

Integration of macroscopic fungal diversity in the Banyak mountain forest area into the fungal e-module: Validity and practicality analysis

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Submitted:
01-01-2025

Accepted:
28-01-2025

Published:
02-02-2025

Abstract: Developing an e-module for biology education is necessary to optimize the learning process. This research aims to evaluate the validity and practice of the macroscopic fungal diversity e-module found in the Banyak mountain forest area, Sragen Regency, as a fungi learning resource. This research employs a research and development (R&D) approach using the ADDIE development model. The e-module was validated by four validators: two media experts and two content experts. At the same time, the practicality test was conducted through individual and small group trials with Xth-grade students. The data collection instruments included a validity assessment sheet for the media and content, as well as a student response questionnaire. Data analysis was conducted both qualitatively and quantitatively, with qualitative data including suggestions and comments from evaluators, while quantitative data were based on evaluator assessments using a Likert scale. The results show that the media validity score was 94%, categorized as very valid, the content validity score was 89%, categorized as very valid, and the practicality test yielded an average score of 87%, categorized as very practical. Based on these results, it can be concluded that the e-module on macroscopic fungal diversity is valid and practical as a learning resource on fungi at a high school in Tangen and can proceed to the next phase, effectiveness testing.

Keywords: E-module, fungi sub-topic, macroscopic fungi, practicality, validity

Abstrak: Pengembangan e-modul pendidikan biologi diperlukan untuk mengoptimalkan proses pembelajaran. Penelitian ini bertujuan untuk mengevaluasi validitas dan praktik e-modul keanekaragaman jamur makroskopis yang terdapat di kawasan hutan pegunungan Banyak Kabupaten Sragen sebagai sumber belajar jamur. Penelitian ini menggunakan pendekatan Research and Development (R&D) dengan menggunakan model pengembangan ADDIE. E-modul divalidasi oleh empat validator yaitu dua ahli media dan dua ahli konten. Sedangkan uji praktikalitas dilakukan melalui uji coba individu dan kelompok kecil terhadap siswa kelas X. Instrumen pengumpulan data meliputi lembar penilaian validitas media dan isi, serta angket respon siswa. Analisis data dilakukan secara kualitatif dan kuantitatif, dengan data kualitatif berupa saran dan komentar dari evaluator, sedangkan data kuantitatif berdasarkan penilaian evaluator dengan menggunakan skala likert. Hasil penelitian menunjukkan skor validitas media sebesar 94% berkategori sangat valid, skor validitas isi sebesar 89% berkategori sangat valid, dan uji praktikalitas menghasilkan skor rata-rata sebesar 87% berkategori sangat praktis. Berdasarkan hasil tersebut dapat disimpulkan bahwa e-modul keanekaragaman jamur makroskopis valid dan praktis sebagai sumber belajar jamur di salah satu SMA di Tangen dan dapat melanjutkan ke tahap selanjutnya yaitu uji efektivitas.

Kata kunci: E-modul, sub materi jamur, jamur makroskopis, kepraktisan, kevalidan

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INTRODUCTION

Curriculum improvement is an essential step in advancing education, aiming to enhance the education system. The independent curriculum has three main characteristics: simpler content (only essential material), projects that strengthen the Pancasila student profile (P5), and educational units are given the freedom to design learning outcomes and instructional hours according to student abilities (Siregar et al., 2023). Furthermore,

teachers are expected to emphasize differentiated learning to improve outcomes. Differentiation can include content, process, product, and environment (Gusteti & Neviyarni, 2022). Educational delivery methods are an important means to conduct education. According to the Republic of Indonesia Law No. 20 of 2003 on the National Education System, learning is the process of interaction between educators, students, and learning resources within a learning environment. Learning, according to Ariani et al. (2022), is essentially an interaction between students and their environment, resulting in a change in behavior toward improvement.

Learning resources are defined as anything that can be used by teachers, either separately or in combination, to support teaching and learning in order to increase effectiveness and efficiency in achieving learning objectives (Dita et al., 2023; Hamdani, 2020). The environment in which students learn is a crucial educational resource, encompassing diverse biological entities. It is vital for students to be exposed to the potential of their environment to develop adaptive thinking systems and behaviors (Nugroho, 2018). Utilizing the environment as a learning medium enables educators to create profound and impactful educational experiences for their students (Irmeilyana et al., 2020). By leveraging the environment as a medium and source of knowledge, educators can help students develop a deeper and more relevant understanding of the subject matter while fostering a greater sense of environmental stewardship (Mutiara, 2021). However, the scarcity of learning resources often poses challenges in education, hindering the achievement of learning objectives and leading to monotonous and unvaried educational experiences.

According to Soleh (2017), integrated local potential refers to skills that can be developed, strengths, abilities, and capacities that can be nurtured for growth. The inclusion of learning materials related to local potential is necessary to prevent the loss of local resources and to develop these local potentials further. The local potential of students' surroundings should be utilized to enhance biology education, allowing students to investigate, process, understand, and engage with the various opportunities available to them (Damopolii et al., 2019; Ule et al., 2021). Each region possesses unique local potential, including natural features such as forests, mountains, lakes, and swamps, as well as man-made structures like temples, various plants used as food or medicine sources, disaster mitigation processes, and more (Horota, et al., 2023; Rusilowati et al., 2016). In biology education, teachers typically provide examples found within the school environment so that students feel confident when participating in discussions. This approach is one way to encourage students to be active by integrating local potential into biology lessons. One example of a learning resource in Sragen Regency is Banyak mount, which offers opportunities for outdoor learning and teaching. This wider spatial dimension fosters a deeper understanding of the surrounding environmental conditions. However, in actual learning situations, this approach becomes a challenge as it requires substantial time, whereas classroom time is limited. Therefore, it is necessary to integrate the environment into teaching media that students can use for independent learning.

Based on observations conducted at one of high school in Tangen, it was found that the curriculum implemented is the "Merdeka Curriculum." In this curriculum, there have been updates to the content of biology subjects as outlined in the Learning Objectives Pathway. Students face difficulties in understanding materials related to fungi. The fungi

material is integrated into biodiversity topics. Due to the implementation of the Merdeka Curriculum, fungi-related materials are not delivered optimally, particularly regarding the topic of macroscopic fungi. Educators have not effectively incorporated the surrounding environment as an engaging learning resource and have largely relied on textbooks. Furthermore, it was observed that the textbooks used for teaching fungi are less appealing to students due to unclear and uncolored illustrations, especially those depicting various fungi types from the divisions Zygomycota, Ascomycota, Basidiomycota, and Deuteromycota. This material not only requires an appropriate learning model to encourage students to understand it effectively but also demands engaging and interactive learning resources, including images, animations, and educational videos, to facilitate better understanding of fungi topics. One approach to enhancing learning media involves combining materials that present concepts or images from research findings (Panjaitan et al., 2019; Pratiwi et al., 2024). Therefore, one medium that meets the criteria for a learning resource is the electronic module (e-module).

E-modules that integrate local environments can be defined as e-module that combine learning materials with knowledge, skills, and values related to the natural environment. Electronic modules are digital learning units designed as effective and accessible educational resources available online (Solikin, 2018). These modules can incorporate various multimedia elements such as images, audio, video, and animations, and often include formative assessments (Dita et al., 2024; Nalarita & Listiawan, 2023). Electronic modules serve as support tools for students throughout their educational journey (Najuah et al., 2020). Electronic modules facilitate independent learning over a defined period, as they are structured into the smallest learning units. The use of electronic modules can enhance students' learning abilities and engagement, making them a practical solution to address challenges related to limited learning time. Previous studies have shown that using electronic modules offers many benefits for the learning process. Interactive e-modules can increase student motivation compared to traditional learning materials (Ramdhani & Khoirunnisa, 2020). Thus, an engaging and interactive e-module can facilitate more interesting and effective learning for students.

Development of teaching materials can be adapted to a model or approach that creates student understanding and allows clear identification of learning goals (Benny, 2019). The lack of variety in learning materials used by teachers, based on observations and interviews, can be addressed by developing e-modules. The development of educational media must consider several factors, including visibility, attractiveness, simplicity, usability, information accuracy, coherence, and organization (Hamka & Effendi, 2019). A good teaching material must meet: validity, practicality, and effectiveness criteria (Trianto, 2007). Validation is important to assess a product's feasibility based on expert evaluations and to provide design recommendations to ensure the final product is suitable for educational use (Gonibala et al., 2019). In addition to being valid, teaching materials must also be practical. Several studies, such as one by Nerita (2019), report that products developed with the "very practical" category mean they are easy to use in the learning process.

Several studies have been conducted on e-modules. Similarly, the development of e-modules has been studied by various researchers, including Sirait (2024); and Apriansyah (2024), who found them suitable, and Nadira (2022), who concluded they met "very valid"

criteria. Based on these descriptions, this study aims to analyze the validity and practicality of e-module learning media in biology education. The development of the e-module on the topic of fungi as a learning resource for 10th-grade biology students is expected to serve as an additional learning resource.

METHOD

This research employs the Research and Development (R&D) methodology, designed to produce specific products and evaluate their effectiveness. The approach used combines mixed-method research design, integrating qualitative and quantitative paradigms (Darmawan, 2019). The development framework adopted is the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation (Figure 1). However, due to time constraints, this research is limited to the Development stage.

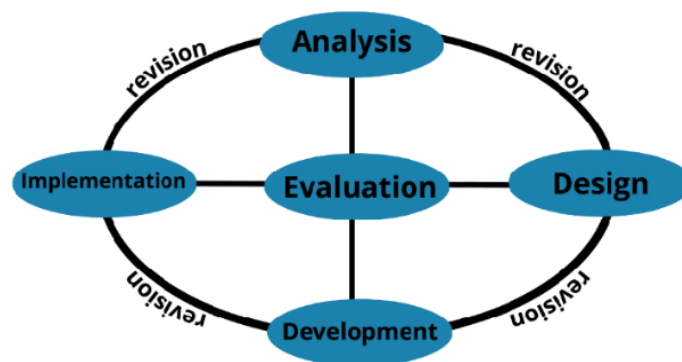


Fig. 1. ADDIE development model (Branch, 2009)

The Analysis stage involved a needs assessment of students and teachers, content analysis, structural analysis, and goal analysis. The Design stage in the ADDIE development model represents a systematic process, starting with designing the concepts and content for the developed product. The Development stage aims to actualize all the previous stages.

This study was conducted in October 2024 with subjects involving the development of an e-module on fungi for validity testing, which included two media experts from Universitas Sebelas Maret (UNS) and Universitas Muhammadiyah Surakarta (UMS), and two content experts from Universitas Sebelas Maret and a biology teacher from SMAN 5 Surakarta. Practicality testing involved limited trials, consisting of individual trials with 3 students and small group trials with 8 students.

Data collection was done through distributing validity questionnaires to validators (media and content experts) and practicality questionnaires to several 10th-grade students. The questionnaires contained a series of predetermined questions or items with standardized answers (Siswono, 2019). The Likert scale with four levels was used. This instrument was used to assess validity as determined by media and content experts and practicality based on student responses. The data analysis technique used in this study is based on the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100\% \quad (1)$$

Explanation:

P = Percentage

Σx_i = Total score from respondent

Σx = Maximum ideal score

The average score for each component is converted into a percentage. The average score of each component is then evaluated based on the criteria outlined in Table 1.

Table 1. Validity and practicality categories for learning media

Percentage (%)	Validity Level
$80\% < P \leq 100\%$	Very Valid/ Very Practical
$60\% < P \leq 80\%$	Valid/ Practical
$40\% < P \leq 60\%$	Fairly Valid/ Fairly Practical
$20\% < P \leq 40\%$	Less Valid/ Less Practical
$0 < P \leq 20\%$	Not Valid/ Not Practical

Source: (Riduwan, 2015)

RESULTS AND DISCUSSION

Analysis

The initial stage of the ADDIE research model is the analysis stage. This phase focuses on identifying the challenges faced by educators and students in the educational process.

A needs analysis was conducted with students from class X at one of high school in Tangen using a questionnaire. Based on the results of the student needs analysis, several issues in learning were identified, such as the textbooks used failing to connect the learning material with the students' surrounding life. From the analysis, it was found that 100% of students use smartphones, 68% of students stated that the topic of biodiversity, particularly fungi, was difficult to understand, and 81% of students agreed that utilizing data and information from the Banyak mount area could help them understand the material better.

A needs analysis for teachers was conducted through direct interviews with the biology teacher for class X and a questionnaire. Based on this analysis, it was found that teachers mainly rely on textbooks for teaching and require teaching materials in the form of e-module that integrate the local environment of the students.

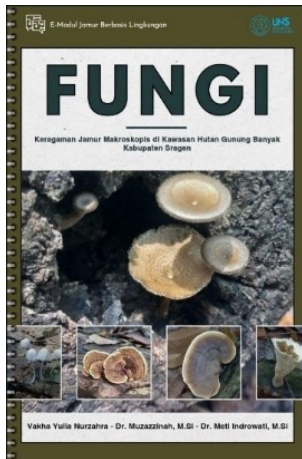
Design

Product selection

The teaching material that fits the needs of both teachers and students, based on the analysis, is an e-module on the macroscopic fungal diversity in the Banyak mount forest area as part of the fungi topic. The e-module was designed using the Canva application and the Heyzine application to convert the PDF file into a flipbook format.

Format Selection

The format for the e-module was chosen based on the standards for creating e-module. The finalized e-module design is illustrated in Figure 2.



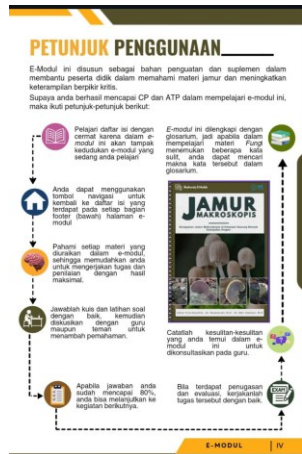
(a) Front Cover



(b) Preface



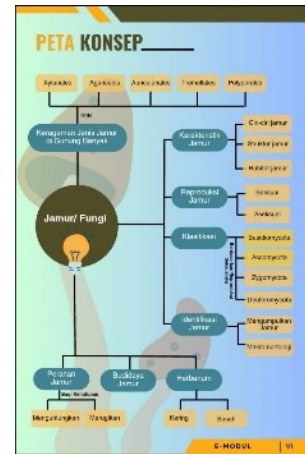
(c) Table of Contents



(d) User Instructions



(e) Introduction



(f) Concept Map



(g) Research Location



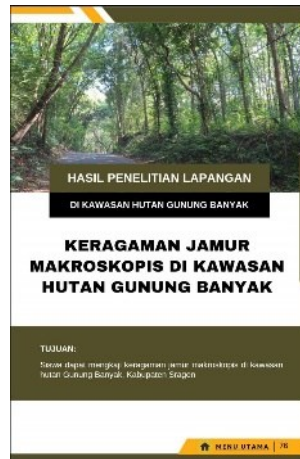
(h) Fungi Material



(i) Material Summary



(j) Quiz



(k) Research Results



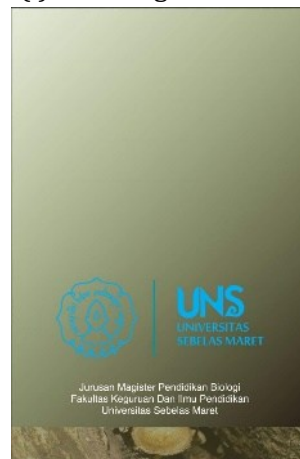
(l) Learning Reflection



(m) Glossary



(n) References



(o) Back Cover

Fig. 2. E-module view

Development

The development phase was conducted to evaluate the product and validate and test the practicality of the resulting e-module based on comments, feedback, and suggestions from validators and student responses. The result of this study is the e-module on the fungi topic as a learning resource for biology students in class X at SMA. The validity assessment of the e-module on the macroscopic fungal diversity in the Banyak mountain forest area as a learning resource for fungi material was conducted using a validation sheet evaluated by media and content experts.

The results of the validation were used to determine the product's feasibility and provide guidelines for revising any deficiencies in the product. Product validation is the process of testing the accuracy of the e-module by experts (Dita et al., 2023; Halid et al., 2023). Validation is required in development research. Once the module is validated, its shortcomings are identified based on the indicators set by the experts.

Validity test of e-module by media experts

The evaluation of the e-module as a learning resource on the macroscopic fungal diversity in the Banyak mountain forest area was conducted to determine the validity of the developed learning media. Media expert validators were distinguished lecturers in the field

of Informatics Engineering and Computing from Universitas Sebelas Maret and Universitas Muhammadiyah Surakarta.

The criteria used for validation by media experts included media efficiency, media content, media graphics, and media usability. The validity of the e-module as a learning resource on macroscopic fungi material is reflected in the evaluation results provided by media expert validators, as detailed in Table 2.

Table 2. Validity test results of the e-module by media experts

No	Assessment Aspect	Indicator	Validator		%	Category
			1	2		
1	Media Efficiency	Ease of using the e-module	4	4	100	Very Valid
		Accessible using smartphones	4	4		
2	Media Content	Relevance of the content to the material	4	4	96	Very Valid
		Appropriateness of language use	4	4		
		Creativity and dynamism	3	4		
3	Media Graphics	Appropriateness of font size and type	3	3	91	Very Valid
		Harmony of text color with the background	4	3		
		Appeal of the presentation and mages	4	4		
		Appropriateness of included videos	4	4		
4	Media Usefulness	Clarity of presentation	3	4	92	Very Valid
		Media aids in learning	4	3		
		Eases material delivery	4	4		
Overall Score			45	45	94	Very Valid

Notes:

Validator I: Lecturer in Informatics and Computer Engineering, UNS

Validator II: Lecturer in Informatics and Computer Engineering, UMS

The data from the evaluation not only include quantitative results but also qualitative feedback in the form of suggestions and comments from expert validators. The suggestions and comments from the two validators are as follows:

- a) Clarify the instructions for the Student Worksheet and quiz.
- b) Remove the answer key if the e-module is intended for student use.
- c) There are links in the table of contents that are not functional.
- d) On certain pages, the color of the column headers does not harmonize well with the background.
- e) For the evaluation questions, links need to be added.

The analysis of the e-module validity test results shows a very high validity level, with an overall average of 94%, categorizing this e-module as highly valid. Each component of the e-module also meets high validity criteria, ensuring that the quality of the e-module is consistent across all aspects. The validity details for each component, as shown in Table 2, reveal that the media efficiency component achieved a perfect score of 100%, the content component scored 96%, the graphics component scored 91%, and the media usability component scored 92%. This data clearly affirms that the developed e-module demonstrates outstanding quality across all evaluative aspects, from efficiency to usability.

Based on the media efficiency perspective, the e-module received a score of 100%. Each indicator of this component falls within the very valid category, meaning the e-module can be easily accessed via a smartphone. The ease of accessing the required sources of information, whether in the form of audio, visuals, written text, or symbols, has been facilitated by technological devices.

In the media content aspect, the goal is to assess the relevance of the learning media to the educational material (Zahwa et al., 2021). The e-module achieved a very high validity score of 96%, categorizing it as highly valid. This achievement indicates that the developed e-module has effectively aligned the content with the material, ensuring the proper use of language and dynamics. This finding is consistent with Hairah (2020) study, which showed that media content validation results fell within the highly valid category, affirming its suitability as a learning medium.

The graphic aspect, related to media experts, concerns the aesthetics of the learning material display, receiving a score of 91% with a very valid category. The evaluation of graphic elements also includes the cohesive arrangement of components, the careful selection of relevant and engaging images, and the effective application of spacing. These factors collectively contribute to an appealing visual attractiveness, thereby enriching the educational experience for students (Putri & Saino, 2020). The effective use of graphic elements not only enhances the visual quality of the material but also facilitates improved understanding, as well-designed visuals can communicate information more clearly and efficiently. In the media usability aspect, a score of 92% was achieved with a very valid category, as the learning media met the validity criteria.

Validity test of e-module by subject matter experts

The validity test of the e-module learning media on macroscopic fungi in fungi material was conducted by subject matter experts to assess the suitability of the content with the established learning indicators in the developed media. The validators, who are subject matter experts, include a fungal expert lecturer from the Biology Education Program at UNS and a biology educator from SMAN 5 Surakarta. The assessment of content validity includes three main aspects: content relevance, language used, and overall presentation. The results of the validity assessment of the e-module learning media on macroscopic fungi in fungi material, as evaluated by the subject matter experts, are presented in Table 3.

The assessment data consists not only of quantitative results but also qualitative feedback in the form of suggestions and comments from the expert validators. The suggestions and comments from both validators are as follows:

- a) Add five answer options to the evaluation questions.
- b) The "Pancasila Student Profile: Creative Thinking" aspect is not yet visible.
- c) The learning objectives need to accommodate various levels of cognitive skills.
- d) The e-module should begin with the basic concepts, followed by examples of mushrooms from observations.
- e) The evaluation questions should be aligned with the learning objectives.

Table 3. Results of validity test of e-module by subject matter experts

No	Aspect	Indicator	Validator		%	Category
			1	2		
1	Content Relevance	The content in the e-module has accurate and correct concepts, and does not lead to misconceptions	4	4	90	Very Valid
		Relevance of the content to the Competency Standards and Basic Competencies	4	2		
		Presentation of the material is clear and accurate	4	3		
		The figures and article links used in the e-module are appropriate for the material	4	4		
		Completeness of examples and practice questions	3	4		
2	Language	Conformity to standard Indonesian language rules	4	3	88	Very Valid
		Sentences used in the explanation of the material are easy to understand	4	3		
3	Presentation	Presentation of the material is engaging	4	3	88	Very Valid
		The photos in the e-module are clear and help differentiate parts of the fungus	4	3		
		The e-module is easy for students to use	4	3		
Overall Score			39	32	89	Very Valid

Notes:

Validator I: Biology Teacher at SMAN 5 Surakarta

Validator II: Lecturer in Biology Education at UNS

The assessment of the content and material suitability, which includes the relevance of the concepts, clarity of the material, completeness of the questions, and alignment of the e-modul media with the learning outcomes, received a score of 90%, indicating that it is highly valid/very suitable. This aligns with Arsyad (2017) statement that learning media should be in accordance with the expected learning objectives.

The language aspect, which relates to the construction of sentences that facilitate the understanding of information, obtained a score of 88%, also classified as highly valid. This is in line with Sudjana (2013) view that the focus of learning should be directed at the core topics or key concepts, so sentences should be concise and meaningful to make it easier for students to comprehend the material.

In terms of presentation, which includes attractive layout, clear images, and easy-to-use e-modul, a score of 88% was obtained, also categorized as highly valid. This supports Tamira (2021) research, which emphasized that the development of learning media should feature attractive presentation, as students initially evaluate the visual appeal of the media

they use. Moreover, effective learning media must include high-quality content, meet validity criteria, and align with students' needs. Therefore, the organization of learning media should be sequential to ensure that the information is easily understood by readers.

The analysis showed that the teaching material designed and developed in the form of an e-module meets the criteria for "very valid" in both media and content aspects. The high validity scores in all aspects indicate that this e-module is suitable to support the learning process. These results are in line with Puspridayanti et al. (2018), who state that the use of electronic modules has been deemed suitable through expert validation with at least a valid criterion. This also agrees with Sevtia et al. (2022), who assert that e-modules are suitable for teaching science when they meet valid criteria based on expert evaluations.

Practicality testing through limited trials: Individual and small group tests

Practicality is a quality criterion for teaching materials, assessed based on their attractiveness and efficiency in learning (Afrizon & Dewi, 2019). The purpose of the limited field trial is to gather feedback from users in the field regarding the revised e-module based on the results of individual responses. The field trial was conducted individually to collect data including assessments, opinions, critiques, and recommendations about the e-module. A small group test, consisting of eight students, participated in the trial, using a questionnaire designed to capture students' responses to the e-module. The results of the individual trial by three students are illustrated in Figure 3, while the results from the small-scale trial involving eight students are shown in Figure 4.

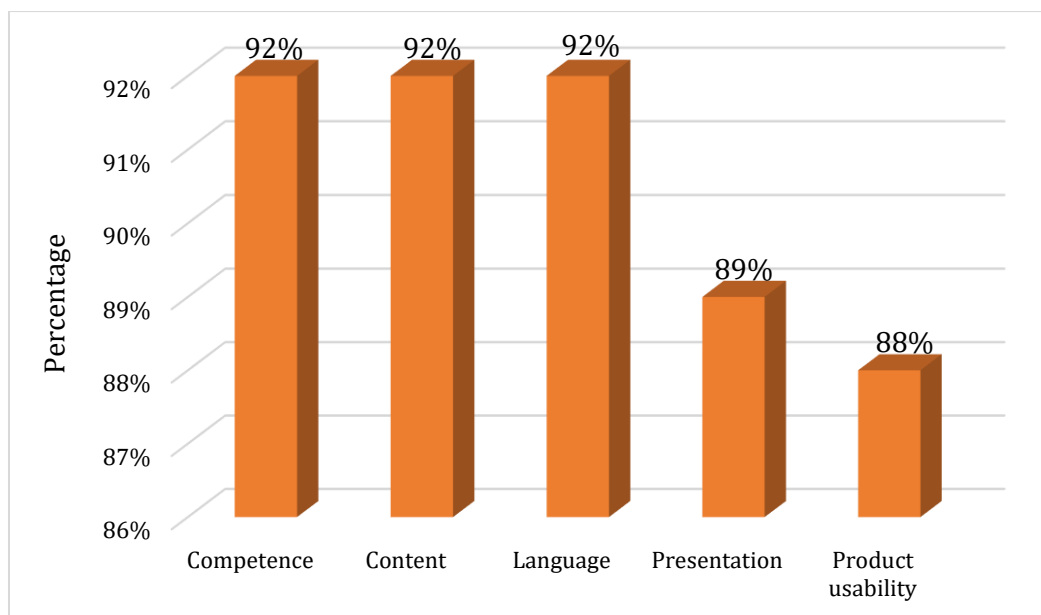


Fig. 3. Results of individual trial by students

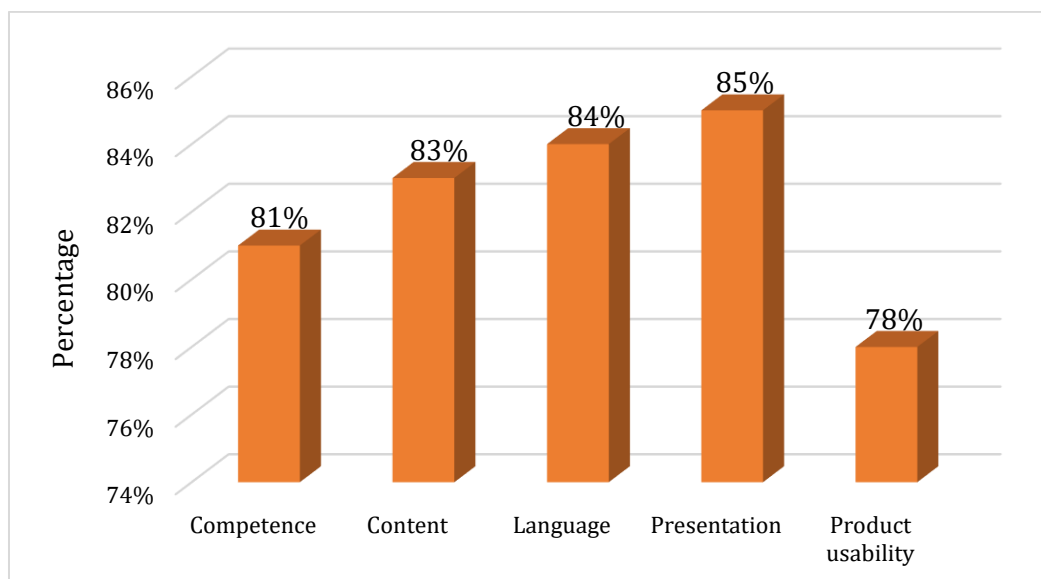


Fig. 4. Results of small-scale trial by students

As shown in Figures 3 and 4, the practicality test includes aspects of competence, content, language, presentation, and product usability. The limited field trial was conducted through individual trials to collect data regarding assessments, opinions, critiques, and suggestions on the e-module. The small group trial (8 students) used a questionnaire to gather student responses regarding the e-module. The opinions from individual and small-scale trials regarding the mushroom e-module can be seen in Table 4.

Table 4. Respondents' perceptions of the e-module

Individual Trials	Small Group Trials
<ul style="list-style-type: none"> The e-module is very useful for students in learning subjects related to fungi, with clear and concise explanations complemented by visual features that make it easy for students to understand. 	<ul style="list-style-type: none"> The colors, fonts, and images support the learning process and are easy to understand, providing a detailed description of fungi that allows for close observation of different types of fungi.
<ul style="list-style-type: none"> The e-module is excellent in terms of content and theory; however, I hope it can be updated in the future. For me, the e-module is already very suitable. 	<ul style="list-style-type: none"> The material presented is easy to understand, but some parts of the writing are not well-organized.
<ul style="list-style-type: none"> The e-module is very well made. 	<ul style="list-style-type: none"> The e-module is easy to comprehend, but the images and text are slightly too small.

Based on Table 4, the general perceptions of students as respondents regarding the developed media namely the e-module integrated with the Banyak mount environment are presented. Feedback and suggestions from respondents serve as a reference for improving the e-module to produce a practical product.

The results from individual trials showed an average percentage of competence at 92%, content at 92%, language at 92%, presentation at 89%, and product usability at 88%, resulting in an overall average of 90%, categorized as very practical. The small group trial showed an average percentage of competence at 81%, content at 83%, language at 84%, presentation at 85%, and product usability at 78%, resulting in an overall average of 83%, categorized as very practical. This indicates that students did not encounter difficulties using the e-module. This is supported by Riefani (2019), and Husin et al. (2023), who stated that the practicality of a developed product can be assessed based on whether users experience difficulties using it.

The practicality of a learning media is deemed practical if its level of practicality meets the criteria for being classified as practical (Bahtiar et al., 2018). Thus, the e-module teaching material is deemed practical for use in a 10th-grade classroom in Tangen, as it is designed to be practical, clear, and engaging, allowing students to use it independently without external assistance.

CONCLUSION

The validity assessment of the e-module on macroscopic fungal diversity in the Banyak mount forest area, designed as a biology learning resource for 10th-grade students, resulted in an average validity score of 94% from media experts, categorized as very valid, and 89% from content experts, also categorized as very valid. Therefore, the average validation score for the e-module from both media and content experts is 92%, categorized as very valid. The practicality test showed an average score of 90% from individual trials, categorized as very practical, and 83% from small group trials, also categorized as very practical, with an overall average of 87%, indicating that the e-module is very practical. Consequently, the developed e-module has been deemed valid and practical, confirming its suitability for use as an educational tool.

ACKNOWLEDGEMENT

The author would like to express gratitude to my supervising lecturers, Dr. Muzazzinah, M.Si, and Dr. Meti Indrowati, M.Si, for their guidance. Also thank the Central Java Regional Division, a work unit of Perum Perhutani, for allowing me to conduct a biodiversity survey in the Banyak mountain forest.

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