JISIP (Jurnal Ilmu Sosial dan Pendidikan)
Vol. 10 No. 2 Maret 2026
e-ISSN : 2656-6753, p-ISSN: 2598-9944
DOI: *10.36312/jisip.v10i1.10171/http://ejournal.mandalanursa.org/index.php/JISIP/index*

The Profile of Students' Critical Thinking Skills and Potential Learning Media for Grade XII Biotechnology Material to Support SDGs 2

Rischa Amelia Putri[1*], Ulfi Faizah[2]
[1,2]State University of Surabaya, Indonesia

Article Info
Article history:
Received: 9 January 2026
Publish: 2 March 2026

Keywords:
Critical thinking;
Biotechnology;
Instructional media;
SDGs 2;
Food security.

Abstract
This study aims to describe the profile of critical thinking skills of grade XII students on biotechnology material and analyze the types of alternative learning media that can support the strengthening of these skills in order to support the sustainable development goals (SDGs) point 2 on food security. The method used is descriptive qualitative with a study literature review approach and strengthening field data through learning reflections and teacher interviews. The results of the study indicate that students' critical thinking skills are still in the low category, with the main obstacles lying in the aspects interpretation, explanation, and evaluation. The learning process is still conventional and minimal practice causes students to be less actively involved in higher-order thinking processes. Based on literature analysis and field findings, recommended learning media to develop critical thinking skills include E-modules and E-LKPD. These media are considered capable of facilitating contextual, reflective, and applicable biotechnology learning so that they are relevant to support the achievement of SDGs 2 related to sustainable food security.

Corresponding Author:
Rischa Amelia Putri
Universitas Negeri Surabaya, Indonesia
Email Coresspondent: rischa.22134@mhs.unesa.ac.id

1. INTRODUCTION

Critical thinking skills are one of the skills that must be mastered to face the challenges of the 21st century. According to the National Education Association, there are four main skills that are essential in this century: critical thinking, creativity, communication, and collaboration (Redana, 2019). Critical thinking, part of Higher-Order Thinking Skills (HOTS), was first introduced in a structured manner by Peter A. Facione through a Delphi project involving experts in the field of education (P. A. Facione, 2011). Critical thinking is a process that involves evaluating arguments and information that is crucial for good decision-making. This ability not only helps students analyze situations but also improves their ability to adapt and create solutions when facing various challenges (Benyamin et al., 2021). Students' critical thinking skills can be measured through critical thinking skill indicators. According to (P. Facione, 2015) lists 6 aspects of critical thinking skills: (1) interpretation; (2) analysis; (3) evaluation; (4) conclusions; (5) explanation; and (6) self-regulation.

Critical thinking skills are essential for students in the learning process, particularly in biology. Biotechnology material is an appropriate choice for improving problem-solving skills, integrating biology and technology. This material covers the meaning, fundamental standards, and roles of biotechnology in science, climate, innovation, and society (salingtemas) to support government assistance for humanity. Although in its application,

students are faced with issues including aspects of science, innovation, society, and climate, top-down attention is expected in addressing issues that benefit daily life (Millah in Nurkhalisha, 2023). Biotechnology material requires students' critical thinking skills to learn and analyze existing problems and be able to address them. Students are expected to be able to search for and discover concepts in biotechnology and be able to solve problems that frequently arise in everyday life. This aligns with findings (Arjaya et al., 2025)which state that biology learning plays a crucial role in developing 21st-century skills, including critical thinking, communication, collaboration, and creativity.

Previous research has shown various effectiveness in improving students' critical thinking skills in conventional biotechnology materials, with indicators such as formulating problems, selecting logical arguments, and drawing scientific conclusions independently (Humayroh et al., 2023). This is in line with research conducted by (Fitriandini & Isnawati, 2025) that Liveworksheet-based E-LKPD media can improve students' critical thinking skills in biotechnology materials. These findings emphasize that the project-based approach can strengthen students' HOTS, especially in the analysis and evaluation aspects. Although several studies have shown that learning media can improve students' critical thinking skills in biotechnology materials, the reality is that the learning process in the field still does not fully encourage the development of these abilities optimally.

Interviews with biology teachers at the school indicate that students' critical thinking skills tend to be low, and biotechnology learning is still dominated by lectures and minimal exploratory activities that encourage critical thinking. Research (Azizah et al., 2025) showed that the critical thinking skills of 12th-grade students at SMAN 1 Payakumbuh were relatively low. These characteristics significantly impact the effectiveness of using learning media in achieving learning objectives. Therefore, it is crucial for educators and media developers to thoroughly understand the student profile so that the media developed is tailored to their needs and circumstances (Titin et al., 2023). This finding also aligns with research by (Sugita et al., 2025), which states that implementing innovative learning approaches such as STEAM can be an effective strategy for improving students' critical thinking skills and creativity in science learning. This suggests the need for evaluation and development of media needed to enhance students' critical thinking skills.

This study aims to describe the profile of critical thinking skills and potential learning media for biotechnology material for grade XII students, as well as explore the contribution of these skills in understanding and supporting the achievement of Sustainable Development Goals (SDGs) 2. In addition, this study also aims to recommend relevant learning media for improving critical thinking skills through a literature review. The benefits of this study are expected to obtain information that will form the basis for developing biotechnology learning strategies that are more contextual, participatory, and oriented towards strengthening students' critical thinking skills. Thus, biology education will not only produce students who understand scientific concepts, but also produce a generation that has social awareness and plays an active role in achieving SDGs 2, namely ensuring sustainable food security.

2. RESEARCH METHODS

This study used a qualitative descriptive approach to describe the profile of students' critical thinking skills in biotechnology and to identify the need for relevant learning media. This approach was chosen because it allows researchers to understand learning phenomena in depth through descriptive data, both from field observations and literature reviews. The data in this study consisted of primary and secondary data. Primary data were obtained through semi-structured interviews with biology teachers and questionnaires distributed to 12th-grade students at a high school in Surabaya. Meanwhile, secondary data were

collected through a systematic literature review focusing on research related to critical thinking skills and biotechnology learning media within the past five years.

The interviews were conducted directly with biology teachers to obtain contextual information regarding the implementation of biotechnology learning, the media used in learning activities, and teachers' perspectives on students' critical thinking skills. The interviews were then transcribed and analyzed qualitatively to identify patterns and key issues emerging in the field. In addition to interviews, researchers also distributed a research questionnaire to 12th-grade students via Google Forms from April to May 2025. Eighty-six respondents completed the questionnaire and comprised 20 questions designed based on six indicators of critical thinking skills according to Facione (2015): interpretation, analysis, evaluation, conclusion, explanation, and self-regulation. This questionnaire aimed to obtain data on students' level of understanding and difficulties in learning biotechnology material, as well as to describe their critical thinking skill profiles more objectively.

A systematic literature review was conducted to strengthen the field findings by searching for relevant scientific sources. Literature was obtained from several online databases, including Google Scholar (24 sources), ScienceDirect (2 sources), and Garuda (4 sources). Literature selection was based on recency (a maximum of the last five years) and relevance to the topic of critical thinking skills and biotechnology learning media. All data obtained was then analyzed using descriptive qualitative analysis techniques, which involved three stages: data reduction, data presentation, and conclusion drawing. The reduction stage was carried out by sorting and focusing relevant information from the interviews, questionnaires, and literature review. The reduced data was then presented in descriptive narrative form and tables for easier understanding. Next, the researchers drew conclusions to describe the profile of students' critical thinking skills and provided recommendations for developing learning media tailored to the field's needs.

The results of the literature review were used as triangulation and to strengthen the primary data, thus enhancing the validity, depth, and comprehensiveness of the research findings. Therefore, this research method provides a comprehensive overview of the current state of biotechnology learning in schools and the direction of developing learning media that can enhance students' critical thinking skills. The relevance of the content to the focus of the study and its contribution have enriched the theoretical understanding and practical application of the learning topics covered. The flow of the literature review is illustrated in Figure 1.

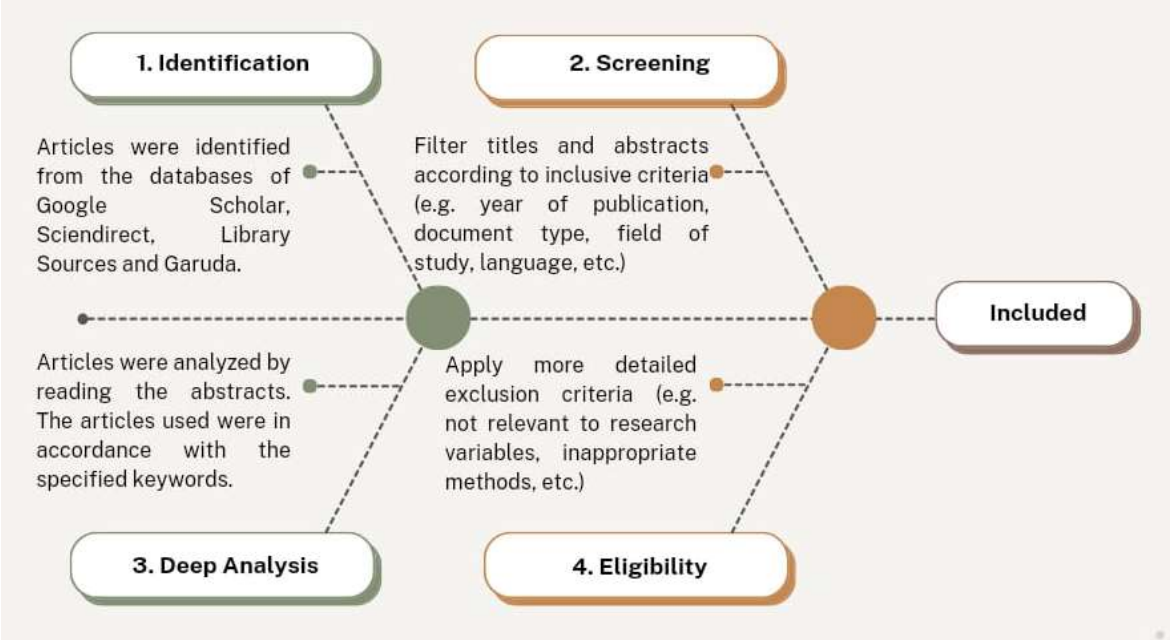

Figure 1. SLR Flowchart
Source: (Musdalry, 2021)

The Systematic Literature Review method is used to find, assess, evaluate, and interpret all relevant research in a specific issue area, along with specific research questions (Maulana et al., 2024). The Systematic Literature Review process in this study was conducted through several systematic stages. First, in the identification stage, articles were identified from various databases such as Google Scholar, ScienceDirect, Garuda, and other library sources using predetermined keywords. This stage aims to collect as many articles as possible that are potentially relevant to the research topic. Next, the screening stage was carried out by selecting articles based on titles and abstracts according to inclusion criteria, such as year of publication, document type, field of study, and publication language. Articles that did not meet the inclusion criteria were eliminated, leaving only relevant articles to be retained.

The next stage was deep analysis, where articles that passed the initial screening were analyzed in more depth by reading the abstracts and contents to ensure their alignment with the research keywords and focus. At this stage, articles that did not align with the research variables or did not support the research objectives were again eliminated. After that, the eligibility stage is carried out by applying more detailed exclusion criteria, for example, articles with irrelevant methods, topics outside the research scope, or not meeting academic standards. Ineligible articles will be excluded at this stage. The final results at this stage will be compiled in a structured manner to obtain data on the profile of students' critical thinking skills, recommendations for effective and innovative learning media as alternative learning methods for the evolution topic to train students' scientific literacy skills, and support the realization of SDG 2.

3. RESULTS AND DISCUSSION

3.1.Research Results

Observations indicate that students' critical thinking skills in understanding biotechnology concepts are still limited, primarily because the learning media used have not been fully designed to challenge students' higher-order thinking (Daryanes & Sayuti, 2022). Analysis of students' critical thinking achievement was conducted to determine the extent to which critical thinking indicators and activities emerged during

the learning process. The findings are visualized in the diagram in Figure 2 to facilitate the identification of trends, dominance, and weaknesses in each indicator. The diagram provides an overview of the most frequently occurring indicators and critical thinking activities carried out by students, from the stages of interpretation, analysis, inference, evaluation, explanation, and self-regulation.

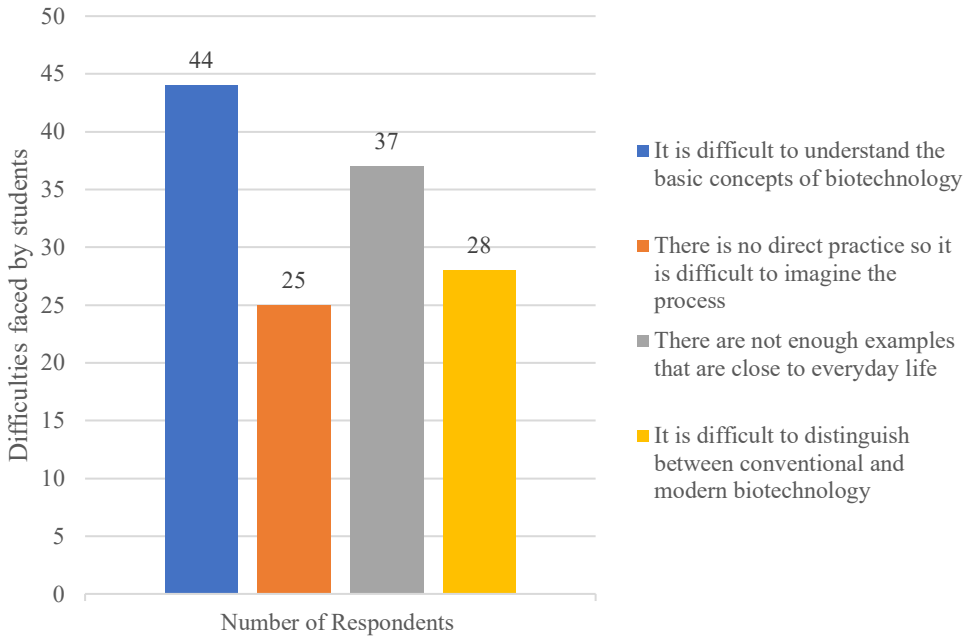

Figure 2. Bar Graph of Student Difficulties in Biotechnology Material

Based on the survey results presented in Diagram 2, it can be seen that the most common difficulty experienced by students in learning biotechnology lies in understanding its basic concepts. This indicates that students still struggle to grasp the terms, principles, and mechanisms that underlie biotechnology. Furthermore, most students also reported difficulties due to a lack of examples relevant to everyday life. This situation illustrates that biotechnology learning is often theoretical, making it difficult for students to connect the material to real-world applications in their environment.

Figure 3 shows the number of media used by students in biotechnology learning. The data indicates that digital learning media, such as E-LKPD, have not been optimally utilized.

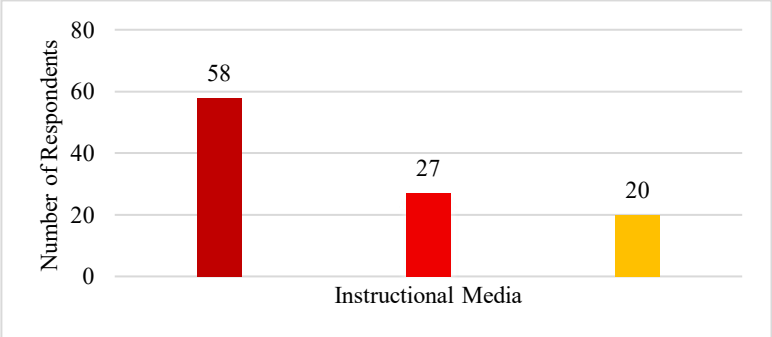

Figure 3. Learning Media Used

The learning media used for biotechnology in high school are quite varied. Student worksheets (LKPD) occupy the most dominant position. This indicates that most teachers still rely on LKPD as the primary guide in teaching and learning activities, particularly to facilitate students' understanding of basic biotechnology concepts through practice problems and structured assignments. Furthermore, electronic LKPD (electronic worksheets) are also quite widely used. This fact indicates a shift towards digitalization of learning media, where teachers are beginning to utilize electronic-based media to provide a more interactive and flexible learning experience. Meanwhile, textbooks remain the primary reference, although their use is relatively lower than both LKPD and electronic LKPD.

The questionnaire then provided results related to students' critical thinking skills and highlighted aspects that still need improvement in biology learning, particularly in biotechnology, as visualized in Figure 4.

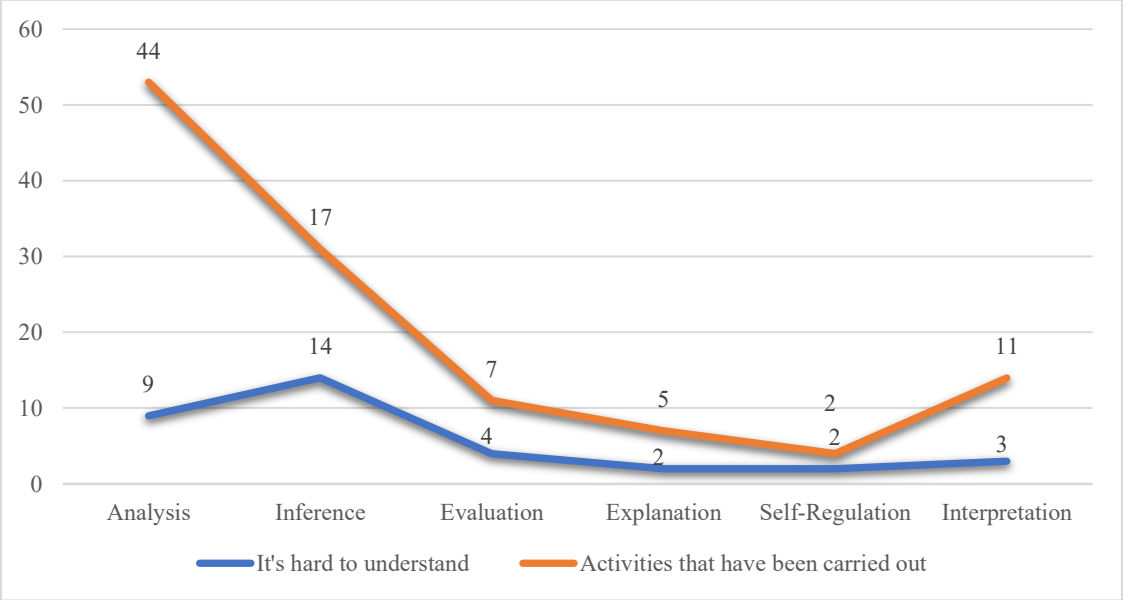

Figure 4. The Most Difficult Critical Thinking Indicators to Understand and Ever Implement

Analytical skills were the most prominent, while self-regulation was the least frequently performed activity. Overall, it can be seen that higher-order thinking activities are rarely practiced evenly, and most students are more accustomed to basic analytical activities than reflective and evaluative ones. Low achievement in these indicators indicates that the use of learning media is still predominantly oriented toward practice problems and conceptual analysis, with less emphasis on reflection, in-depth explanation, and self-control in the thinking process. This aligns with research by Azizah, Lufri, & Arsih (2025), which showed that student achievement in analysis and inference indicators tends to be higher than evaluation, explanation, self-regulation, and interpretation in biotechnology learning.

The results of the literature review in this study indicate the existence of several online sources that provide data and can be used as references to obtain information regarding the profile of critical thinking skills in various regions. After identifying that students' critical thinking skills in biotechnology are still moderate and not yet optimally developed, further analysis is needed regarding alternative learning media

that have the potential to strengthen these skills. Previous studies have shown that learning effectiveness is highly dependent on the media used, particularly if the media is able to provide contextual, reflective learning and encourage higher-order thinking. Therefore, to address the second research objective, a literature review was conducted of various print and digital learning media that have been proven to support the development of critical thinking skills in biotechnology.

Table 1. Literature Review of Alternative Learning Media for Strengthening Critical Thinking

No.	Type of Media	Author(s) (Year)	Main Findings (Media Function)	Relevance to Critical Thinking Skills
1	Liveworksheet-based E-LKPD	(Fitriandini & Isnawati, 2025)	E-LKPD promotes independent exploration and reflective learning.	Encourages analysis and evaluation in critical thinking.
2	E-LKPD	(Sumanik, 2022)	E-LKPD integrates audio, video, and images to enhance student engagement.	Develops information analysis skills, strengthens HOTS, and improves critical thinking and learning achievement.
3	Canva-based E-LKPD	(Arifin, 2024)	User-friendly E-LKPD with collaborative and innovative features.	Develops skills in identifying, analyzing, and evaluating information.
4	PowerPoint-based E-LKPD	(Rhiyanto & Rachmadiarti, 2023)	E-LKPD functions as an engaging and interactive presentation medium.	Enhances learning motivation and students' critical thinking skills.
5	Biotechnology E-Module	(Ma'arif, 2023)	Provides Porifera-based anti-cancer biotechnology simulations to support data exploration.	Improves critical thinking through data evaluation and simulation outcomes.
6	Google Sites-based E-Module	(Setiani et al., 2025)	Includes graphs, images, videos, and independent practice exercises.	Supports critical thinking through idea evaluation, innovation, and reflective learning in biotechnology processes.

No.	Type of Media	Author(s) (Year)	Main Findings (Media Function)	Relevance to Critical Thinking Skills
7	Canva-based E-Book (Heyzine Flipbooks)	(Triandro & Isnawati, 2024)	Provides project-based scenarios for biotechnology innovation.	Develops critical thinking through innovative problem-solving.
8	Autoplay Multimedia	(Anantyarta & Sholihah, 2020)	Interactive multimedia presents biotechnology concepts visually and applicatively.	Facilitates problem identification and critical conclusion drawing.
9	ChatGPT in Biotechnology Learning	(Haidir, 2024)	ChatGPT serves as an interactive discussion medium to broaden students' perspectives.	Trains critical thinking through AI-based questioning and scientific reflection.
10	Vee Diagram-based Laboratory	(Harmelayati et al., 2025)	Laboratory design using Vee diagrams guides biotechnology concept analysis.	Enhances critical thinking through reflection and concept mapping.
11	Bounded Inquiry-based LKPD	(Naibaho & Khairuna, 2025)	LKPD facilitates guided investigations for biotechnology experiments.	Encourages critical thinking through inquiry-based processes.
12	Conventional Biotechnology LKPD	(Humayroh et al., 2023)	Supports product development and activity testing of produced biotechnology products.	Improves students' critical thinking skills in biotechnology learning.
13	R-VGT-based Textbook	(Wibisono, 2020)	Facilitates biotechnology concept mastery through visual and textual representations.	Helps students develop in-depth conceptual analysis skills.
14	Biotechnology Booklet	(Saputri, 2025)	Serves as a contextual guide embedding values and biotechnology concepts.	Supports critical thinking by linking scientific analysis with reflective values.
15	Worksheet (LKS)	(Hatta et al., 2023)	Assists students in conducting biotechnology experiments.	Promotes critical thinking through observation, analysis, and

No.	Type of Media	Author(s) (Year)	Main Findings (Media Function)	Relevance to Critical Thinking Skills
				conclusion stages.

These findings reinforce the urgent need to develop and select learning media that not only convey information but also enable students to engage in in-depth critical thinking. Considering various relevant research findings, biotechnology learning requires media that encourage exploration, contextual engagement, and real-world problem-solving so that students not only understand concepts but also relate them to global issues.

3.2.Discussion

The results of the literature review indicate that students' critical thinking skills still need to be developed in the learning process, particularly in Biotechnology, which demands analytical and problem-solving skills. Based on previous research, students' critical thinking skills can be enhanced through the application of innovative and interactive learning models and media. One effective strategy is to utilize digital media based on interactive e-modules and e-LKPDs, which actively engage students in the learning process (Setiani et al., 2025). Engaging learning media supported by visuals, videos, and project-based activities provides a more meaningful learning experience and fosters higher-order thinking skills.

Furthermore, research by (Fitriandini & Isnawati, 2025) shows that the use of interactive digital learning media has proven effective in improving students' critical thinking skills because it allows students to understand abstract concepts through simulations and independent exploration. The use of technology can also create a flexible and enjoyable learning environment, thus motivating students to seek and process information in depth. This reinforces the finding that technology-based learning innovation is a solution for improving the quality of vocational education, which demands logical, analytical, and creative thinking skills. Furthermore, according to (Sumanik, 2022), biotechnology learning developed with a contextual approach can help students understand the relationship between theory and real-life applications. Digital-based learning that emphasizes solving real-life problems also encourages students to think critically and take responsibility for their own learning process. Integrating interactive learning media with biotechnology topics, such as fermentation or genetic engineering, is a strategic step in developing students' scientific analytical and reflective skills.

Meanwhile, research by (Ariaty et al., 2025) confirms that improving critical thinking skills depends not only on the learning media used but also on the teacher's role as a facilitator capable of creating a collaborative learning environment. Teachers need to utilize digital technology appropriately to guide students in understanding concepts and developing higher-order thinking skills. Therefore, the results of this study confirm that the application of digital-based learning media to biotechnology material is highly relevant for improving critical thinking skills, while simultaneously fostering student motivation and independence in learning.

4. CONCLUSION

Based on the research results, it can be concluded that students' critical thinking skills in biotechnology material have not yet developed optimally or are classified as low, especially in the necessary interpretation, explanation, and evaluation abilities. Therefore, the

recommendation for alternative learning media that can be applied is E-LKPD and E-Modul, because the use of interactive digital media has proven to be more effective in increasing student engagement and enthusiasm for learning, and can direct students to the process of contextual and applicable critical thinking skills to support their understanding of the role of biotechnology in realizing future food security to support the realization of SDGs 2. This finding also has the potential to be further developed in subsequent research with a focus on the implementation and testing of the effectiveness of interactive digital media through experimental or quasi-experimental designs, as well as its integration with project-based or problem-based learning approaches (PjBL/PBL) in order to create a more in-depth, applicable, and sustainable learning experience according to the demands of 21st-century learning.

5. BIBLIOGRAPHY

Anantyarta, P., & Sholihah, F. N. (2020). Pengembangan Multimedia Pembelajaran pada Materi Bioteknologi Menggunakan Program Autoplay. *Journal of Natural Science and Integration*, *3*(1), 45–57. https://doi.org/http://dx.doi.org/10.24014/jnsi.v3i1.9036

Ariaty, E., Ariandini, N., Alfira, E., & Mustari U., A. (2025). Pengaruh Media Digital Interaktif terhadap Motivasi Belajar Siswa Sekolah Menengah. *Media, Jurnal Kependidikan*, *14*, 88–95.

Arifin, A. S. (2024). *Pengembangan E-LKPD Berbasis Project Based Learning Pada Materi Bioteknologi Untuk Siswa Kelas X SMA N 1 Batanghari* [IAIN Metro]. https://repository.metrouniv.ac.id/id/eprint/10602

Arjaya, I. B. A., Hermawan, I. M. S., Surata, S. P. K., Sari, N. K. S. P., Wati, K. U. P., & Dema, K. (2025). Optimalisasi Pengembangan Bahan Ajar Berbasis Deep Learning dan Artificial Intelligence dalam Pendidikan Vokasi. *Jurnal Pengabdian Masyarakat Bangsa*, *3*(4), 1730–1740. https://doi.org/10.59837/jpmba.v3i4.2557

Azizah, F., Lufri, L., & Arsih, F. (2025). Analisis Keterampilan Berpikir Kritis Peserta Didik Kelas XII SMAN 1 Payakumbuh tentang Materi Bioteknologi. *Ilmu Hayat Didaktika*, *1*(1), 1–10. https://doi.org/https://doi.org/10.24036/ihd.v1i1.3

Benyamin, B., Qohar, A., & Sulandra, I. M. (2021). Analisis Kemampuan Berpikir Kritis Siswa SMA Kelas X dalam Memecahkan Masalah SPLTV. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(2), 909–922. https://doi.org/https://doi.org/10.31004/cendekia.v5i2.574

Daryanes, F., & Sayuti, I. (2022). Research-Based Learning in Biology Courses to Train Students' Critical Thinking Skills: Student's Perception. *Biosfer: Jurnal Pendidikan Biologi*, *15*(2), 234–245. https://doi.org/https://doi.org/10.21009/biosferjpb.15212

Facione, P. (2015). *Critical Thinking: What It Is and Why It Counts*. https://www.researchgate.net/publication/251303244_Critical_Thinking_What_It_Is_and_Why_It_Counts

Facione, P. A. (2011). *Critical Thinking: What It Is and Why It Counts*. Insight Assessment. https://www.insightassessment.com

Fitriandini, M. S., & Isnawati, I. (2025). Development of Electronic Student Worksheet (E-Worksheet) Based on Project Based Learning (PJBL) to Train Student's Critical Thinking Skills on Biotechnology Topic of 10th Grade in Senior High School. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *14*(1), 211–218.

Haidir, T. M. (2024). *Penerapan Chat-Gpt Dalam Pembelajaran Biologi Materi Bioteknologi Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Di Man 1 Cirebon* [S1-Tadris Biologi IAIN Syekh Nurjati]. https://syekhnurjati.ac.id/

Harmelayati, Y., Kusnadi, & Amprasto. (2025). Rekontruksi Desain Kegiatan Laboratorium Materi Bioteknologi Melalui Pendekatan Diagram Vee. *JPG: Jurnal Pendidikan Guru*,

6(3), 465–473. https://ejournal.uika-bogor.ac.id/index.php/jpg/article/view/20161

Hatta, H., Umiyati, H., Amane, A. P. O., Santosa, S., Novianti, R., Liniarti, S., & Ahdiyat, M. (2023). *Model-model pelatihan dan pengembangan SDM*. Penerbit Widina.

Humayroh, S., Anas, N., & Adlini, M. N. (2023). Pengembangan LKPD Berbasis Project Based Learning untuk Meningkatkan Keterampilan Berpikir Kritis Siswa pada Materi Bioteknologi Konvensional Kelas XII SMA/IPA. *Sci-Tech Journal*, *2*(2), 202–212. https://doi.org/https://doi.org/10.56709/stj.v2i2.116

Ma'arif, N. A. U. F. A. L. (2023). *Pengembangan E-Modul Bioteknologi Berbasis Studi Anti-Kanker pada Porifera Secara In Silico untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMA* [Universitas Negeri Jakarta]. http://repository.unj.ac.id/id/eprint/40582

Musdalry. (2021). Systemaltic Review: Efektivitals Ideonellal Salkaliensis daln Chlalmydomonals Reinhalrdtii sebagai gen Biodegradasi Plastik Berbalhaln Dasar PET. *Jurnal Biolokus*, *4*(1), 20. http://jurnalltalrbiyalh.uinsu.alc.id/index.php/eunoial/index

Naibaho, A. N. A., & Khairuna, K. (2025). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Keterampilan Proses Sains Model Bounded Inquiry Laboratory pada Materi Bioteknologi. *Bioscientist: Jurnal Ilmiah Biologi*, *13*(1), 1–11. https://doi.org/https://doi.org/10.33394/bioscientist.v13i1.13193

Redana, I. W. (2019). Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1). https://doi.org/https://doi.org/10.15294/jipk.v13i1.17824

Rhiyanto, D. F. P., & Rachmadiarti, F. (2023). Pengembangan Media Pembelajaran Powerpoint Interaktif Add-Ins Classpoint Materi Bioteknologi untuk Meningkatkan Motivasi Belajar pada Peserta Didik Kelas XII SMA/MA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *12*(2), 452–465.

Saputri, D. E. (2025). *Perkembangan Media Pembelajaran Booklet Terintegrasi Keislaman Pada Mata Pelajaran Biologi Materi Bioteknologi di SMAN 1 Padang Ganting*. https://repo.uinmybatusangkar.ac.id/xmlui/handle/123456789/31922

Setiani, I., Sajidan, S., & Fatmawati, U. (2025). Enhancing Creative Thinking Skills On Biotechnology Materials: Development Of An E-Module Using Google Sites. *Jurnal Inovasi Teknologi Pendidikan*, *12*(2), 142–155. https://doi.org/https://doi.org/10.21831/jitp.v12i2.83829

Sumanik, N. B. (2022). Pengembangan Lembar Kerja Peserta Didik Elektronik Berbasis Literasi Sains Untuk Melatih Kemampuan Berpikir Kritis. *Jurnal Penelitian Pendidikan*, *25*(2), 147–161. https://doi.org/https://doi.org/10.20961/paedagogia.v25i2.64080

Titin, Yuniarti, Shallihat, A. P., Amanda, D., Ramadhini, L. I., & Virnanda, V. (2023). Memahami Media untuk Efektivitas Pembelajaran. *JUTECH: Journal Education and Technology*, *4*(2), 111–123.

Triandro, A. Z., & Isnawati, I. (2024). Pengembangan E-Book Berbasis Project Based Learning Materi Inovasi Teknologi Biologi untuk Melatih Kemampuan Berpikir Kreatif pada Peserta Didik SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *13*(3), 550–661. https://doi.org/https://doi.org/10.26740/bioedu.v13n3.p550-661

Wibisono, A. (2020). Pengembangan Buku Ajar Bioteknologi berbasis R-VGT Kelas XI IPA 1 SMAN Senduro Lumajang. *Briliant: Jurnal Riset Dan Konseptual*, *5*(2), 341–347. https://doi.org/http://dx.doi.org/10.28926/briliant