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Implementation of *an Education for Sustainable Development* (ESD)-Based Electronic Module to Improve Critical Thinking Skills and Environmental Awareness Among Students in the Wetland Ecology Course

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A B S T R A C T

The 21st century is known as the era of science and communication. To face these challenges, quality human resources are needed through education. This study aims to determine the improvement in critical thinking skills and environmental awareness among students after using electronic teaching materials on wetland ecology based on Education for Sustainable Development (ESD). The research used a pre-experimental design with a one-group pretest-posttest design. A total of 34 students enrolled in the wetland ecology course in the even semester of 2024/2025 participated in the study. The results showed that students' critical thinking skills improved from the pretest to the posttest. The pretest mean score was 70.47, considered good, while the posttest mean score was 84.28, considered very good. Students' cognitive environmental awareness attitudes also improved between the pretest and posttest. The students' cognitive attitude towards environmental awareness in the pretest was 3.34, considered moderately concerned, and increased to 4.3 in the posttest, considered concerned. Thus, the electronic module on wetland ecology based on ESD as teaching material enrichment can be used to improve students' critical thinking and attitude towards environmental awareness.

1. Introduction

The Biology Education Study Program currently uses the 2020 curriculum based on *Outcome Based Education* (OBE), which focuses on learning outcomes and problem solving or *case method-based* learning. The case method learning model provides opportunities for students to develop their potential, actualize themselves, innovate, and find solutions to the cases being discussed (Widiastuti et al., 2022). The wetland ecology course is a new course included in the elective Field of Expertise Course (MKBK) group with a weight of 2 credits, focusing on environment-based learning, particularly the wetland environment.

The Learning Outcomes of the Wetland Ecology Course (CPMK) consist of knowledge, general skills, specific skills, and attitudes that focus on *the Center of Excellence* of the University of Riau, namely *Wetlands*. Therefore, environmental literacy is essential in developing student competencies integrated into departmental courses, one of which is wetland ecology. In preparing the Semester Learning Plan (RPS), an analysis was conducted on the local potential in Riau Province as a learning resource, and it was found that there are many material concepts for enriching wetland ecology learning. The material concepts developed are the typology of wetland ecosystems, wetland ecosystem problems, and wetland ecosystem restoration and mitigation efforts.

Education for sustainable development (ESD) is learning that is oriented towards sustainable development and is able to improve the character of students (Shinta & Aldila, 2021). According to Ghani (2018), the implementation of education for sustainable development in Indonesia has already begun. Indrati & Hariati (2016) state that ESD is a dynamic concept that has noble values for creating a sustainable future through education. Education is a supporting factor that can be used to introduce ESD, which is where lecturers play a very important role in the learning process. ESD can be instilled in students through the teaching and learning process.

The aspects of ESD that must be instilled in students are Envisioning, which is the characteristic of students being able to imagine a better future; *Critical Thinking*, which is thinking deeply about something or a problem that involves students' logical reasoning; *Participation in Decision Making*, which is the characteristic of developing students in analyzing, planning, and organize their decisions in sustainable development, *Partnership* is a characteristic of ESD to learn to work together, and *Systemic Thinking* is a characteristic that enables students to recognize the complexity of problems and find connections and synergies in complex issues (Rahman et al., 2019). In cultivating sustainability awareness in students, critical thinking skills are needed. According to Taimur & Sattar (2019), critical thinking skills are necessary to enable students to not only have a sustainable perspective but also critical thinking in ESD. Critical thinking skills in problem solving are not acquired naturally but require self-awareness that must be cultivated in students.

From a survey conducted on students taking wetland ecology courses, it was found that most students (67.75%) did not have additional references in taking wetland ecology courses, even though there were main references that were generally in foreign languages. Students tended not to try to obtain these books. In addition, 87% of students were not yet aware of ESD. Therefore, there is still a need to deepen understanding of the concept of wetland ecology based on local wisdom by adding supporting references for students in attending lectures, one of which is an electronic module that is flexible in its use.

The development of 21st century learning requires the use of technology and information to make learning more interesting. This is also in line with Permendikbud No. 22 of 2016 concerning standards for primary and secondary education processes. One of the contents of the process standards is the use of information and communication technology to improve the efficiency and

effectiveness of learning. Therefore, it is very important to review the implementation of the ESD-based electronic wetland ecology module, which contains enriched concepts of local potential in Riau Province integrated with environmental management to improve students' critical thinking skills and environmental awareness in the wetland ecology course of the Biology Education Study Program, FKIP, University of Riau.

2. Methodology

Research Method

The research used a quantitative approach with a *pre-experimental design* method. This was because there were no control variables used in the research and the sample was not selected randomly. The research sample consisted of 34 Biology Education students from the Faculty of Teacher Training and Education, University of Riau, comprising 29 female students and 5 male students who were taking the wetland ecology elective course in the even semester of 2024/2025. According to Sugiyono (2019), the *Pre-Experimental Design* can help to obtain preliminary knowledge regarding the formulation of problems in research.

The research design used was *a one-group pretest-posttest design*, which is a research design that includes *a pretest* before treatment and *a posttest* after treatment to measure the effectiveness of learning, which is considered more accurate because it can compare scores before and after implementation. The *pretest* and *posttest* activities at this stage measure students' critical thinking skills and environmental awareness. This is done to determine the extent of improvement in students' critical thinking skills and environmental awareness after using the wetland ecology electronic module based on *Education for Sustainable Development* (ESD). An illustration of the trial design is presented in Figure 1 below.

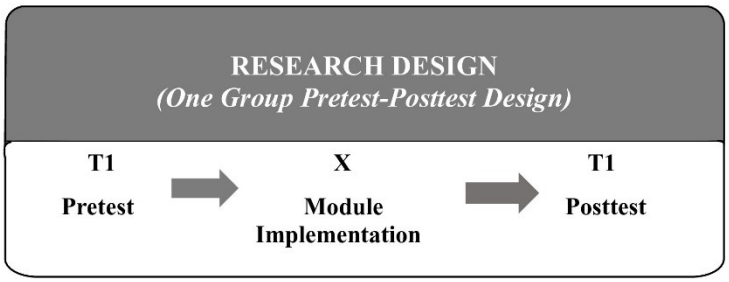

Figure 1. Research Design

The data collected is primary data. The initial test (*pretest*) is conducted to determine learning outcomes before the implementation of the electronic wetland ecology module in learning. After that, students receive the electronic wetland ecology module treatment for 6 meetings. At the end of the treatment, students underwent a final test (*posttest)* to determine their learning outcomes. *The pretest* and *posttest* activities at this stage measured students' critical thinking skills and

environmental awareness. This was done to determine the extent of improvement in students' critical thinking skills and environmental awareness after using the electronic wetland ecology module.

Analysis of Critical Thinking and Environmental Awareness Data

Critical Thinking Skills

Critical thinking skills were assessed using a cognitive test instrument (learning outcomes) given to students to obtain the expected answers in writing both before and after the implementation of the electronic wetland ecology module. The test was developed based on achievement indicators and wetland ecology material by integrating the local potential of Riau Province. The test questions consisted of: (1) Wetland Typology; (2) Wetland Environmental Issues; (3) Wetland Ecosystem Restoration and Mitigation Efforts; (4) Ecosystem issues in Riau Province that are classified as global and national environmental issues; (5) Wetland ecosystem management efforts supported by case studies in Riau Province. The critical thinking skills measured by the area N gain to determine its effectiveness and each critical thinking indicator.

a. Calculate the difference between the *pretest* and *posttest* scores (N-gain).

$$N - gain = \frac{Postest\ score - Pretest\ score}{Ideal\ score - Pretest\ score}$$

The *N-gain* values obtained are interpreted and analyzed descriptively using the criteria in Table 1 below.

Table 1. *N-gain* Categories

Coefficient	Category
N-gain > 0.7	High
$0.3 \leq$ *N-gain* ≥ 0.7	Medium
N-gain < 0.3	Low

b. Calculate the average *pretest* and *posttest* scores for all students.

$$The\ student'average\ score = \frac{The\ student'total\ score}{Total\ student}$$

Critical thinking skills are also calculated from each aspect measured. The data is analyzed to determine the percentage increase per critical thinking indicator using the following formula:

$$critical\ thinking = \frac{JB}{JS}\ X100$$

Explanation:
JB = Number of correct scores

JS = Total score

The critical thinking skill scores obtained were interpreted and analyzed descriptively using the criteria in Table 2 below.

Table 2. Critical Thinking Criteria

Competency Mastery Level	Category
90-100	Very Critical
80	Critical
65-79	Moderately Critical
55	Not Critical
<55	Not Critical at All

Environmental Awareness Attitude

The environmental awareness test was used to obtain data on students' attitudes toward environmental management. It was conducted by providing a number of questions with 5 answer choices scored from 1 to 5 through a closed questionnaire in the form of a student self-assessment questionnaire. The scoring criteria for each assessment item use a *Likert* scale with 5 assessment criteria, namely: Strongly Agree (SS) with a score of 5, Agree (S) with a score of 4, Disagree (KS) with a score of 3, Disagree (TS) with a score of 2, and Strongly Disagree (STS) with a score of 1. The attitude assessment was developed based on three main aspects of environmental awareness assessment, namely: (a) Efforts/Ideas/Concepts, (b) Actions/Participation, and (c) Student Responsibility in Wetland Management.

The classification of assessments can be seen in the following formula.

$$Assessments\ (\%) = \frac{the\ total\ score\ obtained\ for\ each\ item}{the\ ideal\ total\ score\ for\ all\ items} x100\%$$

The environmental concern attitude scores obtained were interpreted and analyzed descriptively using the classification shown in Table 3 below.

Table 3. Classification of Environmental Care Attitude Scores

Score	Level of Concern
> 4.2 to 5.0	Very Concerned
> 3.4 to 4.2	Concerned
> 2.6 to 3.4	Less Concerned
> 1.8 to 2.6	Not Concerned
≥ 1.0 to 1.8	Very Indifferent

3. Results and Discussion

The wetland ecology course is one of the elective courses in the even semester that students began taking in the 2023/2024 academic year. An average of more than 30 students took the course. The course was conducted using the *Case Method* and

Team-Based Project strategies. The average final exam score obtained by students was B-. This shows that student scores are still relatively low. The questions given during the midterm and final exams are critical thinking questions in the form of case study essays that holistically apply critical thinking indicators of analyzing, synthesizing, discovering, and problem solving. In addition, many students do not have additional references such as books or modules related to wetland ecology, relying only on lecture notes. Based on the results of the learning process reflection, it is necessary to make improvements in the learning process, one of which is the application of enrichment of electronic teaching materials on wetland ecology based on ESD.

In the even semester of 2024/2025 when the research was conducted, there were 34 students taking the wetland ecology elective course, consisting of 29 female students and 5 male students. The learning strategy applied was *the Case Method* with additional main references, namely the ESD-based electronic wetland ecology module that had been integrated with the local potential of Riau Province. Lectures using this electronic module were held over 6 meetings. Students worked in groups to discuss and solve cases based on the following material concepts: (1) Wetland Typology; (2) Wetland Environmental Issues; (3) Wetland Ecosystem Restoration and Mitigation Efforts; (4) Ecosystem problems in Riau Province that are classified as global and national environmental issues; (5) Wetland ecosystem management efforts supported by case studies in Riau Province that occurred in peat ecosystems, mangrove ecosystems, and swamp ecosystems.

Students' Critical Thinking Skills

During the wetland ecology lectures, there was a noticeable change in the students' attitude, especially in preparing material concepts from various reference sources supported by electronic modules. The students were very enthusiastic in finding answers to problems occurring in peat, mangrove, and swamp ecosystems. Students were required to analyze, synthesize, solve problems, and draw conclusions from the problems that had to be solved with the hope that their critical thinking skills would improve. Students' critical thinking skills were assessed through *pretest* (before the experiment) and *posttest* (after the experiment) assessments. The results of the study are presented in Table 4 below.

Table 4. Students' Critical Thinking Skills

No	*Pre-Test*		*Post-Test*		*n-gain*	
	Score	**Criteria**	**Score**	**Criteria**	**Value**	**Criteria**
1	**70.47**	Good (B)	84.28	Very Good (A)	0.56	Average

Based on Table 4, it shows that there was an increase in *pretest* and *posttest* scores. The average *pretest* score was 70.47 with a Good criterion, while the average *posttest* score was 84.28 with a Very Good criterion. The increase in critical thinking was due to the students' good understanding of the learning material with the application of ESD-based electronic modules in the Wetland Ecology course material. The analysis results show that there was an increase in critical thinking on *the pretest* and *posttest*. The increase in critical thinking among students was

moderate, with an n-gain value of 0.56 for each module. According to Sapta et al. (2019), the use of electronic modules as digital teaching materials can improve students' critical thinking skills, as evidenced by the students' ability to draw conclusions and solve problems through the ideas presented in the teaching materials. This is also supported by the opinion of Santi et al. (2016) that the use of electronic modules can foster creativity, productive thinking habits, create active, effective, and enjoyable conditions, and develop students' literacy skills. The following is the cover of the electronic module on wetland ecology and student discussion activities during lectures as shown in Figure 2.

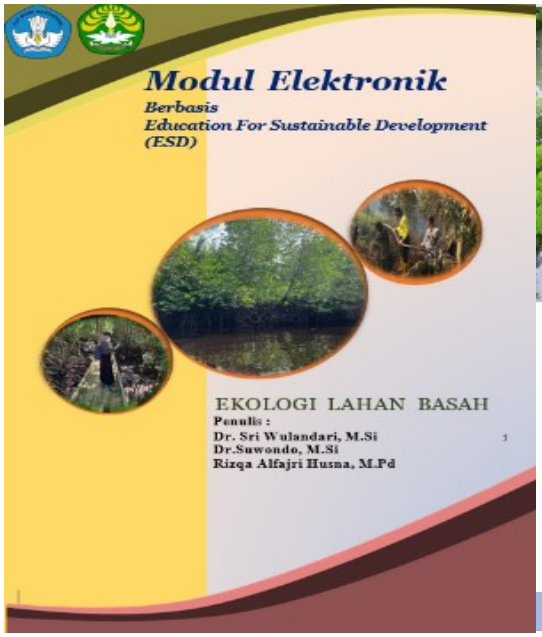

Figure 2a. Cover of the electronic module

Figure 2b. Cover of Module 1

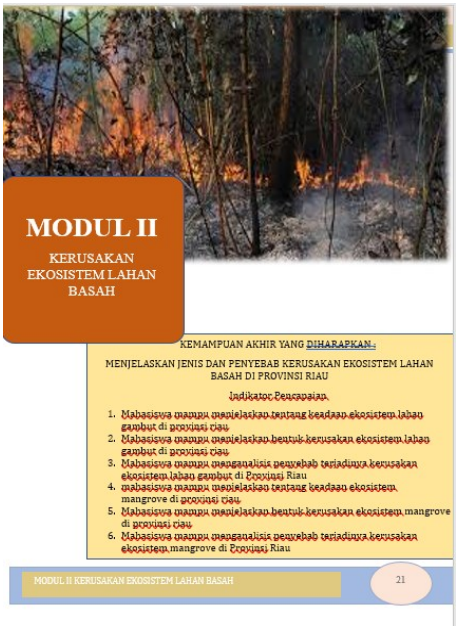

Figure 2c. Cover of Module 2

Figure 2d. Cover of Module 3

During the wetland ecology lecture using the *case method* strategy, students were very enthusiastic in discussion activities using additional references from the electronic wetland module to solve problems in peat ecosystems, mangrove ecosystems, and swamp ecosystems. After the students finished discussing, the next step was for group representatives to present alternative solutions to be responded to by other groups. At the end of the lecture, each student individually completed a formative test contained in the electronic module. The following are the activities of students during the wetland ecology lecture, as presented in Figure 3 below.

Figure 3a. Student group discussion with the electronic module

Figure 3b. Group presentation

Figure 3c. Students taking the formative test in the electronic module

Students' critical thinking skills in each indicator were also measured, including: analyzing, synthesizing, recognizing and solving problems, concluding, evaluating, and assessing. According to Ariadila et al. (2023), critical thinking skills are cognitive abilities in presenting problems and identifying and developing solutions to those problems. Critical thinking is a higher-order thinking process that can be used in the formation of students' conceptual systems. Critical thinking is rational and reflective thinking that focuses on deciding what to believe or do. Reasoning requires critical thinking skills; in other words, critical thinking skills are part of

reasoning. The indicators of students' critical thinking skills are presented in Table 5 below.

Table 5. Indicators of Students' Critical Thinking Skills

No	Critical Thinking Indicators	Score		
		Pre-test	***Posttest***	**n-gain index and category**
1	Analyzing	70 (fairly critical)	84 (critical)	0.46 (Moderate)
2	Synthesizing	71 (fairly critical)	84 (critical)	0.4 (Moderate)
3	Recognizing and Solving Problems	67 (fairly critical)	82 (critical)	0.45 (Moderate
4	Conclusion	71.0 (fairly critical)	85.0 (critical)	0.48 (Moderate)
5	Evaluating and Assessing	71 (fairly critical)	86 (critical)	0.5 (Moderate)
	Average	70.4 (fairly critical)	84.2 (critical)	0.46 (Moderate)

Based on Table 5, there are differences in critical thinking scores for each indicator. During the pretest for the first indicator, analyzing, the average score was 70 with a fairly critical category and increased in the posttest score to 84.0 with an n-gain value of 0.46 with a moderate category. Based on this data, it can be seen that the analyzing indicator increased from the *pretest* score to the *posttest* score. This is related to learning using ESD-based electronic modules. The second indicator, synthesizing, also experienced an increase in value from the pretest, which obtained a value of 71.0 with a fairly critical category, and in the *posttest*, it increased with a value of 84.0 with an n-gain of 0.44 with a moderate category. In using electronic modules, students are required to carry out literacy activities by utilizing electronic module teaching materials and can access various additional references contained in the teaching materials, thereby increasing students' synthesizing abilities.

The third indicator, recognizing and solving problems, received an average pretest score of 67.0, categorized as critically sufficient, and a posttest score of 82.0, categorized as critical, with an n-gain of 0.45, categorized as moderate. Based on these indicators, it can be seen that students' ability to recognize and solve problems improved after using the ESD-based electronic module. In using the electronic module, students are required to be able to recognize and solve problems from several group discussions, thereby improving their ability to solve the problems presented. The fourth indicator concludes that *the pretest* obtained an average score of 71.0 in the fairly critical category, which increased in *the posttest* with an average score of 85.0 in the critical category with an n-gain value of 0.48 in the moderate category. The electronic module also presents videos based on facts and data related to wetland ecosystems, which can improve students' ability to draw conclusions.

This finding is in line with the conclusion of Asri et al. (2024) that electronic modules can improve students' thinking skills because the advantages of electronic modules encourage students to seriously solve problems and trigger them to understand the learning material.

According to Aji & Hudha (2017), the use of electronic modules in learning can bridge and even integrate the experiences and knowledge of students to master the learning material in depth. This is because teaching materials such as modules can simply provide convenience for students in obtaining information, knowledge, experiences, and skills in learning. The results of Sugiarto (2016) research show that learning using problem-based modules can increase students' in-depth understanding. Modules developed by presenting local potential in the form of problems in the surrounding environment can foster students' interest in learning. Students will easily understand learning materials that use modules that present various examples of problems in the surrounding environment. This is because these modules trigger an increase in students' interest and prevent them from feeling bored with the material presented.

A good module will require students to learn independently in solving the problems presented. This is in line with the research by Sujiono (2014), that modules designed from environmental problems can improve problem-solving skills. The use of problem-based modules can also improve students' critical thinking skills Defines problem solving in learning as a complex (*multiple)* step process in which students must be able to find connections between past learning experiences and problems to be solved in the present and formulate solution actions to be taken.

Learning based on local potential issues will strengthen practical understanding. According to Simone (2014), improving students' knowledge competence can be done through collaborative and constructivist learning based on local issues. This learning can be done by raising the potential of the surrounding environment as material to be discussed or studied. The modules developed based on ESD direct learning activities that present authentic and relevant data and facts about problems, so that students are able to increase their knowledge. The use of relevant modules supported by appropriate learning models will be very effective in improving learning outcomes.

Students' Environmental Awareness Attitudes

Environmental awareness is an individual's response to social stimuli and the surrounding environmental conditions. Responses are forms of individual readiness that are divided into three types, namely: (1) cognitive responses, namely: perceptual responses and statements of belief; (2) affective responses, namely: sympathetic responses and expressions of affection; and (3) behavioral (conative) responses, namely: responses in the form of actions and statements regarding behavior. Attitude is a person's tendency to act, think, and feel when facing an object or situation to determine opinions and actions, both positive and negative (Narwati, 2011). This study also assessed students' cognitive attitudes towards environmental care in the application of ESD-based electronic wetland ecology

modules through the distribution of questionnaires before and after learning. The results of the study are presented in Table 6 below.

Table 6. Cognitive Environmental Concern Attitude Scores of Students

NO	*Pre-Test*		*Post-test*		*n-gain*	
	Score	**Criteria**	**Score**	**Criteria**	**Value**	**Criteria**
1	3.45	Concern	4.30	Very Caring	0.52	Moderate

The environmental concern attitude measured consists of environmental management responsibility, environmental management participation, and ideas in environmental management. The analysis results show that there was an increase in the cognitive attitude value of students' environmental concern in *the pretest* and *posttest*. The students' cognitive environmental concern attitude score on the pretest was 3.45 with a criterion of concerned, while on *the posttest* it was 4.30 with a criterion of very concerned. Based on the analysis of the pretest and posttest scores, the students' cognitive environmental concern attitude increased. The overall n-gain score was 0.52 with a criterion of moderate. A comparison of the cognitive environmental concern attitude scores can be seen in Figure 4 below:

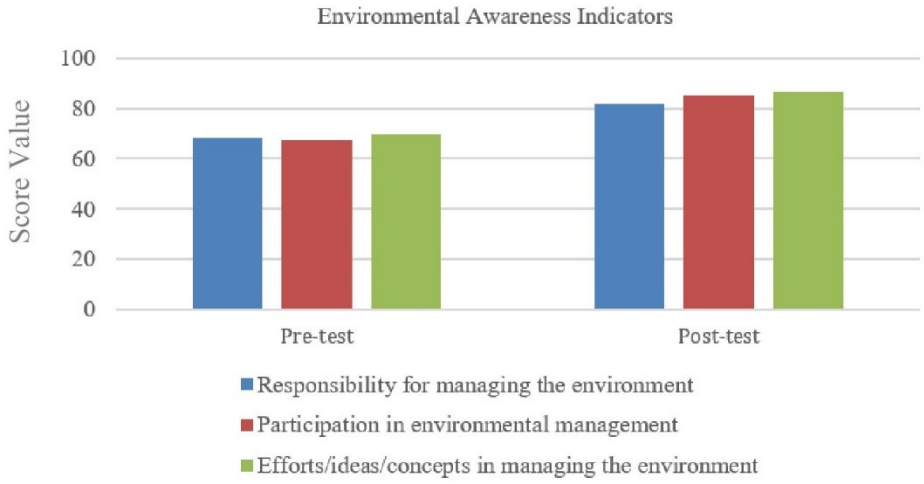

Figure 4. Indicators of Students Environmental Concern Attitude Scores

This increase in cognitive attitudes towards environmental awareness is in line with the improvement in students critical thinking skills. When viewed based on a comparison of students critical thinking and *pretest* and *posttest* attitudes, it can be seen that the posttest increase in attitudes and knowledge is moderate. This score is better than the pretest score, even though it is still in the moderate range. The results of the increase in environmental awareness through learning using modules are also better than without using modules. This indicates that there is some content in the module that is able to provide interest and stimulus regarding the important values of environmental management. These values have basically been presented in the ESD module by presenting various sentences and illustrations that contain

invitations to increase awareness of the surrounding environment so that it is hoped that it will be able to foster students' awareness of the environment.

Critical thinking skills are important in the 21st-century learning process, including in the context of environmental education. According to Fatiah et al. (2022), critical thinking is a rational and reflective thinking process focused on determining what to believe or do. Students with critical thinking skills are able to analyze, evaluate, and draw logical conclusions from various information received, including information related to environmental issues. This ability plays an important role in shaping environmental awareness, as it enables students to rationally understand the impact of human actions on the environment. This is in line with the responsible environmental behavior model proposed by Hines in Unwakoly (2022), which states that environmental awareness is influenced by an individual's knowledge, awareness, and critical thinking skills.

Attitudes are not formed instantly but rather through a developing process. I n good attitudes must be developed over time through a learning process, one of which is through education, namely by teaching, providing stimuli in the form of encouragement of good values, and practicing them in life, therefore, consistent attitude formation is necessary. Kalantari et al. (2010) explain that knowledge plays an important role in improving the quality of attitudes and behaviors that care for the environment by fostering individuals' ability to formulate alternative views and arguments in support of each individual's beliefs and behaviors. Kaiser et al. (1999) explain that *environmental knowledge* and *feelings of* responsibility together influence the intention to care for the environment. According to Lickona (2012), the formation of attitudes and character in a person is supported by three interrelated components, namely: moral knowledge, moral feelings, and moral behavior, which describe one of the approaches used in character building, namely by providing the concept of these values as knowledge. This knowledge can foster strong feelings in children. Knowledge and feelings are then manifested in the form of behavior.

4. Conclusion

The results of the study show that the application of the ESD-based electronic wetland ecology module in the wetland ecology course can improve critical thinking skills, which consist of analyzing, synthesizing, recognizing and solving problems, concluding, evaluating, and assessing, as seen from the increase in *pretest* scores to *posttest* scores in the very critical category. The effectiveness of the application of the electronic wetland ecology module in lectures is in the moderate category. The increase in students' environmental awareness scores also shows an increase from awareness to the very aware category. The electronic wetland ecology module can be used as an alternative teaching material for the elective course on wetland ecology in the next academic year at the Biology Education Study Program, Faculty of Teacher Training and Education, University of Riau, as well as other universities.

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References

Aji, R., & Hudha, M. (2017). The use of learning modules to integrate experience and knowledge in mastering subject matter. *Jurnal Pendidikan dan Pembelajaran*, 12(3), 45–53. https://doi.org/10.31537/jeti.v7i1.1777

Ariadila, S. N., Silalahi, Y. F. N., Fadiyah, F. H., Jamaludin, U., Setiawan, S. (2023). Analisis pentingnya keterampilan berpikir kritis terhadap pembelajaran bagi siswa. *Jurnal Ilmiah Wahana Pendidikan*, 9 (20), 664-669, https://doi.org/10.5281/zenodo.8436970

Asri, K., Haryani, S., Ellianawati, E., Subali, B., & Widiarti, N. (2024). Pengembangan e-modul IPAS berbasis problem based learning untuk meningkatkan keterampilan berpikir kritis siswa SD. *Jurnal Ilmiah*

Fatiah, A., Riyadi, R., & Daryanto, J. (2022). Analisis keterampilan berpikir kritis dalam pemecahan masalah matematika berdasarkan teori robert hennis pada kelas v sekolah dasar. *Didaktika Dwija Indria*, *9*(6). https://doi.org/10.20961/ddi.v9i6.56158

Ghany, H. (2018). Penyelenggaraan pendidikan untuk pembangunan berkelanjutan di sekolah dasar. *Jurnal Madaniyah.* 8(2): 186-192. https://doi.org/10.54957/jurnalku.v4i2.6755

Indrati, Dika Agustia, & Persita Pupung Hariadi. (2016). Education for sustainable development melalui pembelajaran biologi. *Symposium on Biology Education*: 371–82

Kaiser, Florian G., Wolfing., Syibille., Fuhrer , & Urs . (1996), Environmental attitude and ecological behavior. *Procedia - at the 104th Annual Convention of the American Physcholigical Association* (APA).

Kalantari, K., Asadi, A., & Karim, M. (2010). The role of knowledge in improving environmental attitudes and behaviors. *Journal of Environmental Education and Development*, 11(3), 45–56.

Lickona,T. (2012). *Mendidik untuk membentuk karakter: Bagaimana sekolah dapat memberikan pendidikan sikap hormat dan bertanggung jawab*. (Penerjemah: Juma Abdu Wamaungo. Jakarta: Bumi Aksara)

Narwanti, S. (2011). *Pendidikan karakter pengintegrasian 18 nilai pembentuk karakter dalam mata pelajaran*. Famili, Yogyakarta.

Rahman, A., Heryanti, L. M., & Ekanar, B. (2019). Pengembangan modul berbasis Education for Sustainable Development pada konsep ekologi untuk siswa kelas x SMA. *Jurnal Eksakta Pendidikan (JEP),*3(1). https://doi.org/10.24036/jep/vol3-iss1/273

Shinta , P & Aldila N. H. (2021). Education for sustainable development dalam pembelajaran IPA. *Jurnal Kajian Pendidikan IPA*, 1(2), 69-75. https://doi.org/10.52434/jkpi21281

Simone, C. (2014). Problem-based learning in teacher education. *International Journal of Humanities and Social Science. 4 (1), 17-29*.

Sugiarto, B. (2016). Problem-based learning modules for local environmental issues to improve student understanding. *Jurnal Pendidikan Biologi*, 8(2), 101–110.

Sujiono, Y. N. (2014). Pemanfaatan modul berbasis masalah untuk meningkatkan kemampuan berpikir kritis peserta didik. *Jurnal Pendidikan dan Pembelajaran*, 21(2), 115–124.

Sugiyono. (2019). *Metode penelitian kuantitatif kualitatif dan R & D*. Alfabeta. Bandung.

Taimur, S. & Sattar, H. (2019). *Education for sustainable development and critical thinking competency. quality education*, Encyclopedia of the UN Sustainable Development Goals. https://doi.org/10.1007/978-3-319-69902-8_64-1

Unwakoly, S. (2022). Berpikir Kritis Dalam Filsafat Ilmu: Kajian Dalam Ontologi, Epistemologi dan Aksiologi. *Jurnal Filsafat Indonesia*, *5*(2), 95–102. https://doi.org/10.23887/jfi.v5i2.42561

Widiastuti, F., Amin, S., & Hasbullah, H. (2022). Efektivitas Metode Pembelajaran Case Method dalam Upaya Peningkatan Partisipasi dan Hasil Belajar Mahasiswa pada Mata Kuliah Manajemen Perubahan. *Jurnal Pendidikan*, 6(1), 728-731.

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