Ecosystem of Kayu Ara Permai Village, Siak Regency

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ABSTRACT

This study aims to determine the diversity of gastropods in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency, and to develop a biodiversity handout. The background of this study is the limited availability of teaching materials and the lack of contextual learning in schools. To address this problem, a handout based on local environmental potential was developed to help students understand the concept of biodiversity in a concrete and meaningful way. This study used a quantitative descriptive method, while the handout development followed the ADDIE model, including analysis, design, development, implementation, and evaluation, but was limited to the development stage. Gastropod data were collected using line transect and plot methods at three observation stations. The results showed that the gastropod diversity index was categorized as moderate, with six species found in various mangrove conditions. These findings were then used as contextual material in the development of the handout. Validation results by material and media experts showed that the handout was categorized as very valid in terms of content, language, presentation, and graphics. This study contributes by integrating local ecological research into contextual teaching materials, enhancing the relevance of biodiversity learning and supporting more meaningful learning experiences.

1. Introduction

The mangrove ecosystem is a coastal ecosystem that plays a crucial role in maintaining environmental balance. This ecosystem is located in the transitional area between land and sea, influenced by tides, and is dominated by unique vegetation that adapts to high

salinity conditions. Mangroves serve an ecological function by protecting the coast from abrasion and ocean waves, and also serve as habitat, shelter, and foraging areas for various organisms. Furthermore, mangroves also serve an economic function, providing a livelihood for coastal communities and offering potential for ecotourism development (Nanlohy &

Masniar, [2020](#)). Their high biodiversity makes mangrove ecosystems a crucial object of biological study, particularly in understanding the interactions between biotic and abiotic components within an ecosystem.

One biotic component commonly found in mangrove ecosystems is gastropods. Gastropods are a group of mollusks highly adaptable to various substrates, such as muddy, sandy, and rocky. These organisms play a crucial role in the mangrove ecosystem, primarily as detritivores and early decomposers, aiding in the decomposition of mangrove leaf litter. This role is crucial in maintaining nutrient cycles within the ecosystem. Furthermore, gastropods also play a role in the food chain and can be used as bioindicators of environmental quality due to their sensitivity to changes in habitat conditions (Andriati & Rizal, [2020](#)). Thus, gastropod diversity can reflect the ecological condition of a mangrove ecosystem.

However, mangrove ecosystems currently face various pressures that can lead to environmental degradation. Changes in mangrove ecosystem condition are generally caused by natural factors and human activities, such as abrasion, land conversion, and economic activity in coastal areas (Huda, [2008](#)). This condition also occurs in Kayu Ara Permai Village, Siak Regency, which has experienced a significant decline in mangrove area due to exploitation and land use changes (Armanda et al., [2021](#)). This decline in mangrove quality and area has the potential to impact the diversity of organisms living within them, including gastropods. Therefore, research on gastropod diversity in the region is crucial to obtain scientific information on the condition of the mangrove ecosystem and to provide a basis for environmental management and conservation.

Several previous studies have examined gastropod diversity in various mangrove ecosystems and shown that the composition and abundance of gastropods are influenced by environmental conditions, such as substrate type, salinity, and mangrove vegetation density. A study by Ernawati et al. ([2019](#)) demonstrated that gastropods play a role as macrobenthos, aiding in the decomposition of organic matter in mangrove ecosystems. Other studies have also suggested that changes in environmental conditions can affect the structure of gastropod communities, enabling these organisms to be used as indicators of coastal ecosystem health (Uspar et al., [2021](#)) (Naibaho et al., [2023](#)). However, studies on gastropod diversity integrated as learning resources in biology are still relatively limited, particularly those

developed in the form of contextual teaching materials.

On the other hand, the biology learning process in schools still faces various obstacles, particularly in providing contextual teaching materials relevant to students' surroundings. The teaching materials used are generally limited to textbooks and presentation media, thus lacking the ability to connect the material to real-world conditions in the surrounding environment. This is also supported by the statement by Susanti et al. ([2020](#)) that teaching materials such as printed textbooks provided by schools are often inadequate because many are lost and damaged, the presentation of the material is not contextual, and evaluations do not align with the desired learning objectives.

Teachers can also create alternative teaching materials in the form of handout. Although teaching materials play a crucial role in the learning process, the high intensity of teaching tasks often limits teachers' ability to develop teaching materials independently. This situation encourages textbook authors and publishers to adapt and modify existing teaching materials as an alternative development method. However, research shows that the use of teaching materials without adjustment can make it difficult for students to learn the material, so a learning environment is needed that provides active opportunities to students in the learning process and acceptance of new knowledge (Charty & Syofyan, [2024](#)). This situation results in students' understanding of the concept of biodiversity being less than optimal and resulting in low interest and motivation in learning (Irwandi & Fajeriadi, [2019](#)). However, learning that connects material to the local environment can enhance conceptual understanding in a more meaningful way.

One alternative to address this problem is to develop teaching materials in the form of handout based on local potential. Handout are concise, systematic, and easy-to-understand materials, thus helping students understand the material. Handout make learning "portable and enduring" (easy to carry anywhere and lasting) and can load back information that students have obtained and develop tests for students (Ardianto et al., [2019](#)). Using handout that integrate research findings on gastropod diversity in mangrove ecosystems is expected to provide a more contextual learning experience. In addition, teaching materials related to the surrounding environment and culture make abstract concepts more concrete and easier to understand (Istiqomah et al., [2025](#)). Furthermore, presenting material supplemented with local

illustrations can also increase student interest, motivation, and engagement in the learning process.

Based on the description, research on the development of handout on biodiversity material based on gastropod diversity in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency needs to be conducted. This research aims to: (1) analyze gastropod diversity in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency using the Shannon-Wiener Diversity Index (H') supported by data on the number of species and individual abundance; and (2) develop teaching materials in the form of handout based on local potential and test their feasibility through expert validation covering aspects of content, language, presentation, and graphical feasibility. Thus, the purpose of this research is not only to reveal the condition of gastropod diversity quantitatively, but also to produce contextual teaching materials whose validity has been tested to support biology learning on biodiversity material.

2. Methodology

This study used a quantitative descriptive method, which aims to describe and analyze the level of gastropod diversity in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency, based on measured field data. The results of this analysis were used as the basis for compiling handout on local potential-based biodiversity material. Quantitative descriptive is a statistical analysis method used to provide an overview or description of the data that has been collected. The main objective is to summarize and organize data systematically so that it can be understood and interpreted more easily (Haryanti, 2023). The development model used is the ADDIE (analysis, design, development, implementation, and evaluation). This model was chosen because of its systematic and flexible approach to the development of teaching materials (Branch, 2009), with modifications only in three stages: analysis, design, and development. This research is limited to the development stage of the ADDIE model because it focuses on developing handout based on field research findings. Consequently, the resulting product has not yet undergone implementation and evaluation, so its effectiveness in learning needs to be tested through further research.

This research was conducted in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency, Riau Province. The location was selected based on initial observations indicating that the location was a local resource close to the students' environment. The research implementation period began after obtaining permission from the Faculty of Teacher Training and Education and Kayu Ara Permai Village, until the development stage was completed. The research process included various stages, starting from collecting data on gastropod diversity, analyzing the curriculum and materials, designing handout, developing handout, and validating the developed handout.

Gastropod diversity data was collected using line transect and plot methods. Observation locations were determined using a purposive sampling technique, based on differences in mangrove environmental conditions, divided into three observation stations. The data obtained were then analyzed using the Shannon-Wiener Diversity Index (H'). The results of the analysis were then used as a basis for compiling handout on biodiversity material by integrating empirical data into contextual teaching materials, thereby supporting students' understanding of the concept of biodiversity based on real environmental conditions. The modified handout structure, developed by (Saf & Yurnetti, 2019), included a cover, foreword, table of contents, user instructions, curriculum levels, introduction, concept map, content, practice questions, and bibliography. The handout design flowchart can be seen Figure 1 below.

The analysis stage was conducted to identify learning needs and student characteristics. The design stage involved designing the structure, content, and presentation of the handout to reflect the biodiversity material. The development stage involved compiling the handout using the Canva application, followed by printing. Handout validation was conducted by two validators: one material expert and one media expert. The instrument used was a validation sheet with a Likert scale covering aspects of content, language, presentation, and graphical appropriateness (Saf & Yurnetti, 2019). The assessment criteria for each expert are presented in the following Table 1 and Table 2.

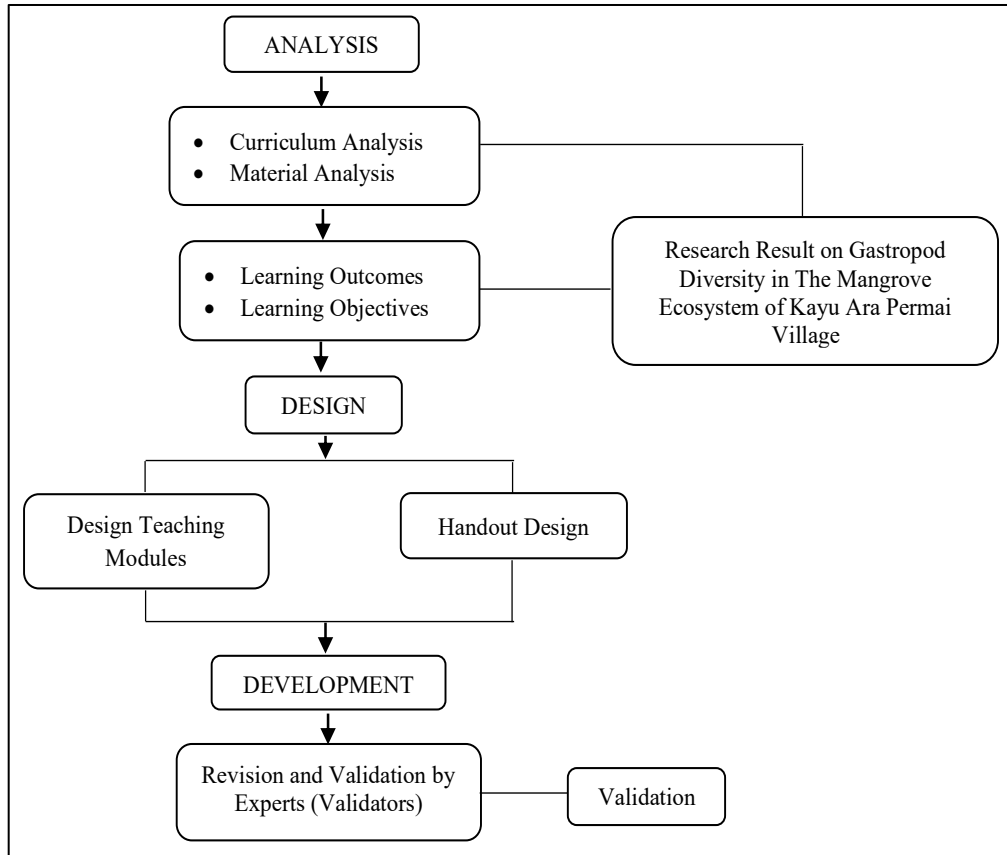


Figure 1. Handout Design Flowchart

Table 1. Material Expert Validation Sheet Grid

| No | Rated Aspect | Number of Grains | Item Number |
|----|----------------------------|------------------|-------------|
| 1 | Content Suitability Aspect | 5 | 1,2,3,4,5 |
| 2 | Linguistic Aspect | 4 | 6,7,8,9 |
| 3 | Presentation Aspect | 4 | 10,11,12,13 |

Table 2. Media Expert Validation Sheet Grid

| No | Rated Aspect | Number of Grains | Item Number |
|----|----------------------------|------------------|----------------|
| 1 | Content Suitability Aspect | 5 | 1,2,3,4,5 |
| 2 | Linguistic Aspect | 4 | 6,7,8,9 |
| 3 | Graphics Aspect | 5 | 10,11,12,13,14 |

After the validation process was completed, the obtained data was analyzed using descriptive analysis techniques. This technique employed calculating scores for each predetermined aspect to measure the validity of the draft handout. Assessment was conducted using a Likert scale, and the results of the

score categorization are shown in the following Table 3.

Table 3. Validator Assessment Criteria

| No | Assessment Score | Category |
|----|------------------|-----------|
| 1 | 4 | Very Good |
| 2 | 3 | Good |
| 3 | 2 | Neutral |
| 4 | 1 | Not Good |

(Sugiyono, 2018)

The validation data was analyzed by calculating the average score using the formula:

$$M = \frac{\sum fx}{N}$$

M = Average score

fx = Total score obtained

N = Number of assessment items

The average score obtained was then converted into validity level categories to determine the suitability of the handout as a teaching material, as seen in Table 4.

Table 4. Product Validity Category

| No | Average Score Interval | Category |
|----|------------------------|------------|
| 1 | $3,25 \leq x < 4$ | Very Valid |
| 2 | $2,5 \leq x < 3,25$ | Valid |
| 3 | $1,75 \leq x < 2,5$ | Less Valid |
| 4 | $1 \leq x < 1,75$ | Invalid |

(Sugiyono, [2018](#))

3. Results and Discussion

Analysis Stage

The analysis stage aims to ensure that the developed teaching materials align with learning needs. This stage consists of curriculum analysis and material analysis. The Merdeka Curriculum emphasizes student-centered learning and allows teachers the freedom to develop contextual learning tailored to their needs. Learning within the Merdeka Curriculum also encourages the use of the surrounding environment as a learning resource, enabling students to understand material more meaningfully and relevantly to real life (Sabila et al., [2025](#)).

The results of the curriculum analysis conducted on the biology learning outcomes for Stage E indicate that research on gastropod diversity is relevant to one of the learning outcomes in the Merdeka Curriculum. This learning outcome requires students to be able to apply the principles of classification of living things and biodiversity conservation. This is because the Merdeka Curriculum is designed to shape a millennial generation that is not only adept at memorizing material but also able to understand concepts quickly and efficiently (Yohana & Nasir, [2025](#)). The results of the analysis of the biology learning outcomes for Stage E for grade 10 of high school can be seen in Table 5.

Table 5. Results of The Analysis of Biology Learning Outcomes in Stage E for Grade 10 of High School

| Elements | Learning Outcome |
|--------------------------|--|
| Understanding of Biology | At the end of Stage E, students will be able to apply the principles of classification and strategies for biodiversity conservation. |

The results of the material analysis on the topic of biodiversity were conducted to ensure that the developed content aligns with the requirements of the biology learning outcomes for Stage E and is relevant to the learning context in grade 10 of high school. Based on the Biology textbook for grade 10 of high school under the Merdeka Curriculum, the biodiversity subtopic that aligns with the results of this

research is the biodiversity levels subtopic. The results of the curriculum analysis and material analysis were then formulated into more specific learning objectives. Learning objectives aligned with the research findings are presented in Table 6.

Based on Table 6, the analysis shows that biodiversity is one topic that can be linked to students' environmental conditions. This material examines various levels of biodiversity, from genetic diversity to species diversity to ecosystems. Therefore, learning about biodiversity will be easier to understand when linked to real-world examples in the students' environment. Integrating local potential into learning can improve students' science process skills and conceptual understanding, encourage active learning and real-world applications, and foster cultural awareness (Kamila et al., [2024](#)).

Table 6. Analysis of Learning Objectives in Biodiversity Material for Class X

| Class/ Semester | Learning Materials | Learning Objectives | Potential |
|-----------------|--------------------|--|-----------|
| X/1 | Biodiversity | Students are able to analyze biodiversity at the species level based on local potential in their area. | Handout |

Design Stage

The design stage aims to design the structure and components of the handout to be developed to meet the analyzed learning needs. This design stage consists of designing the learning objectives and teaching modules, as well as the handout design. The learning objectives and teaching modules were designed based on the results of the curriculum and materials analysis conducted, and adapted to the gastropod diversity data.

The handout design then began with compiling and developing the material, then supplementing it with data on gastropod diversity in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency. The handout was designed using Canva on A4 paper size. The handout design on gastropod diversity in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency, can be seen in the Figure 2.



Figure 2. Handout structure: (A) Cover, (B) Foreword, (C) Table of Contents, (D) User Guidelines, (E) Curriculum Level, (F) Introduction, (G) Concept Map, (H) Contents, (I) Evaluation, (J) Bibliography.

This locally-based handout was designed with an attractive design and emphasized presentation tailored to the students' environmental conditions. The material presented in this handout encourages students to directly recognize and understand their surrounding environment. This is particularly evident in the presentation of the material on levels of biodiversity, where students are encouraged to understand the levels of biodiversity through observation of gastropods in the mangrove ecosystem of Kayu Ara Permai Village. These advantages certainly impact the learning process, especially for students. They are helped to understand the learning material and are able to relate the concepts learned to situations they encounter in everyday life (Maula et al., 2025). In addition, students can study the material independently and can repeat the learning anywhere and anytime. This is because in learning using teaching materials, students learn individually in the sense that they can adjust their learning speed to their respective abilities (Suarmita et al., 2025).

Handout can be used in core learning activities as study guides, additional sources of information, and exercises that can be used by students individually or in groups. Through these handout, students can conduct observation activities, namely observing images, classification, and morphological characteristics of several types of gastropods found in the mangrove ecosystem of Kayu Ara Permai Village. In addition, handout can be used as supporting teaching materials when teachers deliver biodiversity material, and can overcome the limitations of available teaching materials. According to Prastowo (2011), handout can be used as additional teaching materials

to complement the material contained in textbooks or material delivered by teachers because they present material, tables, diagrams, and images.

Development Stage

The development stage aims to realize the previously designed handout teaching materials. This process includes several activities, namely: handout creation, which involves compiling materials according to the planned concept and design using the Canva application; printing the handout products; and validation by material and media experts. The calculation of the validation results by material and media experts can be seen in Table 7 and Table 8.

Based on the validation results by material experts, as shown in Table 7, the developed handout is categorized as highly valid, with an average score of 3.85. The assessment was conducted on aspects of content suitability, language, and presentation. In terms of content suitability, the handout was declared highly valid, with an average score of 3.80. This is because the material presented in the handout has been aligned with learning outcomes, including an explanation of the concept of biodiversity and is relevant to everyday life, thus encouraging students to understand the material more deeply. This indicates that the developed handout has met the content suitability aspect. However, based on input from the validator, several areas needed improvement, particularly in aligning the learning materials with the formulated learning objectives. Learning materials must be aligned with learning outcomes so that the learning objectives formulated in the materials can be optimally conveyed and achieved by students (Jauharati et al., [2022](#)).

In terms of language, the handout was declared very valid with an average score of 4.00 because the language used in the handout complies with good and correct Indonesian language rules. The language used is communicative and appropriate to the level of understanding of students, so the developed handout has met the language aspects. However, based on the validator's input, there are several improvements that need to be made, such as improving ineffective sentences to avoid double meanings. According to Jauharati et al. ([2022](#)), the language in teaching materials must be communicative and pay attention to the clarity of sentences and paragraph structure to make it easier for students to understand the material.

In terms of presentation, the handout was declared very valid with an average score of 3.75 because the presentation of the material provides motivation for

students, the presentation of images and tables supports the material in the handout, and the data presented is relevant to the material. However, there was input from the validator, namely the arrangement of the material to be reordered so that the learning flow becomes clearer and more logical. In addition, the research data is not separated from the learning material, but is integrated directly into each discussion of the material. This aims to enable students to understand learning concepts through real examples derived from research results in the surrounding environment.

Table 7. Calculation of Subject Matter Expert Validation Results

| Rated Aspect | Total Score | Average Score | Category |
|----------------------------|--------------------|----------------------|-------------------|
| Content Suitability Aspect | 19 | 3,80 | Very Valid |
| Linguistic Aspect | 16 | 4,00 | Very Valid |
| Presentation Aspect | 15 | 3,75 | Very Valid |
| Total | 50 | 11,55 | Very Valid |
| Average | 16,6 | 3,85 | |

Based on the validation results by media experts, as shown in Table 8, the developed handout is categorized as very valid with an average score of 3.93. The assessment was conducted on the aspects of content, language, and graphical appropriateness. Based on the content appropriateness aspect, the handout is declared very valid with an average score of 4.00 because the handout material is in accordance with learning outcomes, is contextual, relevant to the students' environment, and supports the development of students' scientific knowledge, attitudes, and skills. Local potential-based teaching materials have advantages because the material is contextual, close to students' lives, and is still structured according to the standards stated in the curriculum (Rozalia et al., [2018](#)).

Based on the linguistic aspect, the handout is declared very valid with an average score of 4.00 because the language used in the handout is in accordance with good and correct Indonesian language rules and the use of scientific terms is explained appropriately. However, based on the validator's input, there are improvements that need to be made, such as improving unclear and ambiguous sentence structures, and there are still repetitive sentences. According to Prastowo ([2011](#)), when writing handout, try to keep the sentences used not too long.

Viewed from the graphic aspect, the handout is declared very valid with an average score of 3.80. The layout of the handout is neatly arranged and proportional, the appearance and color selection are quite attractive, the type and size of the font are easy to read, and it contains clear and relevant images to the material. Images serve to attract students' interest in learning and help explain the concepts presented. Images also function as illustrations that can clarify the material and provide a variety of presentations, so that the information conveyed is easier for students to understand and remember (Rozalia et al., 2018).

Table 8. Calculation of Media Expert Validation Results

| Rated Aspect | Total Score | Average Score | Category |
|---------------------|-------------|---------------|-------------------|
| Content Suitability | 20 | 4,00 | Very Valid |
| Linguistic Aspect | 16 | 4,00 | Very Valid |
| Presentation Aspect | 19 | 3,80 | Very Valid |
| Total | 55 | 11,80 | Very Valid |
| Average | 18,3 | 3,93 | |

Based on Table 9, the average validation score was 3.89, concluding that the product is suitable for use with minor revisions. This indicates that the developed handout has met the eligibility criteria for use by teachers and students in the learning process and aligns with the assessment aspects established in this study. Aspects assessed in the handout validation process include the appropriateness of content, language, presentation, and graphics.

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Table 9. Combined Average Validation Score

| Validator | Average Score | Category |
|-----------------|---------------|-------------------|
| Material expert | 3,85 | Very Valid |
| Media expert | 3,93 | Very Valid |
| Total | 3,89 | Very Valid |

When compared with the research of Halimah et al. (2023), the results of this study indicate consistency

with the findings stating that contextual teaching materials tend to have a high level of validity and are more effective in supporting learning. Previous research reported that pocket books developed with a contextual approach, namely on environmental pollution and climate change, obtained valid to very valid categories in terms of content and presentation, because they were able to link the material to students' real experiences. Furthermore, this study also showed that the use of environmental-based teaching materials can increase student engagement and conceptual understanding. This strengthens the point that the high validation results in this study not only indicate the feasibility of the product but also align with the trends in research results in the existing literature.

Theoretically, contextual learning emphasizes the connection between learning materials and students' real-world situations. In this study, the use of gastropod diversity data as a source of material in handout allows students to construct knowledge more meaningfully. This aligns with constructivism theory, which states that knowledge is not only obtained through the learning process but can also be acquired through discussion, experience, and the surrounding environment (Suparlan, 2019). Thus, the developed handout serve not only as a source of information but also as a means to connect concepts with reality.

However, this study has several limitations that need to be considered. The research was only conducted up to the development stage in the ADDIE model, so direct implementation and evaluation in the classroom have not yet been carried out. Therefore, the effectiveness of the handout in improving student learning outcomes cannot be determined empirically. This limitation provides an opportunity for further research to conduct a trial of the use of handout in real-life learning and measure their impact on learning outcomes, motivation, and student engagement. Thus, the development of this gastropod diversity-based handout can be further studied not only in terms of validity but also its effectiveness in supporting the learning process.

4. Conclusion

This research has successfully developed handout teaching materials based on the diversity of gastropods in the mangrove ecosystem of Kayu Ara Permai Village, Siak Regency, which displays various types of gastropods in the mangrove ecosystem of Kayu Ara Permai Village as a concrete form of biodiversity learning. This teaching material is designed to overcome the limitations of teaching materials used in

schools, as well as answer the need for contextual and more engaging learning. Through the development process, this teaching material was validated by material and media experts, and was declared very valid for use in the learning process. This teaching material is able to help and facilitate students in understanding biodiversity material. The success of this development proves that the use of handout based on local potential can be a solution for alternative teaching materials that are contextual and engaging. For further research, this handout teaching material needs to undergo an implementation and evaluation stage for its use in the learning process at school.

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