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Development of a Supplementary Ecosystem Booklet for 10th Grade High School Students: A Case Study of Mangrove Edupark Tambakrejo

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Abstract

This study aims to develop a biology learning supplement based on the local potential of the surrounding school area, specifically the Mangrove Edupark Tambakrejo Semarang, and to improve the learning outcomes of 10th-grade high school students. The research method used in this study is an adaptation of the 4D model developed by Thiagarajan, modified to only be implemented in the research location. This study involved 45 students from two classes as research subjects, selected through purposive sampling at SMA Sultan Agung 3 Semarang. The results showed that the Mangrove Edupark-based ecosystem booklet is feasible to use as a learning supplement and can improve students' learning outcomes. The practical implication of this study is that the ecosystem booklet can be an effective alternative to support biology learning in 10th grade and enhance students' creative thinking skills through meaningful learning, allowing students to better recognize the environmental wisdom around them. However, this study has limitations in terms of sample distribution, which is limited to only one school, and the incompleteness of the material content. Therefore, future research can involve more school samples around the Mangrove Edupark Tambakrejo area and improve the ecosystem material content to be more comprehensive.

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INTRODUCTION

Previous research has noted that many students experience difficulties in understanding complex biology topics, including ecosystem material. In high school, ecology material is taught in 10th grade with a focus on KD 3.10, which is to analyze components and interactions in ecosystems. However, Solihat (2020) found that many students still experience misconceptions about ecology/ecosystem material, especially in low-quality schools. Objective tests show that students have misconceptions about food chains, energy flow, trophic levels, and energy flow concepts. Therefore, there is a need for an appropriate approach to teaching ecosystem material so that students can understand it well.

One way that teachers can use to teach ecosystem material is to take students to locations outside the classroom or to the nearest mangrove forest (field trip) so that students can experience and observe directly. On the other hand, there is a natural potential that can be utilized as a learning medium, namely the Mangrove Edupark Tambakrejo. The Mangrove Edupark Tambakrejo is an educational and conservation area located in Tambak Rejo RT 04 RW 16, Tanjung Mas, Semarang Utara, Kota Semarang. In this edupark area, there are several types of mangroves from seedlings to mature mangrove plants, as well as other plants and animals that interact with each other. Currently, a 225-meter jogging track is being developed along the edupark area.

However, due to the pandemic, the edupark area has not been widely introduced, despite its potential as an educational area, especially for biology lessons that are closely related to the environment. However, some teachers in the school have not conducted field trips due to various reasons such as security concerns, time constraints, and costs, so ecosystem material is learned through lectures, discussions, information, and question-and-answer methods. One solution is to use or develop teaching materials or learning supplements as a reference that is related to the students' environment. Teaching materials can help biology teachers in the learning process to be more effective. For example, a booklet that is compiled based on the environmental conditions around students can be used as a relevant learning supplement. Using a booklet as a learning supplement can increase students' interest in learning and improve their ability to learn and understand the material. According to Ratu et al. (2019), learning outcomes are the ability of students to analyze information and make correct conclusions based on observations. This ability is very important to apply in everyday life. With a booklet that links the material to the students' environment, students will find it easier to understand and relate the material to the real world, thus improving the overall quality of learning.

Based on this background, there is a need to develop teaching materials that can make it easier for students to understand ecosystem material and think critically by linking the material to the students' environment, so that meaningful learning can be achieved. The environment around the students is the Mangrove Edupark Tambakrejo, which can be developed as a biology textbook.

RESEARCH METHOD

This research is a research and development study. The learning device developed in this study is a learning supplement in the form of a booklet based on the local potential of the Mangrove Edupark Tambakrejo, which is used to support learning in SMA Islam Sultan Agung 3 Semarang to determine the feasibility and effect of the booklet on students' cognitive learning outcomes. The learning device was developed using the 4D Thiagarajan development model, which consists of Define (definition), Design (design), Development (development), and Disseminate (dissemination) (Sugiyono, 2015). The dissemination stage was carried out in a limited manner, only at the research location (SMA Islam Sultan Agung 3 Semarang). The development of this learning supplement went through a validation process by 2 experts (validators), the first revision activity to obtain the 2nd draft, the trial activity, and analysis and revision based on the trial results to obtain a final and valid learning supplement (booklet).

RESULTS AND DISCUSSION

This research is a research and development study with the product developed being an ecosystem booklet based on the local potential of the Mangrove Edupark Tambakrejo Semarang as a learning supplement for 10th-grade high school students. The study was conducted on 10th-grade students at SMA Sultan Agung 3 Semarang. The procedure used in this study is a modification of the 4D development method. The dissemination stage was carried out in a limited manner, only at the research location (SMA Islam Sultan Agung 3 Semarang). The results showed that the booklet is feasible to use as a supplement based on the validation results of experts and the learning outcomes of students using this booklet have a value above the minimum completion criteria.

Table 1. Results of Expert Validation

No	Assessment Aspect	Average Validity	Criteria
1	Media	96%	Very Valid
2	Material	76%	Valid

The Effect of Media on Student Academic Achievement

At this stage, students were provided with instruction on ecosystem material, supported by a supplementary learning medium in the form of an ecosystem booklet. Following the learning session, students were given practice exercises to assess their learning outcomes after utilizing the booklet. Additionally, students were asked to complete a response questionnaire to evaluate the feasibility of the booklet. The feasibility/practicality questionnaire was administered to a total of 45 students from class X MIPA 1 and X MIPA 2. The results indicated that each item received a response rate exceeding 80%, suggesting that the booklet meets the criteria for being highly positive and is considered valid and feasible for use as a supplementary learning resource in teaching ecology material for Grade X senior high school students.

Class	Number of Students	Average Score
X MIPA 1	20	78.75
X MIPA 2	25	88.40

Based on the analysis of students' academic performance in class X MIPA 1, with the Minimum Mastery Criterion (KKM) set at 75, it can be observed that a portion of the students have successfully achieved or exceeded the established mastery threshold. The class average for assignments and examinations indicates a fairly satisfactory performance, with an average score of 78.75. However, three students—namely PD 8, PD 10, and PD 18—scored below the minimum mastery criterion.

Similarly, the analysis of the learning outcomes in class X MIPA 2, with the same KKM of 75, reveals that

the majority of students have managed to meet or surpass the required standard. The overall class performance was deemed satisfactory, with an average score of 84.1. Given the KKM threshold, a significant number of students achieved or exceeded the benchmark. Notably, several students recorded average scores above 90, indicating excellent academic achievement.

Table 2. Analysis of X MIPA 1 Students' Scores Below the Minimum Mastery Criterion (KKM)

Student Code	Item 1	Item 2	Item 3	Item 4	Item 5	Total Score	Final Score
PD 8	3	1	2	4	4	14	70
PD 10	3	2	2	2	4	13	65
PD 18	3	4	1	1	2	11	55

Based on the table above, the student with the sample code PD 8 obtained the lowest score on item number 2, which assessed the ability to identify and respond to the relevance and irrelevance related to a mangrove ecosystem case. The student was unable to provide a relevant opinion supported by an appropriate solution, resulting in the lowest score for that item.

Table 3. Analysis of X MIPA 2 Students' Responses Below the Minimum Mastery Criterion (KKM)

Student Code	Item 1	Item 2	Item 3	Item 4	Item 5	Total Score	Final Score
PD 25	4	4	2	0	4	14	56

Based on the table above, the student with the sample code PD 25 obtained the lowest scores on item numbers 2 and 4. In item 2, PD 25 demonstrated limited ability to develop responses involving identification and evaluation of relevant and irrelevant information related to a mangrove ecosystem case. In item 4, the student provided no response at all, resulting in a score of 0.

An analysis of the four students who scored below the Minimum Mastery Criterion (75) shows that their lowest performance occurred on questions requiring in-depth analytical and opinion-based responses. These students were unable to provide relevant and well-developed answers. To address this issue and improve the quality of students' responses, it is recommended to enrich the booklet content by incorporating real-life cases related to the mangrove ecosystem in Tambakrejo. These contextual cases can be linked to the topic of ecosystem balance within the Ecosystem chapter of the Grade X senior high school curriculum, thereby encouraging students to produce more critical and reflective responses.

Media Practicality

This study successfully developed a booklet based on the local ecosystem, titled "Edupark Mangrove Tambakrejo", to serve as a supplementary learning resource for the Ecology material taught in the even semester of Grade X at SMA Islam Sultan Agung 3 Semarang. Validation by media and content experts yielded positive results, with a validity percentage of 96% from the media expert and 76% from the content

expert.

Overall, the average score across all items was 87.5%, indicating that the booklet meets the criteria of being highly positive and is considered valid and feasible for use as a supplementary learning material in teaching ecology to Grade X high school students. However, several statements in the student response questionnaire received lower levels of agreement, suggesting areas in the booklet that may require further development. These aspects are outlined in the following:

Table 4. Student Response Analysis Toward the Booklet

No	Statement	Number of Students Disagreeing	Number of Students Slightly Disagreeing
1	The color and layout elements are attractive	1 student	2 students
2	The use of font variations (bold, italic, underline) is appropriate and not excessive	1 student	1 student
3	The image size does not interfere with the content	1 student	4 students
4	I am interested in learning directly at the Mangrove Edupark Tambakrejo, Semarang	1 student	4 students
5	The layout elements on the cover page are attractive	-	5 students

Based on the table above, there are several aspects of the booklet's design that were perceived as less appealing by students.

First, regarding the statement "the color and layout elements are attractive," some students disagreed, indicating that the background color selection and layout arrangement need greater attention in future revisions. These elements should be more carefully considered, following a balanced template design and taking into account appropriate color contrast to enhance visual appeal and readability.

Second, concerning the statement "the use of font variations (bold, italic, underline) is appropriate and not excessive," one student disagreed and another slightly disagreed. The disagreement stemmed from the presence of scientific terms that were not italicized, as conventionally expected, and the perception that bold formatting was used excessively in certain sections. To address this, future development of booklets or other textual media should include thorough proofreading and multiple cross-checking steps to minimize typographical and formatting errors.

Third, on the statement "the image size does not interfere with the content," one student disagreed and four others slightly disagreed. These students noted that some images were too large, which reduced the space available for accompanying text and negatively impacted the booklet's overall aesthetics. Therefore, future booklet designs should carefully consider image sizing to maintain balance and visual harmony, making the material more engaging for students.

Fourth, regarding the statement "I am interested in learning directly at the Mangrove Edupark Tambakrejo, Semarang," one student disagreed and four slightly disagreed. This feedback was likely due to a lack of detailed information about the site's advantages in the booklet. To enhance student interest, future revisions

should include more comprehensive information about this local potential, possibly incorporating links or names of the site's social media accounts. This would allow students to explore further through digital platforms and potentially increase their motivation to visit and engage with the local environment.

Fifth, on the statement "the layout elements on the cover page are attractive," five students slightly disagreed. This response may be attributed to the abstract placement of images and the use of white font for the author's name, which lacked contrast against a green background, making it difficult to read. In future designs, a more formal and structured template is recommended. The selection of text and background colors should ensure sufficient contrast, and font size should be bold and large enough to enhance legibility and aesthetic appeal.

CONCLUSION

Based on the results of the research and development conducted, several conclusions can be drawn as follows:

The Edupark Mangrove Tambakrejo-based ecosystem booklet was designed as a printed learning medium using A5-sized paper and consists of 25 pages. The font used is Calisto MT, size 12, with a line spacing of 1.15. The dominant color in the booklet is green, symbolizing nature, environment, and eco-friendliness. The content includes both material and photographs related to ecosystem topics contextualized within the Edupark Mangrove Tambakrejo area.

The booklet achieved a feasibility score of 76% from the material expert and 96% from the media expert. In terms of practicality, the students gave an average score of 87.5%, indicating that the booklet is appropriate for use as a supplementary teaching material for ecology topics in senior high school.

Furthermore, the ecosystem booklet, which is equipped with practice questions, supports the learning process effectively. This is evidenced by students' achievement levels, where the average scores exceeded the Minimum Mastery Criterion (KKM) of 75, with Class A achieving an average of 78.75 and Class B achieving 88.4..

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