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Trends in the Use of Interactive E-Modules in Ecology Learning

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Abstract

This study aimed to analyze the trend of interactive e-module usage in Ecology learning and identify the gap between students' needs and experiences of using them. The research method used a mixed-method research design by combining Systematic Review and quantitative descriptive method, reinforced by student needs questionnaire data. The results of the study indicate that students' needs and interests in interactive e-modules are in the high category, especially for visual and interactive learning media. However, the experience of using interactive e-modules is still relatively low. This finding indicates a gap between students' needs and the implementation of e-modules in Ecology learning. Therefore, the development and implementation of interactive e-modules that are appropriate to students' needs need to be optimized to support more effective Ecology learning.

Keywords: Interactive e-modules, Ecological learning, Digital learning media, Mixed-Method

INTRODUCTION

The development of digital technology in the world of education is driving a transformation in the way student learning, including in Ecology learning. Ecology learning requires visualization, environmental exploration, and understanding of abstract concepts, so that demands learning media that are interesting, interactive, and easy to access (Arsyad, 2019). One of the media that is developing rapidly is the interactive E-Module, which not only displays material, but also includes simulations, videos, interactive exercises, and navigation that flexible (Daryanto, 2018).

Various previous studies have shown that the use of interactive E-Modules able to increase student motivation and understanding. Rizka & Fitrihidajati (2025) found that interactive E-Modules can improve science literacy and student engagement. Nasution & Uqba (2024) also reported that the use of interactive E-Modules on the material ecology has a positive impact on conceptual understanding and learning interest. Other research by Pramesti, *et al*., (2025) showed an increasing trend in the use of digital media in science learning, especially in visual and multimedia contexts.

However, although various studies have shown the effectiveness of E-Modules, there are not many research that maps actual trends in student needs, especially in the context of Ecology learning, which has the characteristics of environment-based learning and field

observations. Kusnadi & Azzahra (2024), research focused more on development of E-Modules and testing their effectiveness, but rarely does anyone examine the trends use of interactive E-Modules based on students' real needs, especially in aspects interests, accessibility, and prior digital experience.

On the other hand, the results of the student needs questionnaire showed important findings regarding potential use of interactive E-Modules. The majority of students stated that they found it easier understanding the material when accompanied by pictures and videos 11 strongly agree and 22 agree is a core feature of the interactive E-Module. In addition, 16 strongly agreed and 16 agreed that they requires interesting and interactive digital learning media. However, the actual use of still low, with 24 respondents in a neutral position and 9 disagreeing that they have ever using E-Modules or other digital teaching materials.

The gap between high demand and low experience of using this E-module shows the existence of a relevant research gap, namely the need for studies on trends. the use and need for interactive E-Modules in Ecology learning in a more comprehensive manner comprehensive based on student data.

Based on this, the objectives of this research are:

1. Describe students' needs for interactive E-Modules in learning Ecology.
2. Identify trends in student usage and experiences with interactive E-Modules.
3. Analyze the gap between student needs and the implementation of E-Modules interactive.

METHOD

This research used used a mixed-method research design by combining Systematic Review and quantitative descriptive method, reinforced by student needs questionnaire data. This method was chosen to explore and map the tendency of using interactive E-Modules in Ecology learning based on in-depth review of previous research and strengthened with questionnaire data student needs. In the context of a Systematic Review, the research data source is not in the form of human participants, but rather scientific articles relevant to the E-Module topic interactive, digital learning media, and ecological learning (Ilmiati, *et al*. 2025).

Determination of articles to be reviewed is carried out through a selection process based on inclusion criteria. and exclusion. Articles were included if they were published between 2018 and 2024. has a focus on the use of E-Modules or interactive learning media in science or ecology education, available in full text form, and containing empirical data can be processed quantitatively or qualitatively. On the other hand, irrelevant articles, opinion-based, incompletely available, or of low methodological quality excluded from the analysis process. The research instrument is in the form of an assessment checklist. article quality based on

PRISMA guidelines and data extraction sheets that record important information from each article such as title, year of publication, research method, subject research, the type of E-Module used, and the main findings of the research.

The data collection process is carried out in several stages. At the identification stage, Researchers search for relevant articles from various databases such as Google Scholar, DOAJ, Sinta, ERIC, and ResearchGate use keywords related to E-Modules interactive and ecological learning. Data analysis was conducted using a descriptive approach. quantitatively by calculating the frequency and trends of the article categories that have been collected, such as trends in the use of interactive E-Modules based on publication year, level of education, learning methods, and their impact on learning outcomes.

In addition, a quantitative synthesis was conducted to group the research findings into in several themes such as the effectiveness of interactive E-Modules , increasing learning motivation, visualization of ecological concepts, and the challenges of their implementation. The results of the analysis are then compared with the student needs questionnaire data to obtain a clearer picture. comprehensive regarding the suitability between research trends and the real needs of students. With Thus, the Systematic Review method with a quantitative descriptive approach enables research to produce actual and evidence-based trend mapping regarding the use of interactive E-Modules in Ecology learning.

RESULTS AND DISCUSSION

The results of this study were obtained through analysis of student needs questionnaire data and synthesis. findings from previous studies reviewed using the Systematic method Review with a quantitative descriptive approach. The analysis was conducted to describe trends in needs, experiences, and use of interactive E-Modules in Ecology learning. Questionnaire data is used to provide an overview of actual conditions in field, while the results of the literature study serve to map trends in the use of E-Modules interactively based on published empirical findings (Table 1).

Table 1. Results of the Student Needs Questionnaire Analysis for Interactive E-Modules

No.	Statement	Very Agree	Agree	Neutral	No Agree	Absolutely Not Agree
1	Student is happy learn with image help and video	11	22	11	0	0
2	Students interested on learning which is exploratory	11	24	9	1	0
3	Students feel bored with method learning book-based text	8	17	18	2	1
4	Students Need learning media digital interesting and interactive	16	16	13	1	0
5	Students need module learning who can accessed through Mobile Phone/Laptop	10	22	12	1	0
6	Students have use E-Module or teaching materials digital	3	8	24	9	0

The student needs questionnaire analysis focused on aspects of learning preferences, needs digital learning media, as well as student experiences in using interactive E-Modules. The data obtained were then processed descriptively by calculating the frequency and distribution of responses to each statement. The results of this analysis show a tendency students' need for learning media that is visual, interactive, and easy to use accessed via digital devices (Table 2).

Table 2. Trends in Previous Research Findings on Interactive E-Modules (Systematic Review)

Aspect Tested	Key Findings	Research Sources
Motivation to learn	Interactive E-Modules increase students' interest and motivation to learn	Rizka & Fitrihidajati (2025)
Concept Understanding Ecology	Visualization and simulation in E-Modules help understanding abstract concepts	Nasution & Uqba (2024)
Media Usage Trends Digital	There has been an increase in the use of digital media in science learning	Pramesti *et al*. (2025)
Effectiveness of E-Modules	E-Modules are effective as independent and interactive learning media	Arsyad (2019); Daryanto (2018)
Implementation Challenges	Limited access and experience of using E-Modules	Research synthesis results

In addition, the results of the Systematic Review were used to identify patterns of findings. previous research related to the effectiveness, usage trends, and challenges of implementing E-Modules interactive learning in Ecology and Science. Quantitative synthesis of articles that analyzed to provide an overview of the suitability between the results of previous research with the current conditions and needs of students. The following is a description of the research results presented concisely and systematically in table form to make it easier for readers to understand the main findings of the study (Table 3).

Table 3. Gap Analysis between E-Module Needs and Implementation

Aspect	Ideal Conditions (Student Needs)	Current Conditions (Usage)	Gap
Media Visual & Interactive	Students need images, videos, and simulation	E-Module not yet widely used	High
Accessibility	Module is accessible via cellphone/laptop	Use of E-Module still limited	Currently
Experience Study Digital	based learning technology	The majority of students have not used to	High
Implementation in the classroom	Integrated E-Module ecological learning	Still dominant method conventional	High

The results of the study show that students' need for the use of E-Modules interactive learning in Ecology is in the high category. This can be seen from the dominant response of students who stated they agreed and strongly agreed with the statement that learning becomes easier to understand when accompanied by images and videos. Findings This strengthens the views of Arsyad (2019) and Daryanto (2018) who stated that the media Visual and multimedia-based learning can help students understand concepts abstract, including complex and contextual ecological concepts. As well as research findings shows that the use of visual learning media is effective in improve students' understanding of abstract concepts, increase engagement students, as well as helping students connect learning materials with real experiences (Wahidin, 2025).

In addition to the need for visualization, students also showed a strong interest towards digital learning media that is interesting and interactive and can be accessed via devices personal devices such as mobile phones and laptops. This condition is in line with the learning trend digital reported by Pramesti *et al*. (2025), which states that the integration of Technology in science learning is increasingly needed to adapt to characteristics of the digital generation. In the context of Ecology learning, interactive E-Modules are assessed able to bridge the limitations of conventional learning which often only relying on textbooks and lectures & students' low understanding of the concept of bonds Chemistry is often associated with conventional teaching methods that still rely on lectures and textbooks, without the support of interactive media that can bridge concepts abstract into concrete (Telaumbanua *et al*. 2025).

However, despite the students' need and interest in interactive E-Modules is relatively high, the results of the questionnaire show that the experience of using the E-Module is still relatively low (Budiono & Utami, 2024). Most students are in the neutral and disagree when asked about experiences using E-Modules or teaching materials digital. This finding indicates a gap between needs and implementation Interactive e-Modules in schools. This gap can be caused by several factors, such as the limited availability of E-Modules that are in accordance with the curriculum, the lack of teachers' skills in developing digital media, as well as the less than optimal integration technology in the Ecology learning process (Sinambela *et al*., 2024).

The results of the Systematic Review also show that most of the research Previously, more emphasis was placed on the development of E-Modules and testing their effectiveness. on students' learning outcomes, motivation, and scientific literacy. Research by Rizka dan Fitrihidajati (2025) and Nasution and Uqba (2024) showed that interactive E-Modules contributed positive impact on student engagement and conceptual understanding. As well as

research from Rahmawati, *et al*., 2025; Mutiara *et al*., 2024; Sakinah & Hakim, 2023, the interactive e-module has the function namely making it easier for students to understand the material, adding learning resources, and improve students' learning independence. However, studies on trends in student needs and mapping of actual use of E-Modules is still relatively limited. Therefore, research This complements previous research by presenting a student needs perspective. as an important basis in the development and implementation of interactive E-Modules.

By comparing the results of the student needs questionnaire and previous research findings, It can be concluded that interactive E-Modules have great potential for implementation. in Ecology learning, but requires a more systematic implementation strategy. The development of E-Modules needs to be adapted to the characteristics of the ecological material that demands environmental observation, exploration, and critical thinking. In addition, training support for teachers and the provision of adequate digital infrastructure is an important factor for minimize the gap between the needs and actual use of interactive E-Modules.

Overall, this discussion confirms that the trend of using E-Modules interactive in Ecology learning continues to increase and is relevant to the needs 21st century learning. However, the success of its implementation is highly dependent on suitability of media to student needs, educator readiness, and system support digital learning in schools. Thus, the results of this study can be the basis for development of Ecology learning policies and practices based on interactive E-Modules more effective and sustainable.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the trend The use of interactive E-Modules in Ecology learning shows great potential. high to support a more effective and meaningful learning process. The results of the analysis student needs show that the majority of students need learning media digital which is visual, interactive and easy to access, especially those containing images and videos to help understand complex and abstract ecological concepts. With Thus, this study emphasizes the importance of developing and implementing E-Modules. interactive, based on student needs and integrated with learning characteristics Ecology. Implementation of interactive E-Modules supported by educator readiness, availability digital infrastructure, and appropriate learning strategies are expected to be able to optimize Ecology learning and bridging the gap between needs and practices field learning.

REFERENCES

Arsyad, A. (2019). *Learning Media*. Jakarta: Rajawali Press.

Budiono, D. & Utami, I. (2024). Analysis of Interactive E-Module Development Needs Digital Economy to Improve Students' Economic Literacy. *Program Journal Studies in Economic Education*. 12 (2), 379-387. https://doi.org/10.24127/jp

Daryanto. (2018). *Learning Media*. Yogyakarta: Gava Media.

Ilmiati, M. S., Muhammad, R. W. M., & Agnestasia, R. P. (2025). Development of E-Modules Interactive Climate Change Topic for Elementary School Students. *Pendas: Scientific Journal Elementary Education*. 10 (2), 422-436.

Kusnadi, E. & Azzahra, S. A. (2024). The Use of Interactive Learning Media Based on Wordwalls in Improving Students' Learning Motivation in Subjects PPKn at MA Al Ikhlash Padakembang Tasikmalaya. *Journal of Educational Dimensions and Learning*. 12 (2), 323-339.

Mutiara, A., Alfiriani, A., & Novita, R. (2024). Development of Interactive E-Modules on Material Data Analysis of Informatics Subjects for Grade X at SMKN 1 Solok Selatan. *JATI (Journal Student Technique Informatics)*. 8(5), 10558–10565. https://doi.org/10.36040/jati.v8i5.10976

Nasution, R. & Uqba, M. S. S. (2024). Preparing For Tomorrow's Challenge: Tren Teknologi & Media in Future Education. *Kirana: Social Science Journal*. 1 (2), 76-86. https://doi.org/10.61579/kirana.vIi2.167

Pramesti, N. M., Trisnantari, H. E., & Sari, E. Y. (2025). Interactive E-Module Development Canva Application-Based Material on Changes in the State of Matter for Grade IV Elementary School. *Jupeis: Journal Education And Knowledge Social*. 4 (3), 556-566.

Rahmawati L., Bachtiar S. B., & Irena, Y. M. (2025). Literature Review: The Influence of E-Modules Interactive Learning on Student Motivation in Learning. *PAEDAGOGIE*. 20 (2), 47-58. https://doi.org/10.31603/paedagogie.v20i2.14025

Rizka, A.N. & Fitrihidajati, H. (2025). Validity of Interactive Electronic Module Development Based on Problem Based Learning on the Sub-Material of Organic Waste Processing for Improving Learning Outcomes of Class X Students. *Bioedu: Scientific Periodical of Biology Education*. 14 (3), 608-618.

Sakinah, M., & Hakim, D. L. (2023). Student Responses to the Use of Interactive E-Modules Barsil in Independent Learning of Mathematics. *Coordinate of MIPA Journal*. 4(2), 54–65. https://doi.org/10.24239/koordinat.v4i2.71

Sinambela, S. M., Joy, N. Y. L., Mima, D. S., Mangunsong, A. F., Chairun, N., Johan, P. S., Jamaludin. (2024). Digital Divide in the World of Education Today and Tomorrow Forthcoming. *Indonesian Education Star Journal (JUBPI)*. 2 (3), 15-24. https://doi.org/10.55606/jubpi.v2i3.3003

Sugiyono. (2019). *Educational Research Methods: Quantitative, Qualitative, and Interpersonal Approaches R&D*. Bandung: Alfabeta.

Telaumbanua, D. A., Wildawani, S., & Uswatun, H. (2025). Media Feasibility Test Technology-Based Learning on Chemical Bonding Material in Class X of State Senior High School 1 Gomo. *Journal of Education and Teaching Review*. 8 (2), 6223-6227.

Wahidin. (2025). Development of Visual Learning Media to Improve Students' Conceptual Understanding. *Educational Scientific Journal*. 11 (1), 285-295.