UNIVERSITAS SEBELAS MARET
BIOEDUKASI: JURNAL PENDIDIKAN BIOLOGI
https://jurnal.uns.ac.id/bioedukasi
1693-265X (Print) | 2549-0605 (Online)

Development of Flashcards on the Diversity of Macroscopic Fungi in Sultan Adam Mandiangin Forest Park to Train Students' Critical Thinking Skills

Riya Irianti [a, 1, *], **Dharmono** [a, 2], **Mahrudin** [a, 3]

[a] Biology Education Department, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Indonesia
[1] riyairiantipbiounlam@ulm.ac.id; [2] dhar66@ulm.ac.id; [3] udherdana@ulm.ac.id
* Corresponding author: riyairiantipbiounlam@ulm.ac.id

Submission : 15/12/2025

Revision : 11/06/2026

Accepted : 21/06/2026

ABSTRACT

Taman Hutan Raya Sultan Adam Mandiangin possesses rich macroscopic fungal diversity that can be utilized as a contextual learning resource in biology education. This study aimed to develop a flashcard-based learning medium on macroscopic fungal diversity from Tahura Sultan Adam Mandiangin to promote university students' critical thinking skills. The study employed the Plomp and Nieveen educational design research model consisting of three phases: preliminary research, prototyping, and assessment. Product validation involved three experts in biology education, while practicality and effectiveness testing involved students who had completed the Cryptogamae course. Data were collected using validation sheets, practicality questionnaires, readability questionnaires, and critical-thinking assessment instruments and were analyzed descriptively. The results showed that the developed flashcard achieved a validity score of 4.5 (very valid), a practicality score of 95% (very practical), and an effectiveness score of 88 (very effective). The flashcard successfully facilitated six dimensions of critical thinking, namely interpretation, assumption, deduction, evaluation, inference, and self-regulation. The novelty of this study lies in integrating local macroscopic fungi biodiversity with critical-thinking-oriented learning activities within a contextual flashcard medium. These findings indicate that local biodiversity resources can be transformed into innovative learning materials that support meaningful biology learning and critical thinking development. Future studies should involve larger participant groups and experimental research designs to examine further the long-term impact of flashcard-based learning on students' learning outcomes.

Keywords: critical thinking skills, flashcard, local biodiversity, macrofungi diversity

Introduction

Indonesia is one of the world's most biodiverse countries. According to the Ministry of Environment and Forestry (KLHK), Indonesia is among the countries with the highest levels of biodiversity in the tropics (Kemenetrian Lingkungsn Hidup dan Kehutanan, 2020). In line with this, Myers et al. (2000) emphasized that tropical regions, including Indonesia, are centers of global biodiversity. This biodiversity encompasses all forms of life, from microorganisms to plants and animals, which interact within an ecosystem (Odum & Barrett, 2005). One of the main ecosystems contributing to biodiversity is the tropical rainforest, characterized by high rainfall, stable humidity, and relatively constant temperatures year-round. These conditions, as stated by Whitmore (1998), support the growth of various organisms, including fungi, which play a crucial role as decomposers, breaking down organic matter and returning nutrients to the soil (Alexopoulos et al., 1996). Therefore, understanding fungal diversity is important in both ecological and educational contexts. MacKinnon et al. (1996) stated that Kalimantan has a very rich forest ecosystem with environmental conditions that support the growth of heterotrophic organisms such as fungi. One area that represents this condition is the Sultan Adam Mandiangin Grand Forest Park in South Kalimantan. Previous research results have shown the presence of various types of macroscopic fungi growing in habitats such as rotting wood, litter, and forest floors (Ayunisa et al., 2020; Rahmawati, 2017). The potential diversity of macroscopic fungi can be utilized as a contextual learning resource in biology lessons. From a sociocultural theory perspective, Vygotsky (1978) emphasized that learning is more meaningful when linked to students' social and environmental context. Rogoff (2003) reinforced this, stating that interaction with the surrounding environment can help individuals build a deeper understanding. Using local potential, such as fungal diversity in the surrounding environment, can increase the relevance of learning. For student teachers, this contextual learning experience is crucial so they can develop meaningful and applicable biology learning in schools.

However, not all student teachers are familiar with the diversity of macroscopic fungi in the local environment, particularly in the Sultan Adam Mandiangin Forest Park. This is due to limited available learning resources. Most still consist of textbooks and scientific articles covering general material. A preliminary needs analysis conducted among students who had completed the Cryptogamae course revealed that textbooks and scientific articles still dominated learning resources. Students reported difficulties in identifying local macrofungi species and connecting theoretical concepts with field observations. These findings indicate a need for innovative learning media that integrate local biodiversity content with active learning processes. Arsyad (2017) stated that limited learning media can hinder students' active involvement in the learning process. Therefore, innovative media are needed that can bridge the gap between theoretical concepts and real-world conditions.

One alternative medium is flashcards. Flashcards are a visual learning medium that present information concisely and systematically, facilitating understanding and memory. Susilana & Riyana (2009) explain that flashcards effectively increase student retention and engagement. Furthermore, flashcards can be combined with HOTS-based questions to develop students' critical thinking skills. At the higher education level, this medium can help students organize information and relate concepts to real-world learning contexts. Although several studies have developed flashcard media in biology learning, development specifically addressing macroscopic fungal diversity based on local potential remains very limited. Previous research generally focused on general material and failed to integrate local context as the primary learning resource (Putri et al., 2021). Therefore, this study introduces a novel flashcard media based on local potential that not only serves as a learning resource but also trains students' critical thinking skills.

Based on the above description, this study aims to develop a learning medium in the form of flashcards on macroscopic fungal diversity in Sultan Adam Mandiangin Forest Park that is feasible, practical, and effective in training students' critical thinking skills.

Furthermore, this research is expected to contribute to the development of contextual biology learning based on local potential and serve as a reference for developing innovative learning media in higher education.

Methods

This study employed the Plomp and Nieveen Educational Design Research (EDR) model, consisting of three phases: preliminary research, prototyping, and assessment. The study was conducted at Taman Hutan Raya Sultan Adam Mandiangin, South Kalimantan, and the Biology Education Study Program, Faculty of Teacher Training and Education, Lambung Mangkurat University. Preliminary research included curriculum analysis of the Cryptogamae course, student needs analysis through interviews and questionnaires, and an inventory of macrofungi diversity in Tahura Sultan Adam Mandiangin. These findings formed the basis for developing the flashcard prototype. The prototyping phase included content selection, flashcard design, preparation of critical thinking-oriented learning activities, expert validation, and product revision; the assessment phase comprised readability, practicality, and effectiveness testing.

The participants included three biology education lecturers and 18 students who had completed the Cryptogamae course. Students were involved in readability testing (n = 3), practicality testing (n = 6), and effectiveness testing (n = 9). The flashcards were developed based on macrofungi diversity data collected from field research at Sultan Adam Forest Park. Data were gathered using validation, practicality, and evaluation questionnaires and analyzed descriptively. Three experts evaluated media feasibility using a validation questionnaire covering content, presentation, and language. Content validation included suitability with PLO, CLO, and sub-CLO; material accuracy; and content relevance. Presentation validation assessed completeness, presentation techniques, and visual design, while language validation focused on clarity, communicativeness, and appropriateness for student development. Responses were scored using a 5-point Likert scale and analyzed descriptively to determine media validity. After validation and revision, the flashcards were tested for practicality and effectiveness using student response questionnaires and evaluation tests to measure critical thinking skills. The more complete research scheme is presented in Figure 1 below:

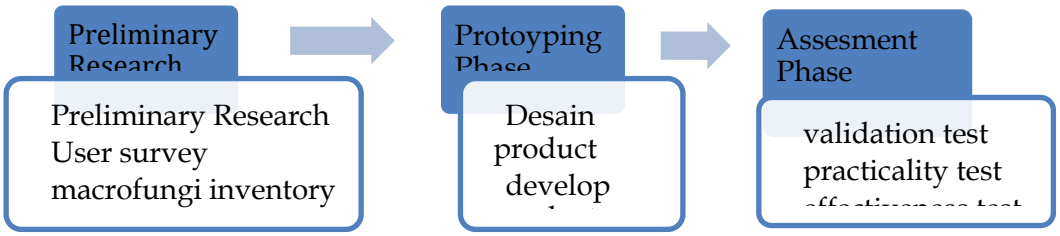

Figure 1. Research scheme

Results and Discussion

Preliminary Research

The preliminary research phase consisted of curriculum analysis, student needs analysis, and an inventory of macroscopic fungal diversity. The curriculum analysis results served as the basis for analyzing the material (Magdalena et al., 2020). The curriculum analysis revealed that the Cryptogamae course, within the course objectives, aims to enable students to understand fungal diversity based on its characteristics, kinship relationships, and the most important groups; understand its position in the taxonomic hierarchy; understand its life cycle; understand its distribution area; and understand the importance of examples found in wetlands to humans. This, of course, requires the development of higher-order thinking skills

and supporting teaching media. However, available learning resources are primarily textbooks and scientific articles, providing limited contextual information regarding local biodiversity. The needs analysis indicated that students require learning resources containing visual representations, concise information, and contextual examples derived from the local environment. According to interview results with teachers and students, students prefer learning media that are interesting and practical. These media are designed to make learning materials easier to understand and capture learners' attention. Attractive media will support the learning process at school. According to Nuryana & Sahrir (2019), the learning process becomes more interesting when the right media are used, motivating students to pursue the knowledge they are studying. This aligns with Yanti (2017), who stated that using learning media is very helpful. Flashcards are an effective and efficient tool for theoretical learning and practical work in the laboratory and in the field. The field inventory activity documented various macroscopic fungal species found growing on decaying wood, leaf litter, and forest floor substrates in the Sultan Adam Mandiangin Forest Park (Tahura). These findings confirmed the area's educational potential and served as the primary basis for developing flashcard learning media.

Prototyping phase

The flashcards were designed with a content structure that met the assessment indicators for content, presentation, and language feasibility. The flashcards were also developed to meet the needs of lecturers and students, based on preliminary research findings. The material was presented with clear general descriptions and an attractive appearance and design. The flashcards displayed contextual images of macroscopic fungi per type. The flashcards were also arranged systematically and alphabetically, with a variety of colors to prevent users from getting bored, but each flashcard had a white background. Using white as the background color ensures that the brightness of other elements is not disturbed (Putri et al., 2021). The flashcards include questions to train students' critical thinking skills. The flashcards include HOTS questions for evaluation, a glossary, and an author's bio. Evaluation activities aim to measure students' learning success and achievement of learning objectives in curriculum outcomes (Suarga, 2019). In addition, according to Widiastika et al. (2020), learning accompanied by exercises makes it easier to grasp material and develop critical thinking. The types of evaluation are arranged according to the stages of student recognition in conducting identification activities or fungi recognition, starting with recognizing and studying other things, such as characteristics in shape, color, or habitat. The flashcard product developed is shown in Figures 2 and 3 below.

Figure 2. Flashcard cover (left: English version and right: Indonesian)

Figure 3. Presenting HOTS based questions (left: English version and right: Indonesian)

Assessment Phase

Expert Validation

The overall validation results of expert validation can be seen in Table 1.

Table 1. Expert validation results

No.	Validation aspects	χ
1.	Content Suitability Aspect	4.8
2.	Presentation Feasibility Aspect	4.4
3.	Language aspect	4.2
Average score		4.5
Category		Very valid

Based on expert validation results, the developed flashcard obtained an average score of 4.5 and was categorized as very valid. The validators suggested several improvements, including enhancing the cover design, increasing font size, improving image quality, clarifying critical-thinking prompts, and expanding the glossary section. The team incorporated these suggestions into the revised product before further testing. The high validity score indicates that the flashcard successfully met the criteria of content accuracy, presentation quality, and language appropriateness. This is reinforced by Esmawati (2008) who states that teaching material is valid and appropriate if it aligns with the curriculum, competencies, indicators, and learning objectives to be achieved. Integrating authentic photographs of macrofungi collected from Tahura Sultan Adam Mandiangin increased the contextual relevance of the learning material. In addition, the inclusion of critical-thinking-oriented questions aligned the flashcard content with the intended learning outcomes of the Cryptogamae course. These findings support previous studies reporting that expert validation plays an important role in ensuring the quality and instructional suitability of educational products. A valid learning medium is expected to provide accurate information and facilitate meaningful learning experiences for students. As explained by BSNP (2014), the results of a rational assessment are those based on rational reasoning, not necessarily presenting facts on the ground. The developed flashcards are complete, including design, material descriptions, images, simplicity, guidance on critical thinking skills, and explanations of each macroscopic fungus, leading experts to provide a highly valid assessment for use as teaching materials for

the Cryptogamae course. As explained by BSNP (2014), if these components are complete, the teaching material will be deemed valid for use in an educational institution.

This is reinforced by Hera et al. (2014), who state that product validation results using valid criteria indicate that the developed teaching material is of good quality and can be used. Expert validation of flashcards is crucial to identify weaknesses or deficiencies in the developed teaching material in terms of relevance, accuracy, language, and learning. This input helps improve the developed flashcard product based on the validation findings. Expert testing or validation is useful for reviewing the initial product and providing input for improvement. Therefore, expert validation is necessary to assess the design of the developed teaching materials. As reported by Dharmono et al. (2020), expert validation is necessary in developing the Swamp Plants BIP to improve students' critical thinking skills. Zaini et al. (2020) reported the same, stating that validation is necessary when developing Student Worksheets on Microbial concepts based on urban wetlands to improve critical thinking skills at the high school level.

Practicality test

The results of development products that have been declared valid by experts are continued with the main product test to obtain practicality data for the flashcards developed for 3 students through a readability test and 6 students in a practicality test, which are presented in Table 1 and Table 2 below:

Table 1. Flashcard readability test results

Statement Items	Average
Each section studied is easy to understand	4
The entire flashcard content is complete	4
The words used are easy to understand	4
The image quality is good and the meaning is understandable	3,7
No typos or grammatical errors were found	3
The photo on the cover is clear and the meaning is understandable	3,7
Average score (%)	93,1
Category	Very good

Table 2. Flashcard practicality test results

Statement Items	Average
The content is easy to learn and understand	3.8
The learning materials are interesting to study	4
I can read the text in the learning materials easily	3.6
I like the overall appearance of the learning materials	4
I can understand the material with the help of good-quality images.	4
The time allotted for studying the flashcards is sufficient	3,5
The flashcard teaching method has never been implemented before	3,7
Average score (%)	95
Category	Very practical

The readability test with three students yielded an average score of 93.1%, categorized as very good. Students reported that the flashcard content was easy to understand, the language was clear, and the photographs helped them recognize macrofungi characteristics more effectively. Minor suggestions mainly concerned image clarity and cover appearance.

The practicality test involving six students yielded an average score of 95%, indicating that the flashcard was very practical for learning activities. Students considered the material attractive, easy to use, and capable of supporting independent learning. The concise presentation format enabled students to access information efficiently without reducing conceptual understanding.

The high practicality score shows that the developed flashcard can be easily implemented in biology learning activities. Its visual design, contextual content, and systematic organization contributed positively to students' learning experiences. Similar findings have been reported in previous studies showing that contextual biodiversity-based learning resources tend to improve learner engagement and learning motivation. The practicality of a developed product can be seen, among other things, in the results of the readability test and the product's practicality (Tessmer, 2014). As stated by Dick et al. (2001), the readability test was conducted to obtain data on potential errors such as poor grammar, spelling errors, punctuation errors, and unclear instructions. It also focused on more intrinsic criteria, such as the appropriateness of the examples, the systematic nature of the material, ease of use, attractiveness, and even student satisfaction. Based on the results of the student readability test, three students expressed strong interest in using the developed flashcards. They stated that they were very effective and practical for learning Cryptogamae, although minor revisions were needed based on student suggestions.

This indicates that the flashcards are easy to understand and easy to use in lectures. This aligns with (Sugiyono, 2012), which states that design revisions are conducted to mitigate weaknesses and deficiencies in the product design based on expert validation results. Practicality relates to how well the flashcards integrate with learning. According to (Dharmono et al., 2019), a developed product is considered practical if it is easy for students or educators to use and is richer than textbooks. This aligns with this flashcard development research, as it is easy to understand and use. Practicality means ease of use. A developed product is considered practical if the learning resource can be used by both educators and students, while also being efficient in terms of time and effort (Edi & Rosnawati, 2021).

Effectiveness test

The results or development products that have been declared very valid by experts and very practical from the readability test and practicality test, then continued with an effectiveness test to obtain data on the effectiveness of flashcards with indicators of student success in developing their critical thinking skills which include the interpretation aspect with indicators of being able and fluent in understanding or formulating categorizations of differences and being fluent and capable in detecting, paying attention and describing important information content. The assumption aspect includes indicators of being able to identify and obtain the elements needed to draw temporary conclusions about the causes of macroscopic fungal diversity based on observation results. The deduction aspect includes recognizing and finding supporting sources when collecting information on factors that influence the existence of macroscopic fungi and formulating alternatives to solve problems in an effort to preserve macroscopic fungal populations. The argument evaluation aspect, with indicators of being able to provide reasons for accepting claims or disagreeing with a statement. The inference aspect, with indicators of being able to use appropriate inferences to determine the position, opinion, or point of view that must be taken toward a particular problem or issue; the self-regulation aspect, with indicators of being able to reflect on oneself and make objective self-assessments, Table 4 and Figure 3 present the results below.

Table 3. Summary of flashcard effectiveness test results

No.	Aspects of critical thinking skills	Maximum score	
1.	Interpretation	20	17,7
2.	Assumptions	15	12,8
3.	Deduction	15	12,9
4.	Evaluation	20	18,9
5.	Inference	15	12,8
6.	Self-regulation	15	13,3
	Overall average	88	
	Category		Very effective

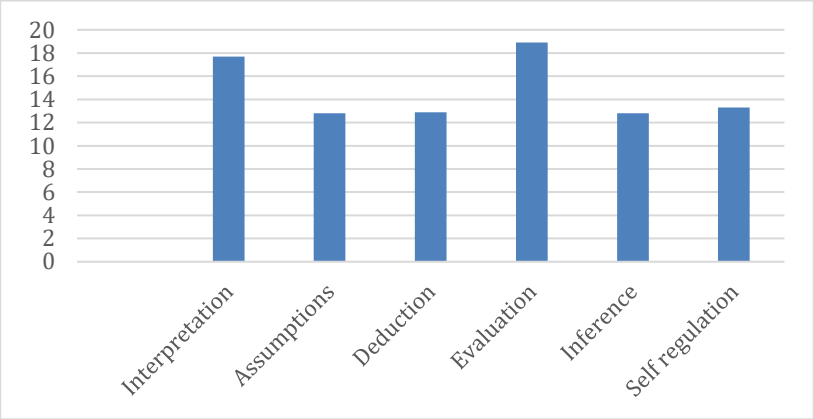

Figure 4. Graph of flashcard effectiveness test results

The effectiveness test produced an average score of 88, which falls within the very good category. This result indicates that the developed flashcards effectively facilitated students' critical thinking skills during learning activities. Students performed strongly across six critical thinking dimensions: interpretation, assumption, deduction, evaluation, inference, and self-regulation. According to the literature, critical thinking skills are not inherent but can be trained and learned (Syafitri, 2023; Winata et al., 2019). This suggests that the more students practice answering questions that require critical thinking, the more their critical thinking processes will improve. This aligns with research Illahi et al. (2019) and Sarangih (2019), which shows that more complex training improves critical thinking skills.

Several previous studies Wijayanti et al. (2024), Masruroh et al. (2023) and Putri et al. (2023) reported that the developed teaching materials were able to train the critical thinking skills of the subjects tested. This shows that the developed LKPD successfully trained critical thinking skills, with a very good category in all six aspects. The developed flashcards contain questions covering six aspects of critical thinking skills. These questions are used as a reference to train critical thinking skills in students who have taken the Cryptogamae course. Therefore, critical thinking skills can be honed through questions aligned with the aspects of critical thinking skills used. The flashcards include six aspects of critical thinking: interpretation, assumption, deduction, argument evaluation, inference, and self-regulation. The results of student effectiveness are described in more detail as follows:

1. Interpretation Aspect

Based on student responses to the student worksheet (LKPD), the study showed that students could interpret key points learned using macroscopic fungal diversity flashcards. This aligns with Adawiyah et al. (2023) who found that strong interpretation skills help students understand how to interpret data effectively, including grouping. The use of flashcards enabled students to understand and fluently formulate categorizations of

differences, as well as to fluently and effectively detect, attend to, and describe important information on the flashcards.

2. ***Assumption Aspect***

This was evident in the students' responses to the LKPD, which demonstrated their ability to identify and gather the elements needed to draw tentative conclusions about the causes of macroscopic fungal diversity and presence based on observations using the developed flashcard.

3. ***Deduction Aspect***

This is evident in students' responses, which demonstrate their ability to identify and seek out supporting sources to gather information on factors influencing the presence of macroscopic fungi and formulate alternative solutions to problems in efforts to conserve macroscopic fungi in the Sultan Adam Mandiangin Grand Forest Park.

4. ***Argument Evaluation***

This is evident in students' responses to student worksheet questions using flashcards. Students can provide reasons for accepting claims or disagreeing with statements about the sustainability of fungi. This aligns with Norrizqa (2021), who explains that the evaluation aspect includes assessing claims and evaluating arguments.

5. ***Inference***

The inference aspect is evident in students' responses, which demonstrate the appropriate ability to determine positions, opinions, or perspectives based on important concepts presented on flashcards. This aligns with Fitriani (2025), who defines the inference aspect as the ability to identify and obtain supporting sources to gather relevant and logical information. This is also supported by Zahroh & Yuliani (2021) who explain that inference is the ability of students to make assumptions based on data analysis and hypotheses based on evidence and facts and to draw conclusions.

6. ***Self-regulation***

Self-regulation is evident in students' answers, which consistently demonstrate strong self-regulation skills related to concern for mushroom conservation, based on analytical and judgmental abilities to recognize, validate, and adjust conclusions drawn from prior thinking (self-regulation). This aligns with Fitriani (2025), who states that the sub-skill of self-regulation involves making objective and thoughtful self-assessments (metacognitive) of one's opinions and the reasons for holding them. This is in line with Edi & Rosnawati (2021), who define self-regulation as self-awareness in monitoring cognitive activities, the elements used in those activities, and the results developed, primarily through the use of skills in analyzing and evaluating one's inferential judgments with a perspective, through questioning, confirmation, validation, or correction of one's assessment results. Among these dimensions, evaluation obtained the highest average score (18.9), followed by interpretation (17.7). These findings suggest that students could assess information critically, identify relevant evidence, and justify their conclusions using scientific reasoning. The contextual presentation of macrofungal diversity and the inclusion of critical-thinking prompts may have helped students analyze ecological phenomena and develop evidence-based arguments. The flashcards' effectiveness may also be attributed to the integration of authentic local biodiversity content. By using macrofungal species found in Tahura Sultan Adam Mandiangin as learning materials, students were encouraged to connect theoretical concepts with real environmental conditions. Contextual learning experiences such as these are known to promote deeper understanding and higher-order thinking skills. The findings are consistent with previous studies reporting that biodiversity-based learning resources and inquiry-oriented learning materials can improve students' critical thinking abilities. The present study extends previous findings by demonstrating that local macrofungal diversity can be transformed into a practical and effective flashcard medium for supporting critical thinking development in higher education biology courses.

Conclusion

The macrofungal diversity flashcard developed from local biodiversity resources in Tahura Sultan Adam Mandiangin proved highly valid, practical, and effective in promoting students' critical thinking skills. This study's novelty lies in integrating local macrofungal diversity with six dimensions of critical thinking within a contextual, flashcard-based learning medium. The developed flashcard not only provides accurate biological content but also encourages students to interpret information, evaluate evidence, formulate arguments, and reflect on their reasoning processes. The findings suggest that local biodiversity resources can be transformed into meaningful learning materials that support contextual biology learning in higher education. Therefore, the developed flashcard has the potential to be utilized as an enrichment learning resource in Cryptogamae courses and other biodiversity-related subjects. Future studies are recommended to implement the flashcard with larger populations and in different educational contexts, using experimental approaches to investigate further its impact on learning outcomes and long-term critical thinking development

Acknowledgement

The authors thank Universitas Lambung Mangkurat for funding this study through the Penelitian Dosen Wajib Meneliti (PDWM) Grant Program 2025. The authors also thank the Faculty of Teacher Training and Education, Universitas Lambung Mangkurat; the management of Tahura Sultan Adam Mandiangin; research assistants; and all parties who contributed to the successful completion of this study.

Generative AI Disclosure

The use of artificial intelligence in this manuscript is limited to language, translation, and editing to improve readability, without affecting the scientific substance, data analysis, or research interpretation.

References

Adawiyah, R., Zaini, M., & Kaspul, K. (2023). Keefektifan ensiklopedia famili Myrtaceae koleksi Kebun Raya Banua untuk melatihkan keterampilan berpikir kritis mahasiswa. *Jurnal Jeumpa*, *10*(1), 83–95. https://doi.org/10.33059/jj.v10i1.7385

Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory mycology (4th ed)*. John Wiley & Sons.

Arsyad, A. (2017). *Media pembelajaran*. PT RajaGrafindo Persada.

Ayunisa, S., Naemah, D., & Payung, D. (2020). Inventarisasi jamur makroskopis di KHDTK (Kawasan Hutan Dengan Tujuan Khusus) Universitas Lambung Mangkurat. *Jurnal Sylva Scienteae*, *3*(5), 945–953. https://doi.org/10.20527/jss.v3i5.2564

BSNP. (2014). *Instrumen penilaian buku teks pelajaran*. (B. S. N. Pendidikan (ed.)).

Dharmono, D., Mahrudin, M., & Maulana, K. R. (2019). Kepraktisan handout struktur populasi tumbuhan rawa dalam meningkatkan keterampilan berpikir kritis mahasiswa pendidikan biologi. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *1*(2), 105–110. https://doi.org/10.20527/binov.v1i2.7864

Dharmono, D., Utami, N. H., & Sari, M. M. (2020). Kepraktisan buku ilmiah populer botani tumbuhan rawa dalam melatihkan keterampilan berpikir kritis mahasiswa. *Wahana-Bio: Jurnal Biologi Dan Pembelajarannya*, *14*(2), 149–158. https://doi.org/10.20527/wb.v14i2.16099

Dick, W., Carey, L., & Carey, J. O. (2001). *The systematic design of instruction (5th)*. Longmann.

Edi, S., & Rosnawati, R. (2021). Kemampuan berpikir kritis siswa dalam pembelajaran matematika model discovery learning. *JNPM : Jurnal Nasional Pendidikan Matematika*, *5*(2),

234–246. https://doi.org/10.33603/jnpm.v5i2.3604

Esmawati, E. (2008). *Pengembangan bahan ajar.*

Fitriani, R. (2025). Pengaruh kemandirian belajar terhadap pemahaman konsep IPA materi dasar-dasar Biologi: studi korelasional pada kelas VIII di SMP swasata Al Munir tambun selatan. *Jurnal Media Akademik (JMA)*, *3*(7), 1–10. https://doi.org/10.62281/v3i7.2597

Hera, R., Khairil, & Hasanuddin. (2014). Pengembangan handout pembelajaran embriologi berbasis kontekstual pada perkuliahan perkembangan hewan untuk meningkatkan pemahaman konsep mahasiswa di Universitas Muhammadiyah Banda Aceh. *Jurnal EduBio Tropika*, *2*(2), 223–229. https://garuda.kemdiktisaintek.go.id/documents/detail/566959

Illahi, K., Pujiastuti, H., & Samsuri, S. (2019). Pengaruh pendekatan model eliciting activities (MEAs) terhadap kemampuan berpikir kritis dan disposisi matematis siswa. *Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, *5*(2), 190–197. https://doi.org/10.29407/jmen.v5i2.12891

Kemenetrian Lingkungsn Hidup dan Kehutanan. (2020). *Status lingkungan hidup Indonesia 2020.* KLHK RI.

MacKinnon, K., Hatta, G., Halim, H., & Mangalik, A. (1996). *The ecology of Kalimantan.* Oxford University Press.

Magdalena, I., Fauziyyah, B. S., Afiani, R., & Fushilat, L. A. (2020). Inovasi teknologi dalam pembelajaran pada masa pandemi COVID-19 di MI Nurul Yaqin. *PENSA*, *2*(3), 408–419. https://doi.org/10.36088/pensa.v2i3.1017

Masruroh, H., Hadi, W. P., Ahlied, M., Tamam, B., & Sutarja, M. C. (2023). Efektivitas penggunaan media pembelajaran berbasis augmented reality terhadap pemahaman konsep siswa. *Jurnal Natural Science Educationa Research*, *6*(3), 2654–4210. https://doi.org/10.21107/nser.v6i3.16517

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403*(6772), 853–858. https://doi.org/10.1038/35002501

Norrizqa, H. (2021). Berpikir kritis dalam pembelajaran IPA. *Prosiding Magister Pendidikan Ilmu Pengetahuan Alam*. https://jbse.ulm.ac.id/index.php/PMPIPA/article/view/37

Nuryana, N., & Sahrir, D. C. (2019). Respon guru terhadap kegiatan pendampingan implementasi kurikulum 2013 edisi revisi. *Dimasejati: Jurnal Pengabdian Kepada Masyarakat*, *1*(1). https://doi.org/10.24235/dimasejati.v1i1.5401

Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology (5th ed).* Thomson Brooks/Cole.

Putri, A. S., Zaini, M., & Kaspul, K. (2023). Validitas buku ensiklopedia famili Meliaceae di Kebun Raya Banua untuk melatihkan keterampilan berpikir kritis. *Pena Edukasi*, *10*(1), 19–26.

Putri, R. A., Sari, D. P., & Lestari, I. (2021). Pengembangan media flashcard pada pembelajaran Biologi untuk meningkatkan pemahaman konsep siswa. *Jurnal Pendidikan Biologi Indonesia*, *7*(2), 123–130. https://doi.org/10.22219/jpbi.v7i2.12345

Rahmawati, N. (2017). Keragaman jamur makroskopis di Taman Hutan Raya Sultan Adam Mandiangin Kalimantan Selatan. *Jurnal Hutan Tropis*, *5*(2), 89–95.

Rogoff, B. (2003). *The cultural nature of human development.* Oxford University Press.

Sarangih, M. (2019). Peningkatan kemampuan berpikir kritis dengan pembelajaran berbasis scientific approach siswa kelas viii sltp swasta parulian medan marlindoaman saragih dosen universitas simalungun. *Jurnal Ilmiah Simantek*, *3*(2), 101–108. https://garuda.kemdiktisaintek.go.id/journal/view/18025

Suarga, S. (2019). Hakikat, tujuan dan fungsi evaluasi dalam pengembangan pembelajaran. *Inspiratif Pendidikan*, *8*(2), 327–338. https://doi.org/10.24252/ip.v8i1.7844

Sugiyono. (2012). *Metode penelitian kuantitatif kualitatif dan R&D*. Alfabeta.

Susilana, R., & Riyana, C. (2009). *Media pembelajaran hakikat, pengembangan, pemanfaatan, dan penilaian*. CV Wacana Prima.

Syafitri, N. (2023). *Hidup dari Purun: Kontradiksi keberlanjutan usaha ekonomi kreatif masyarakat*

berbasis tumbuhan purun di Kampung Purun Kota Banajarbaru. Universitas Lambung Mangkurat.

Tessmer, M. (2014). *Paradigma Penelitian Desain dan Pengembangan.*

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Harvard University Press.

Whitmore, T. C. (1998). *An introduction to tropical rain forests (2nd ed)*. Oxford University Press.

Widiastika, M. A., Hendracipta, N., & Syachruroji, A. (2020). Pengembangan media pembelajaran mobile learning berbasis android pada konsep sistem peredaran darah di sekolah dasar. *Jurnal Basicedu*, *5*(1), 47–64. https://doi.org/10.31004/basicedu.v5i1.602

Wijayanti, E., Kaspul, K., & Zaini, M. (2024). Keterampilan berpikir kritis buku ensiklopedia famili Sapotaceae melalui penelitian pengembangan. *JUPEIS: Jurnal Pendidikan Dan Ilmu Sosial*, *3*(2), 19–25. https://doi.org/10.57218/jupeis.Vol3.Iss2.1044

Winata, A., Sulistyaningrum, H., & Cacik, S. (2019). Peningkatan kemampuan berpikir kritis mahasiswa menggunakan pembelajaran berbasis android pada matakuliah konsep ipa. *Edustream: Jurnal Pendidikan Dasar*, *3*(2), 1–9. https://journal.unesa.ac.id/index.php/jpd

Yanti, G. S. (2017). Communicative Language Teaching: The Perceptions of English Teachers in Mempawah Hilir. *Jurnal Ilmiah SPECTRAL*, *3*(1), 010–025. https://journal.stbapontianak.ac.id/index.php/spectral/article/view/13

Zahroh, D. A., & Yuliani, Y. (2021). Pengembangan e-LKPD berbasis literasi sains untuk melatihkan keterampilan berpikir kritis peserta didik pada materi pertumbuhan dan perkembangan. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *10*(3), 605–616. https://doi.org/10.26740/bioedu.v10n3.p605-616

Zaini, M., Amintarti, S., Ajizah, A., Nadhira, D., Hayati, M., & Hidayati. (2020). Lembar kerja peserta didik konsep-konsep mikroba berbasis lahan basah perkotaan untuk meningkatkan keterampilan berpikir kritis pada jenjang SMA. *BIO-INOVED: Jurnal Biologi-Inovasi Pendidikan*, *2*(1), 56–68. https://ppjp.ulm.ac.id/journal/index.php/bino/index