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Pengembangan Media Pembelajaran *Flipbook* Berdasarkan Identifikasi Morfologi Jamur Makroskopis Di Kawasan Perkebunan Pinus Gunung Gumitir

(Development of a Flipbook Learning Media for Macroscopic Fungi Identification in the Gumitir Pine Plantation)

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ABSTRACT. *This research aims to develop an innovative and effective flipbook learning medium for morphological identification of macroscopic fungi in the pine plantation area of Mount Gumitir. This research is based on the lack of attractive, relevant teaching materials for tenth-grade students, particularly in the areas of biodiversity and the role of fungi in ecosystems. The research method used is the 4-D development model (Define, Design, Develop, Disseminate), which involves the stages of needs analysis, product design, development, and dissemination. Data collection was conducted in two phases: expert validation (language, material, and media experts) and field trials with tenth-grade students at SMK Raudatul Ulum and SMK Bahrul Ulum. The instruments used included validation sheets for experts and student response questionnaires. The collected data were analyzed quantitatively and qualitatively to determine the feasibility and effectiveness of the flipbook as a learning medium. The results showed that the developed flipbook met the valid criteria from all experts, with an average score indicating an outstanding category after the revision process. Student responses also showed positive results, with most students stating that the flipbook was attractive and easy to understand, and helped them improve their understanding of macroscopic fungi. Thus, it can be concluded that this Mount Gumitir-based local potential flipbook has the potential to be an effective and innovative alternative learning medium for enhancing the quality of biology learning, particularly in the context of fungi materials.*

INTRODUCTION

Forest areas with specific characteristics serve as protection, life-support systems, biodiversity conservation, and the sustainable utilization of biological natural resources and their ecosystems. Pine plantations provide ecological benefits to ecosystems, including the absorption of carbon dioxide, a process essential to plant photosynthesis. Carbon dioxide is a harmful gas if inhaled in the long term, such as from the exhaust of motor vehicles. Pine plantations in Indonesia are protected forests where the natural resources can be utilized for timber in a limited manner without reducing their protective function. Pine trees are widely distributed on Earth in both tropical and cold climates. Pine trees are not native plants to Indonesia, but are essential in the plantation sector [1].

Fungi are multicellular microorganisms that do not have chlorophyll, are hyphae-shaped, have cell walls made of cellulose, are eukaryotic, absorb nutrients by absorption, and reproduce sexually and asexually. Fungi live by utilizing organic matter as a nutrient source. Fungi are often found in agricultural and plantation lands, acting as natural decomposers to reduce decay and help increase the availability of nutrients for plants. As decomposers, fungi are more efficient at using carbon than other decomposers. Therefore, fungi release minimal carbon dioxide for each unit of carbon transformed aerobically. Some fungi can act as cellulase decomposers, breaking down cellulose in dead plant tissues, such as plantation waste and fallen trees, into simpler compounds that other organisms can utilize [2].

Fungi form fine threads that connect to the roots of pine trees to absorb carbon released by the pine trees. The carbon utilization cycle in fungi begins when pine trees absorb carbon dioxide from the air through their leaves, enabling them to carry out photosynthesis using solar energy and convert carbon dioxide into other carbon compounds. Meanwhile, fungi absorb carbon from the roots in the form of sugars or carbohydrates by connecting fungal hyphae to the tree roots. Approximately 20-40% of the photosynthetic products of pine trees are transferred to the fungi. In contrast, the nutrient release cycle in fungi begins with the uptake of nutrients from the soil through hyphae that can reach broader, deeper areas to break down organic material into simpler elements. The nutrients

released by pine are phosphorus taken from simplified soil minerals, which are essential for root growth and energy. Nitrogen is obtained from organic matter absorbed by fungi from the remains of dead organisms, which is necessary for the development of pine tree leaves, and other minerals such as potassium, magnesium, and copper. The advantage gained is efficient energy use, optimal resource utilization, and more effective nutrient recycling. This cycle demonstrates a highly organized, mutually beneficial relationship between pines and fungi. Therefore, fungi also contribute significantly to the overall health of the forest ecosystem. This illustrates the complexity of underground ecological networks in supporting forest survival, particularly in the face of climate change [3].

Two phyla of fungi that are classified as macroscopic fungi are Basidiomycota and Ascomycota. Basidiomycota fungi are characterized by having septate hyphae, where each hyphal cell contains a single nucleus and is separated by septa. The spores of this fungus are sexual, called basidiospores, produced by a specialized structure called a basidium, which is shaped like a club. This type of fungus has a body that is clearly visible on the surface of the soil or other substrates. Meanwhile, Ascomycota fungi are characterized by filaments separated by septa, where they produce spores called ascospores. These spores are produced by a specialized structure called an ascus, which resembles a sac. Basidiomycota and Ascomycota fungi typically thrive in a temperature range of 20 °C to 30°C [4]. Little sunlight and moisture are habitats favored by fungi because they are negatively phototropic. Fungi grow optimally during the rainy season and decline during the dry season. Fungi can grow in the temperature range of 20°C - 30°C, so the rainy season is the beginning of fungal growth [5].

Learning media is a vital component of learning, serving as a valuable resource for students and a guide for teachers throughout the learning process. All learning materials are systematically arranged, and one must pay attention to their principles, characteristics, and functions to achieve effective, efficient learning objectives [6]. Learning media can take the form of written or unwritten materials that contain information, tools, and texts necessary for teachers to plan and implement learning effectively. Learning media vary in content, including learning methods, limitations, and evaluation methods. Learning media is designed in accordance with instructional principles and adapted to the applicable curriculum. Understanding learning media is crucial for educators in creating and compiling teaching materials, as it can significantly impact the success of the learning process [7].

Learning media come in many forms, including teaching aids, modules, files, applications, and textbooks. The development of learning media has begun to keep pace with the times, supporting and enhancing students' knowledge acquisition and achievement [8]. The use of technology-based learning media that collaborates by utilizing the internet, which all groups can access, is a step toward increasing students' understanding of the material and making it easier for them to explore unfamiliar concepts. Students not only read books to gain knowledge but also learn how to access technology-based learning media [9]. Learning media not only have to be easily understood by students but also have to be interesting, so students are more motivated to learn. The use of learning media is very beneficial not only for students but also for teachers. Learning media can save teachers' time in teaching and shift teachers' roles from deliverers of learning materials to facilitators for students [10]. The selection of attractive and innovative technology-based learning media is another, such as a flipbook. A flipbook is software that provides editing tools for adding hyperlinks, images, videos, and sounds as supporting material, as well as multimedia objects on pages that can be flipped back and forth, similar to real books. Flipbook learning media has advantages over other learning media because it not only presents a series of texts but also combines them with audiovisual media. Therefore, flipbook learning media is very suitable for stimulating students' interest and enthusiasm in an effective and efficient learning process [11]. This research aims to identify the types of macroscopic fungi present in the pine plantation area of Mount Gumitir, and to develop and evaluate a flipbook as a feasible teaching material to enhance understanding of the role of fungi in the ecosystem.

Despite the crucial role of fungi in forest ecosystems, learning resources that present fungal biodiversity in a contextual and visually engaging format remain limited. Most existing materials are theoretical and lack field-based documentation that connects students directly with real ecosystem processes. Consequently, this study becomes important because it combines ecological exploration with the development of technology-based learning media, ensuring that students not only learn biological concepts but also understand their real-world applications. Thus, this research aims to bridge the gap between ecological knowledge and meaningful biology learning.

RESEARCH METHODS

This research employs the 4-D development model, comprising four main stages: Define, Design, Develop, and Disseminate. The 4-D development model aims to produce a technology-based flipbook learning

media product, a digital package book with pages that can be flipped, equipped with realistic images and video features to facilitate student learning. Several experts in specific fields, including media, language, and material experts, then validate it. Following this, a limited trial is conducted with tenth-grade students at two schools, during which questionnaires are distributed to gather their opinions on the developed learning media.

This research development procedure uses a development method carried out with (Research and Development). This research method is a series of gradual processes used to produce new, effective, and more productive products. Using this method, the research design employed is the 4-D model, which comprises four stages [12].

1. *Define*

The definition is the initial stage to define the purpose of flipbook development as a teaching material for students. The aim is to determine learning requirements, starting with an analysis of objectives and limitations to be developed, including the following: a) Determining the type of research. This type of research is development research, employing a descriptive approach with observational methods and direct observation to describe the phenomena and existing information on the diversity of macroscopic fungi in the pine plantation area of Mount Gumitir. b) Determining the researcher's presence phase. There are two phases in the researcher's presence phase: the field phase and the media compilation phase. The field phase is the activity of researchers being directly involved in observation and exploration activities in the pine plantation area of Mount Gumitir to determine various types of macroscopic fungi by taking samples of fungi found with visual documentation using digital camera aids and recording in detail the location of the mushroom discovery, temperature, pH, and morphological analysis. The observation instrument for the field phase of this research is as follows:

Table 1. Macroscopic Mushroom Observation

No.	Image	Scientific Name	Phylum	Diameter	Growth Location	Temperature	pH	Coordinate Point
1.								
2.								
3.								
…								

The media compilation phase is the second phase, following the collection of relevant material for flipbook learning media, including research results, scientific references, and literature on fungi. Designing the creation of virtual content and compiling scientific information with an attractive and easy-to-understand appearance for students, validated by experts. The steps for compiling flipbook media as an output in this research are as follows: 1) Initial product design with Canva, including cover, foreword, table of contents, basic competencies, indicators, learning objectives, primary material, practice questions, author identity, and bibliography. 2) Changing the shape of the flipbook with additional Heyzine features and further designs in Heyzine, such as style, settings, and interactions. 3) Then you can share links, QR codes, downloads, social media, web, and email [13].

2. *Design*

The design aims to develop learning tools based on the learning objectives for creating flipbook learning media. Designing a flipbook attractively, learning media, and according to the needs of students, and given input by supervising lecturers, which will later be validated by several validators, including media experts, language experts, and material experts.

3. *Develop*

At this stage, development is carried out to produce learning media that are effectively and validly developed when used. There are two main steps, including the following: a) Expert validation is carried out to obtain suggestions and input from experts to evaluate, so that the learning media developed is valid and in accordance with applicable regulations. b) Trials are carried out to obtain learning media that are consistent and efficient in assisting the learning needs of students in more interesting and non-boring learning.

4. *Disseminate*

Dissemination is the final stage of the 4-D model. Suppose the learning media obtains a positive value from experts. In that case, it is then packaged and applied on a small scale by disseminating the developed learning media to students who have completed the questionnaire. Respondents are tenth-grade students at SMK Raudatul Ulum, located in the Ledokombo sub-district, and SMK Bahrul Ulum, situated in the Mayang sub-district. The trial subject of this research was conducted in the pine plantation area of Mount Gumitir, situated in Silo District,

Jember Regency. This location was chosen for its high biodiversity and the presence of macroscopic fungi with potential as teaching materials. The trial subjects in this study were tenth-grade students from two different schools: SMK Raudatul Ulum, located in the Ledokombo sub-district, and SMK Bahrul Ulum, situated in the Mayang sub-district.

a. Trial subject

The trial subject of this research was conducted in the pine plantation area of Mount Gumitir, located in Silo District, Jember Regency. This location was chosen for its high biodiversity and the presence of macroscopic fungi with potential as teaching materials. The trial subjects in this study were tenth-grade students from two different schools: SMK Raudatul Ulum, located in Ledokombo sub-district, and SMK Bahrul Ulum, located in Mayang sub-district.

The observation process employed a variety of tools and materials to support data collection and analysis. The tools used included a laptop, digital camera, stationery, roll meter, raffia rope, knife, bamboo pegs, soil tester, macro detachable lens, and ruler. The primary material observed was macroscopic fungi, which served as the main object of study.

To ensure the validity and feasibility of the developed learning media, an expert validation process was conducted. The validation instrument consisted of an expert assessment questionnaire designed to evaluate the learning media on content, language, and presentation. The experts assessed the feasibility of the developed product by completing the questionnaire based on their professional judgment. A four-point Likert scale was used, with the following response options: Excellent (score 4), Good (score 3), Sufficient (score 2), and Poor (score 1) [14].

Table 2. Grid of Material, Language, and Media Expert Validation Instruments

No.	Material Assessment Indicator	Total	Language Assessment Indicator	Total	Media Assessment Indicators	Total
1.	Material Actuality	5	Suitability with language rules	5	Media Quality	10
2.	Material Feasibility	5	Dialogical and interactive	5	Product Usage	5
3.	Material Accuracy	5	Suitability with student development	5	Technical Quality Aspects	5
4.	Material Presentation Feasibility	5	Straightforward	5	Creativity and Innovation Aspects	5
5.	Encourages Curiosity	5	Communicative	-	-	-

[15]

The results of the questionnaire data from material experts, language experts, and media experts will be analyzed using the formula for calculating the average questionnaire as follows:

$$NP = \frac{R}{SM} X\ 100\% \quad (1)$$

Description: NP = Expected percentage value
R = Score obtained
SM = Maximum score

To strengthen the data on the feasibility of developing a level of qualification criteria as follows:

Table 3. Media Feasibility Criteria

Score in percent (%)	Feasibility Category
81 - 100 %	Very Feasible
61 - 81 %	Feasible
41 - 61 %	Quite Feasible
21 - 41 %	Less Feasible
0 - 21 %	Not Feasible

[16]

b. Student response

This instrument presents the results of testing the flipbook learning media on grade 10 students before and after their use, in the form of a questionnaire with statement items administered to respondents (10th-grade students) to assess the feasibility of the learning media for the learning process. The questionnaire uses a Likert

scale with four response options: “Excellent” (score of 5), “Good” (score of 4), “Sufficient” (score of 3), and “Not Good” (score of 2) [14].

c. Data analysis technique

The data analysis technique based on observation and sampling will be conducted descriptively. Fungal characteristics will be analyzed based on existing literature. Fungal classification will be carried out according to the macroscopic fungal identification guide. The results of the data analysis will be presented in the form of infographics, with images and text arranged concisely and attractively to facilitate understanding. To determine the feasibility category of flipbook learning media using a Likert scale.

RESULTS AND DISCUSSION

The development procedure is defined, which consists of 3 stages: 1) preparation stage, 2) data collection stage, and 3) identification stage. In the preparation stage carried out in the development of flipbook learning media based on the identification of macroscopic fungal morphology in the Mount Gumitir plantation area, the tools and materials needed for data collection in the field are prepared as follows: Ruler, raffia rope, roll meter, bamboo stakes, soil tester, knife, macro detachable lens, stationery, digital camera/cellphone, and laptop. The second stage of the defined process is data collection, which is conducted at three stations. Each station has two observation plots measuring 10 x 10 meters each. Observations were made by directly exploring and documenting the visual macroscopic fungi, recording detailed morphology, temperature, diameter, growth site/substrate, coordinates, and pH. The third stage is the identification stage, which follows the data collection process. In the identification stage, the collected fungal documentation is named according to the characteristics of each fungus using the Global Biodiversity Information Facility website, Plantamor, iNaturalist, and journals. The macroscopic fungi identified are grouped by classification, as shown in Table 4.

Based on research conducted in the Gunung Gumitir pine plantation, 53 macroscopic fungal species were identified, belonging to two phyla: Basidiomycota and Ascomycota. These phyla are further classified into four classes, ten orders, twenty-five families, thirty-nine genera, and fifty-three distinct fungal species. These macroscopic fungi were found on various substrates, including wood, soil, pine litter, and foliage. The following table presents the identification report of macroscopic fungal species found in the Gunung Gumitir pine plantation area.

Table 4. Identification report of macroscopic fungal species in the Gunung Gumitir pine plantation area

Class	**Ordo**	**Family**	**Genus**	**Spesies**
Agaricomycetes	Agaricales	Agaricaceae	Coprinus	*Coprinus comatus*
			Lepiota	*Lepiota rubrotinctoides*
			Leococoprinus	*Leococoprinus birnbaumii*
				Leococoprinus cepistipes
				Leococoprinus fragilissimus
			Macrolepiota	*Gymnopus albuminous*
				Macrolepiota clelandii
		Amanitaceae	Amanita	*Amanita subjunquillea*
		Crepidotaceae	Crepridotus	*Crepidotus cristatus*
		Hygrophoreaceae	Hygrocybe	*Hygrocybe reesiae*
			Lichenomphalia	*Lichenomphalia umbellifers*
		Lyophyllaceae	Termitomyces	*Termitomyces heimii Natarajan*
		Marasmiaceae	Baeospora	*Baeospora myosura*
			Marasmius	*Marasmius rotula*
				Marasmius haematocephalus
				Marasmius siccus
		Mycenaceae	Mycena	*Mycena stylobates*
				Mycena interrupta
			Xeromphalina	*Xeromphalina tenuipes*
		Psathyrellaceae	Coprinellus	*Coprinellus disseminatus*

				Coprinellus disseminatus
			Coprinopsis	*Coprinopsis atramentaria*
				Coprinopsis urticicola
		Schizophyllaceae	Schizophyllum	*Schizophyllum commune*
		Strophariaceae	Deconica	*Deconica merdaria*
			Protostropharia	*Stropharia semiglobata*
		Tricholomataceae	Leucopaxillus	*Leucopaxillus gentianeus*
	Polyporales	Polyporaceae	Amaropostia	*Amaropostia stiptica*
			Fabisporus zmitrovich	*Pycnoporus sanguineus*
			Ganoderma	*Ganoderma resinaceum*
				Ganoderma curtisii
			Lentinus	*Lentinus arcularis*
				Lentinus squarrosulus
			Polyporus	*Polyporus arcularis*
			Trametes	*Trametes variegata*
				Trametes gibbosa
				Trametes versicolor
		Panaceae	Cymatoderma	*Cymatoderma dendriticum*
		Steccherinaceae	Steccherinum	*Steccherinum ochraceum*
	Auriculariales	Auriculariaceae	Auricularia	*Auricularia auricula judae*
				Auricularia polytricha
	Boletales	Boletaceae	Suillellus	*Suillellus queletii*
		Suillaceae	Suillus	*Suillus grevillei*
	Geastrales	Geastraceae	Geastrum	*Geastrum mirabile*
	Hymenochaetales	Hirchioporaceae	Hirchioporus	*Hirchioporus abietinus*
	Russulales	Hericiaceae	Hericium	*Hericium coralloides*
		Stereaceae	Stereum	*Stereum hirsutum*
Dacrymycetes	Dacrymycetales	Dacrymycetaceae	Dacrymyces	*Dacrymopinax spathularia*
Sordariomycetes	Xylariales	Hypoxylaceae	Daldinia	*Daldinia concentrica*
		Xylariaceae	Xylaria	*Xylaria polumorpha*
				Xylaria cubensis
				Xylaria hypoxylon
Leotiomycetes	Helotiales	Dermateaceae	Pezicula	*Pezicula cinnamomea*

Here are the results of developing flipbook learning media based on the identification of macroscopic fungal morphology in the Gunung Gumitir pine plantation area, available as a link and QR Code.

https://heyzine.com/flip-book/8851f93fce.html

Figure 1. QR Code of the mushroom flipbook media


BASIDIOMYCOTA
Class : Agaricomycetes

(a)


BASIDIOMYCOTA
Class : Agaricomycetes

(b)


BASIDIOMYCOTA
Class : Agaricomycetes

(c)


BASIDIOMYCOTA
Class : Agaricomycetes

(d)

(e)

Figure 2. Documentation of fungi found in the Gunung Gumitir pine plantation area.

In the development stage, there are two stages, namely the validation stage and the trial stage. The validation stage is carried out by validators/experts across three required fields: language, material, and media. In the validation stage, the experts provide suggestions and input on improvements to the flipbook's media, materials, and language.

In this study, the validation stage, comprising assessments from language, material, and media experts, was conducted twice to ensure that the flipbook learning media being developed met standards of quality, clarity, and feasibility before it was tested on students. The purpose of performing the validation in two cycles was to obtain results that were not only accurate and objective but also reflective of expert judgment based on established criteria for instructional media development. In this regard, the language expert involved in evaluating the linguistic aspects of the flipbook learning media on fungal material was Mrs. Fita Fatimah, M.Pd., who served as the validator responsible for examining the appropriateness of grammar, sentence structure, terminology, readability, and overall language presentation within the media. During the first stage of expert validation, the language expert carefully reviewed the flipbook content and provided assessments based on a structured evaluation instrument. The initial validation results yielded a total score of 59 out of a possible 100 points, which corresponds to a percentage of 59%. According to the predefined categorization criteria used in this research, this percentage places the flipbook learning media in the “Fairly Feasible” category, indicating that although the media shows potential for instructional use, several revisions and enhancements are still required to improve clarity, linguistic accuracy, and the overall quality of the content before progressing to the next development phase.

The second validation results for the flipbook learning media, as assessed by the language expert, follow up on the initial validation. Quantitatively, the second validation results, as evaluated by the language expert, yielded a total score of 87 out of 100, equivalent to 87%. Based on the criteria used, this percentage places the flipbook learning media in the “Very Feasible” category. Thus, it can be concluded that this learning media has met the expected quality standards from a linguistic aspect, and is ready to be tested on students. This significant improvement highlights the importance of validation by language experts in the development of learning media.

The next stage is to validate the flipbook learning media on fungal material by the material expert validator, Mrs. Dwi Sucianingtyas Sukamto, M.P. The expert validation stage was carried out twice. The first validation results, as assessed by the material expert, yielded a total score of 63 out of 100, equivalent to 63%. Based on the criteria used, this percentage places the flipbook learning media in the "Fairly Feasible" category. The second set of validation results for the flipbook learning media, as a follow-up to the initial validation, was provided by the material expert. Quantitatively, the second validation results, as assessed by the material expert, yielded a total score of 89 out of 100, equivalent to 89%. Based on the criteria used, this percentage places the flipbook learning media in the "Very Feasible" category. Thus, it can be concluded that this learning media has met the expected quality standards from a material aspect, and is ready to be tested on students.

This significant improvement confirms the importance of validation by material experts in developing high-quality, practical learning media. The next stage is to validate the flipbook learning media on fungal material by the media expert validator, Mrs. Dr. Nurul Komaria, M.Pd. The expert validation stage was carried out twice. The first stage of the media expert validation yielded a total score of 60 out of 100, equivalent to 60%. Based on the assessment criteria used, this score places the flipbook learning media in the "Fairly Feasible" category. The second validation results for the flipbook learning media, as a follow-up to the initial validation, were provided by the media expert. Quantitatively, the second stage of the media expert validation yielded a total score of 93 out of 100, equivalent to 93%. Based on the assessment criteria used, this score places the flipbook learning media in the "Very Feasible" category. Thus, it can be concluded that the flipbook has experienced significant quality improvement and meets most standards as an attractive and effective learning medium. These results demonstrate the importance of the validation and revision process in developing high-quality learning media.

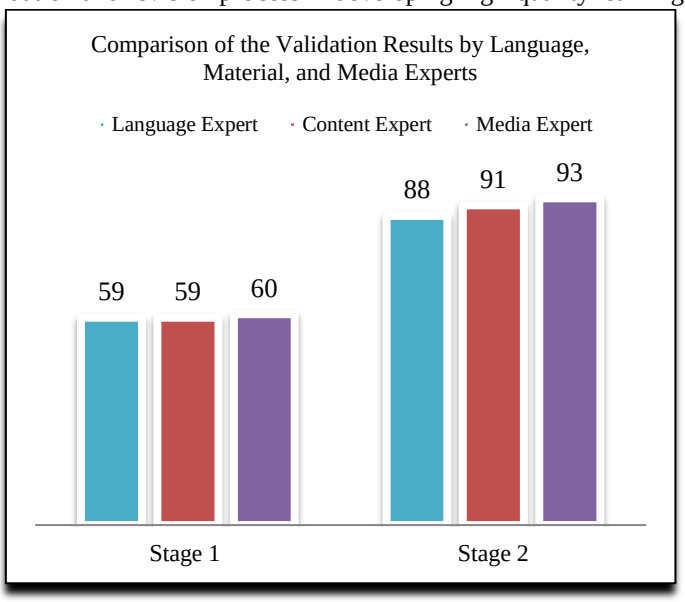

Figure 3. Graph of expert validation results comparison

The graph comparing validation results from language, material, and media experts shows a significant improvement in the quality of flipbook learning media following a revision process. In general, validation scores in the early stages tend to be lower and categorized as "Fairly Feasible," whereas those in the final stages are classified as "Very Feasible." This indicates that the input and suggestions from the experts have been effectively implemented to improve the learning media. This increase in validation scores reflects the development team's commitment to producing high-quality learning media that meet the expected standards. A more detailed comparison reveals that the rise in validation scores was not uniform across all aspects. For example, the increase in language expert validation scores may exceed that in material expert validation scores, or vice versa. This may be due to differences in focus and assessment criteria among the experts. However, overall, this comparison graph provides strong evidence that the validation and revision process by experts has a significant positive impact on the quality of flipbook learning media. It also underscores the importance of involving experts with diverse perspectives in the development of learning media.

In the trial stage of the flipbook learning media, which has been declared feasible by language, material, and media experts. Then, the learning media were tested on students in two different schools. The first school is SMK Raudatul Ulum, with 50 students in grades 10A and 10 B. The second school is SMK Bahrul Ulum, with 23

10th-grade students. The trial was conducted to determine students' responses to the developed flipbook learning media on fungal material. The learning media were tested on all grade 10 students. The following is the data from the trial results of the flipbook learning media that has been developed.

Analysis results of the responses of grade 10 A and 10 B students at SMK Raudatul Ulum to the use of flipbook learning media in the teaching and learning process. The data presented are students' responses to a series of questions or statements in a questionnaire designed to measure their perceptions, interests, and understanding of the material in the flipbook. This analysis is crucial for assessing the effectiveness of learning media from the user's perspective and for identifying potential advantages and disadvantages to be considered in the further development of learning media. The analysis results show variations in student responses to various aspects of the flipbook learning media. Most students gave positive responses to the visual appearance, ease of use, and clarity of the material presented. This is reflected in the high percentage of students who agreed or strongly agreed with statements related to these aspects. Overall, the analysis of responses from Grade 10 A and 10 B students at SMK Raudatul Ulum presents a positive picture of the use of flipbook learning media. Although there are aspects that need improvement, the majority of students showed enthusiasm and a high interest in this learning medium. This suggests that flipbooks have the potential to be an effective and engaging learning medium for students, supporting the achievement of established learning objectives. These analysis results can also serve as a basis for developing more innovative learning media that better meet students' needs in the future.

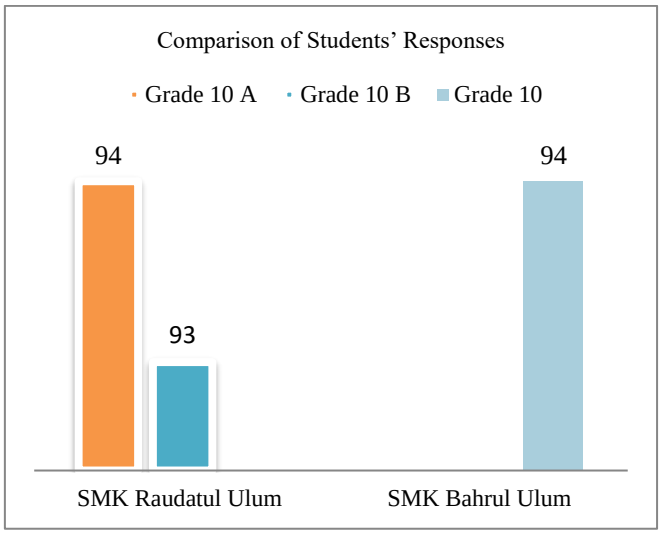

Figure 4. Graph of student response comparison

The graph of student response comparisons provides a detailed visualization of how students from two different schools, SMK Raudatul Ulum and SMK Bahrul Ulum, perceived the use of flipbook-based learning media within their respective learning environments. This visualization offers a more comprehensive depiction of students' impressions by presenting their responses in a structured and easily interpretable format. The graph presents a comparative overview across several key aspects that were evaluated, including the visual appeal of the flipbook design, the ease with which students were able to navigate through the pages and features, the clarity and coherence of the instructional content provided, the level of interactivity embedded in the media, and the degree of overall engagement experienced during the learning process.

By displaying the response patterns from both student groups side by side, the graph allows readers to observe not only the strengths and positive attributes of the flipbook as a learning medium but also to identify potential differences, nuances, and variations in how students from distinct educational settings interpret, utilize, and experience digital learning tools. This side-by-side comparison enriches the interpretation of the data by showing how contextual factors such as school facilities, students' familiarity with technology, and classroom implementation strategies may influence their perception of the same learning media.

Generally, the graph displays a similar trend in student responses from both schools, indicating a relatively consistent pattern of perception toward the flipbook learning media across the two educational settings. Both groups of students provided positive assessments of the flipbook's visual appearance and ease of use, as reflected in their noticeably high average scores in these categories. This consistency suggests that the flipbook possesses an appealing visual design, intuitive layout, and user-friendly navigation system that make it accessible and

engaging for students from diverse backgrounds, regardless of differences in learning environments or levels of technological familiarity.

However, despite the similarities in several aspects, the graph also reveals significant differences in student responses to the interactivity component of the flipbook. Students from one school provided higher ratings for this aspect compared to those from the other school. This discrepancy may stem from variations in how the flipbooks were introduced and implemented during classroom activities, differences in the learning support provided by teachers, or varying levels of digital literacy, motivation, and learning characteristics among the students in both schools. These contextual factors can influence how students interact with digital learning tools and how deeply they engage with interactive features embedded in the media.

Further analysis of the graph comparing student responses can provide deeper and more comprehensive insights into the overall effectiveness of flipbooks as a digital learning resource. By systematically comparing student responses across multiple aspects of the learning media, researchers and educators can more accurately identify the strengths, limitations, and areas that require improvement to optimize the design and implementation of flipbooks in different educational contexts. Such information is valuable for guiding the development of future flipbook versions that are more effective, responsive, and relevant to students' needs. In addition, comparing student responses from different school settings helps educators better understand how variations in student characteristics, classroom environments, and instructional practices influence their perceptions, levels of engagement, and learning experiences when using digital learning media.

This research successfully identified the diversity of macroscopic fungi present in the Gunung Gumitir pine plantation area and examined the effectiveness of flipbooks as an innovative teaching material for grade 10 students studying fungal concepts. The findings of the study demonstrate that the Gunung Gumitir region possesses substantial potential for fungal biodiversity, as indicated by the variety of macroscopic fungi discovered during field observations. This richness in biodiversity not only provides important ecological information but also offers a valuable source of authentic learning material that can be utilized in future educational activities, scientific investigations, and conservation initiatives.

In addition to documenting biodiversity, this research evaluated the pedagogical value of flipbooks and found that they are highly effective in enhancing students' knowledge, comprehension, and interest in learning about fungi. The effectiveness of flipbooks is supported by consistently positive student responses, improved learning outcomes, and increased engagement during the learning process. Several contributing factors were identified, including the attractive visual design of the flipbook, the ease with which students were able to navigate its features, and the structured presentation of content that aligns with curriculum requirements. These strengths enable the flipbook to function as a modern and interactive medium that captures students' attention and supports their understanding of complex scientific concepts.

Moreover, the positive responses from students indicate that flipbooks can create a learning experience that is more interactive, enjoyable, and accessible compared to traditional learning materials. This contributes to heightened student motivation, active participation, and a greater sense of curiosity in exploring biological topics. Overall, the integration of biodiversity findings with the development of technology-based learning media demonstrates that flipbooks have strong potential to become an effective and engaging educational tool. They bridge real-world scientific observations with classroom learning and ultimately contribute to a more meaningful and student-centered educational environment.

CONCLUSION

This development research has produced flipbook learning media on fungal material for grade 10 students, following an assessment stage conducted by experts as validators. The results, based on feasibility criteria, were assessed by the experts as "Very Feasible." Based on the results of expert validation, language experts 90%, material experts 90%, and media experts 90%. After validation and trials, which were found to be very feasible based on the trial results, Grade 10 A at SMK Raudatul Ulum achieved a score of 94%. In comparison, Grade 10 B achieved a score of 93%. At SMK Bahrul Ulum, Grade 10 students achieved a 94% score. Based on research and product studies, this flipbook on fungi is highly recommended as a supplement to grade 10 teaching materials, especially for the material on the classification of living things. Teachers can use the flipbook as a substitute or complement to textbooks, assign it for independent study, or use it as a presentation medium in class. The advantage of flipbooks, which present information visually and interactively, is that they help students understand abstract and complex concepts more easily.

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