Feasibility of eco-literacy-based interactive teaching material to promote critical thinking skills

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Abstract

Students' ccritical thinking skills and awareness of the environment are low. One of the efforts to improve this is through the development of eco-literacy-based interactive teaching materials (EITM). This study aims to test the feasibility of EITM to enhance students' critical thinking skills. The EITM feasibility test was conducted by two content experts and two media experts and involved 18 science teachers and the participation of junior high school students. After the teaching materials were revised, they were then tested on 50 students to measure their subsequent critical thinking skills. The results of the expert assessments were determined by percentages and categorized, the teacher assessments were calculated by CVR and CVI, and the acceptance data were analysed descriptively and quantitatively. The results of the feasibility test show that EITM has a valid category. Therefore, they can be used in science learning to promote critical thinking skills.

Keywords: critical thinking, eco-literacy, feasibility, interactive, teaching material;

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1. Introduction

The 21st century requires students to have critical, creative, collaborative, and communicative thinking skills. Moreover, the COVID-19 pandemic has changed almost all areas of life, including education. Learning that initially took place offline is now online. This change has had a considerable impact on teachers and students, especially in the use of technology. Technological developments in the 21st century are also causing changes to the environmental balance. Therefore, environmental awareness needs to be instilled in the community from an early age. One of the efforts that can be made to instil this in students is to develop eco-literacy-based teaching materials.

1.1. Conceptual or Theoretical Framework

Eco-literacy

Eco-literacy is a lifelong process that forms individual awareness of the importance of living in synergy with the universe and protecting the environment (Salimi et al., 2021). It is a type of cognitive intelligence based on understanding the role of the universe in supporting the survival of living things. Vargas-Madrazo (2018) states that eco-literacy is complex and supported by intellectual, social, and emotional intelligence. Knowledge, environmental awareness, and skills possessed by students need to be applied to preserve the environment. The education field has made many efforts to build awareness of environmental problems, including environmental education, environmentally, friendly schools, and the Adiwiyata program (Muliana et al., 2018). Environment-based teaching materials can increase the eco-literacy of elementary school student teachers (Arga & Rahayu, 2018). Therefore, eco-literacy needs to be applied to learning in schools, especially in Natural Science subjects, to develop students' caring attitudes towards the environment. One way of doing this is through the development of eco-literacy-based teaching materials.

Teaching Materials

Teaching materials are learning tools or facilities that comprise materials, methods, limitations, and ways of evaluating, which are designed systematically and attractively to achieve the expected competencies. The coronavirus (COVID-19) pandemic has caused changes in various activities in the world (Pan, 2020; Wang et al., 2020; Salzberger et al., 2020; Zou et al., 2020; Tian et al., 2020). Policies have been implemented to maintain distance and human interaction in various countries to reduce the impact of the spread of the virus. This has also affected teaching and learning activities in schools. Learning now takes place remotely using various facilities, including the change of teaching materials from printed to digital, and the use of interactive teaching materials.

The use of mobile technology, such as smartphones, laptops, computers, tablets, and phones, which can be used to access information anytime and anywhere (Gikas & Grant, 2013), is making a major contribution to educational institutions, including the achievement of distance learning goals (Korucu & Alkan, 2021). To support the implementation of distance learning, teaching materials in digital and interactive forms are needed. In contrast to printed teaching materials, which tend to be conceptual, such interactive ones are designed with an attractive appearance accompanied by various menus to engage students actively and enthusiastically in learning, including in science. Such materials can also be easily accessed by students and teachers using appropriate tools (Elvarita et al., 2020; Fourlilla & Fauzi, 2019). They comprise materials, methods, and learning evaluations that are designed to be practical and to attract students' interest in learning (Istuningsih, 2019). Santoso et al. (2019) concluded that the

effectiveness of e-books is higher than that of printed books, such teaching materials are expected to increase students' critical thinking.

Critical Thinking

Students who think critically will show intellectual thinking skills such as reasoning, analysing, solving problems, reading comprehension, scientific thinking, creative thinking, evaluating, and making accurate decisions (Sarigoz, 2012). Critical thinking is also convergent thinking, logic, and reasoning (Seventika et al., 2017). Several researchers have attempted to strengthen the development of critical thinking skills, including the application of constructivist-based learning strategies (Adak, 2017); scaffolding strategies (Alake & Ogunseemi, 2013); socio-biological case-based learning (Suwono et al., 2017); innovative thematic learning (Pursitasari et al., 2018); inquiry learning (Duran & Dökme, 2016; Wartono & Batlolona, 2018; Pursitasari et al., 2020); and inquiry-discovery (Putra et al., 2018). In addition to the efforts that have been made, several researchers have also developed printed teaching materials (Pursitasari et al., 2019; Laos & Tefu, 2020) and multimedia (Djamas & Tinedi, 2018). Teachers need to prepare materials that are packaged into interactive teaching materials with easy access

1.2. Purpose of the Research

Based on previous research results, the purpose of this study is to produce eco-literacy-based interactive teaching materials to promote students' critical thinking. Such thinking is necessary for facing the 21st century and achieving sustainable development goals.

2. Methods

2.1. Research Design

This research is R&D to produce eco-literacy-based interactive teaching materials to promote students' critical thinking skills. The research design employs Analysis, Design, Development, Implementation, and Evaluation (ADDIE). The research focuses on feasibility tests of teaching materials by content and media experts and, teachers, together with empirical tests on students.

2.2. Participants

The study involved two expert content validators and two expert media validators. In addition, 18 teachers participated as users to provide assessments and input on the teaching materials developed. The test of the effectiveness of the materials was conducted on 50 students in one of the junior high schools in Bogor city, Indonesia.

2.3. Data Collection Tools

The feasibility test of the teaching materials comprised expert validation sheets, teacher assessments, and student acceptance. There were two validation sheets, namely the material expert and media expert sheets. Aspects of expert validation included assessment of the content, presentation, and language, while the media aspects included usability, functionality, and visual communication. The student acceptance instrument for the materials was adopted from Sriadhi (2019) and consisted of four components: material, evaluation, design and multimedia facilities, and pedagogical effects. Measurement of critical thinking skills was made using a critical thinking skills test in the form of an essay. Aspects of students' skills included interpretation, self-regulation, analysis, inference, and explanation (Facione, 2013). There were 10 questions, with a reliability coefficient of 0.86. Another instrument used was an

observation sheet of the learning process which took place when the students used the teaching materials developed.

2.4. Data Collection Process

By following the research objectives, data collection began with validation by the content and media experts. In addition to providing quantitative assessments, the validators also provided input and suggestions for the resulting teaching materials. Furthermore, the teaching materials were given to the teachers to determine the Content Validity Ratio (CVR) and Content Validity Index (CVI). The teachers also provided input and suggestions. After the teaching materials were revised, they were then tested on students to obtain student acceptance data. The final stage in the data collection was to distribute the validated interactive teaching materials to class VIII students. After they had used the teaching materials, a critical thinking skills test was conducted.

2.5. Data Analysis

The analysis of the feasibility test by the experts was made using the following formula:

$$\text{Percentage of feasiblity} = \frac{\sum \text{scores obtained}}{\text{total scores}} \; x \; 100\% \; \dots\dots\dots\dots\dots \; (1)$$

The results of the calculation were categorized according to the feasibility level, as shown in Table 1.

Table 1. Categorization of the teaching material feasibility level

Value obtained (%)	Category
80-100	Valid
60-79	Quite valid
40-59	Less valid
0-39	Invalid

The teacher assessment results were calculated using the content validity ratio (CVR) and content validity index (CVI). Calculation of the CVR was made using the following formula:

$$\text{CVR} = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \; \dots\dots\dots\dots\dots\dots\dots\dots\dots \; (2)$$

n_e is the number of respondents who stated "yes" or agreed, and N is the total number of respondents. The CVR value obtained was then compared with the table CVR value (Lawshe, 1975) at p = 0.05 for the one-sided test (Table 2). If the CVR value calculated was greater than the table CVR, the teaching materials were suitable for use.

Table 2. Minimum value of CVR in the one-sided test at p = 0.05

Number of respondents	Minimum CVR value	Number of respondents	Minimum CVR value
5	0.99	13	0.54
6	0.99	14	0.51
7	0.99	15	0.49
8	0.85	20	0.42
9	0.78	25	0.37
10	0.62	30	0.33
11	0.59	35	0.31
12	0.56	40	0.29

The CVI value was determined by calculating the average acquisition of the CVR value (Lawshe, 1975) using the following formula:

$$CVI = \frac{\sum CVR}{number\ of\ sub-statements\ received} \quad ....\ (3)$$

The student acceptance results were calculated using formula 1 and categorized as shown in Table 3.

Table 3. Categorization of student acceptance of interactive teaching materials

Percentage of acceptance (%)	Category
81-100	Very good
61-80	Good
41-60	Fair
21-40	Poor
0-20	Very poor

The next stage was to give the revised interactive teaching materials to 50 junior high school students to measure their critical thinking skills and scientific attitudes. The scores of the students' critical thinking skills were analysed descriptively and quantitatively. Based on the results of the implementation, an evaluation was made to determine the effectiveness of the teaching materials in their possible used by junior high school students in learning about the environment and changes to it.

3. Results and Discussion

Teaching materials are part of the learning resources that teachers and students can use to support learning success. Currently, the need for electronic and interactive teaching materials is very high (Eka-milasari et al., 2021). The change from printed teaching materials to interactive electronic ones can reduce students' boredom when learning; They can be developed with multimedia applications because they can combine various media in text, images, graphics, music, animation, video, and interactions in digital files (Artiningsih et al., 2019). Digital teaching materials can be used by students widely and are not limited by space and time. Based on this, eco-literacy-based interactive teaching materials have been developed on the topic of the environment and its changes. The initial appearance of the teaching materials is shown in Figure 1.

Figure 1. Teaching materials on the environment and its changes

The developed teaching materials were then tested for feasibility by two material experts and two media experts. This was determined based on the content, presentation, and language components. The results of the validation test are shown in Table 4.

Table 4. Results of the feasibility assessment of the teaching materials

Aspect of Assessment	Validator 1 (%)	Validator 2 (%)	Average (%)
Content	87.5	95.0	91.2
Presentation	85.0	95.0	90.0
Language	92.5	95.0	93.8

Based on Table 4 the overall average of the assessment of content feasibility from the expert assessment is 91.7%. The results of the expert assessment show that the lowest value is for presentation feasibility. This is in line with the suggestions from the experts, as shown in Table 5, some relate to the presentation aspect.

Table 5. Validator suggestions and revisions made

No.	Expert suggestions	Revisions
1.	It is necessary to include features to be clicked to direct the steps that media users must pay attention to, especially in the material section, which consists of nine features.	A screen has been added containing a sequence of features accompanied by explanations.
2.	Pay attention to the writing of questions and answers; some use capital letters and lowercase letters, not consistently.	Writing and punctuation corrected.

Aspects assessed by the multimedia experts included ease of use (usability), usefulness (functionality), and visual communication. The results of the assessment are shown in Table 6.

Table 6. Results of multimedia feasibility assessment

Aspects of Assessment	Validator 1 (%)	Validator 2 (%)	Average
Usability	100	100	100.0
Functionality	95	100	97.5
Visual communication	100	95	97.5

Based on Table 6, the overall average is 98.3% in a valid category. The highest score is for usability. This result shows that the main teaching materials menu and the text are easy to understand; the selected menu can display pages quickly; the colour composition is appropriate; the visualization is attractive; the teaching materials are easily accessible; and the content is easy to understand. The findings of Davids (2014) demonstrate the importance of usability in developing teaching materials, as it can determine user satisfaction with teaching materials that use computers (Alshehri et al., 2019). Sukardjo and Sugiyanta (2018) measured the usability of web-based interactive multimedia, with the results of the usability value of mathematical multimedia ranging from 70 to 90%. The 18 teachers then assessed the revised teaching materials to determine the CVR and CVI values; the results are shown in Table 7. The aspects of content assessment were the feasibility of content, presentation, and language

Table 7. Results of teacher assessment

No.	Aspect of assessment	∑ CVR	CVI
1.	Content	7.6	0.95
2.	Presentation	5.3	0.88
3.	Language	5.8	0.97
	Average value of CVI		0.93

Table 7 shows that the highest CVR core is the content aspect of 7.6. This indicates that the teaching materials conform with the core competencies, basic competencies, learning objectives, the level of student development, the relevance of the material presented with competency indicators, truth in conveying material, conformity to the needs of students, and the suitability of student worksheets and quizzes/evaluations to develop their critical thinking skills and attitudes towards science. The highest CVI is the aspect of language. The average CVI obtained from the teacher assessment was 0.93, in the high category. The high feasibility aspect indicates that the prepared teaching materials could continue

to the student acceptance stage, which needed to be determined they could be tested on the students. Aspects measured included student acceptance of the material, evaluation, design and media facilities, and pedagogical effects (Sriadhi, 2019). The results of students' acceptance of the environmental teaching materials and the changes made to them are shown in Figure 2.
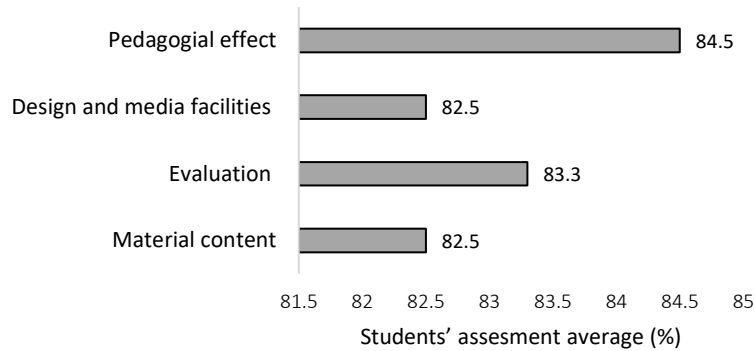

Figure 2. Results of student acceptance

Figure 2 shows that the levels of student acceptance of the four aspects are very similar, with an average score of 83.3%. The most significant score obtained related to the pedagogical effect was 3.4. This shows that the teaching materials met the students' needs regarding environmental changes; generated interest in being more active in learning; improved critical thinking skills, and environmental care. A pedagogical acceptability test was also conducted by Ifedayo et al. (2021) in relation to podcasts. Although the acceptance level of podcast pedagogy is low, it is advantageous to maximize its use in learning. Several studies to determine the factors that influence users to accept m-learning and independent learning have been conducted by Yeop et al. (2019), Li et al. (2019), and Sánchez-Prietoa et al. (2019). Students seem to be more motivated and improve their performance when using interactive teaching materials. This is in line with the opinion of Kong (2018), who states that m-learning improves parental involvement with their children, and increases learner motivation and students' performance. Furthermore, interactive teaching materials can be given to students, and their critical thinking skills determined after using these.

Students' Critical Thinking Skills

The teaching materials that were tested for feasibility by experts, assessed by teachers, and student acceptance were given to students. The role of the teacher is to provide initial direction and assist students in studying the interactive teaching materials concerning the Environment and Its Changes. The achievements of critical thinking skills are descriptively presented in Table 8.

Table 8. Description of students' critical thinking skills

Description	Score
Average	71.3
Minimum score	50.0
Maximum score	92.0
Standard deviation	10.4
Range	42.0

Table 4 shows that students' average critical thinking skills are in a good category, with an average of 71.3. The reason for this is that the developed teaching materials facilitated students to think critically.

The presentation of the materials begins with presenting problems in the form of discourse, tables, pictures, and videos, which require students to develop their critical facilities. Examples of student interactions in studying eco-literacy-based teaching materials are shown in Figure 3.

Figure 3 shows student activities related to answering the questions contained in the teaching materials. The questions are in various forms, with one correct answer, and a description by considering the component of eco-literacy. Eco-literacy needs to be owned by students because it is related to human awareness of the environment to ensure sustainability. The teaching materials developed cover students' knowledge, attitudes, skills, and participation (Noviana et al., 2018). These four aspects were developed by presenting the problem of spraying pesticides to eradicate planthoppers. This problem requires students to use their knowledge about the dangers of pesticides to living things. In addition, the problem also questioned students' attitudes towards the actions of a woman who sprayed pesticides. Student skills are shown in analyzing and criticizing the woman's actions and suggesting efforts to prevent excessive pesticide use. Therefore, eco-literacy-based interactive teaching materials can be used to promote students' critical thinking skills. Other efforts to promote critical thinking skills have been made by Putri & Aznam (2019), Aufa et al. (2021), and Suwatra et al. (2018) through the development of e-modules.
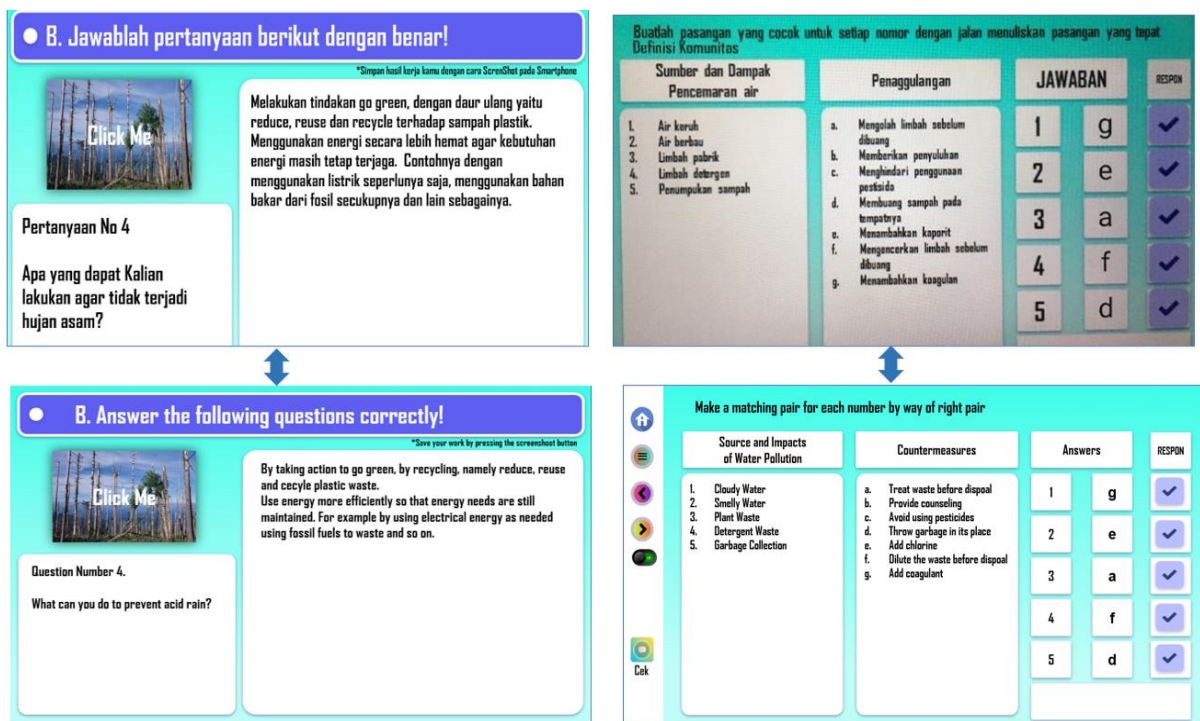
Figure 3. Student interaction in studying the teaching materials

The highest students' critical thinking skills related to the interpretation aspect, and the lowest to explanation (Figure 4). The first step taken by students is to interpret the problem to obtain the right solution. The high level of interpretation is because students are used to defining a problem in teaching materials. This finding is in line with the research results of Suwatra et al. (2018), which show that the indicator of defining statements/problems has the most significant percentage (85%) compared to others. On the other hand, the research finding is that the students' ability to explain the conclusions reached remains low. Students study teaching materials independently, so the explanations outlined are not discussed with other students or teachers. As a result, students are less trained in explaining conclusions. This is supported by the research results of Suwatra et al. (2018), which demonstrate that

the indicators conclude and explain the conclusions obtained have an average of 65% in the medium category.
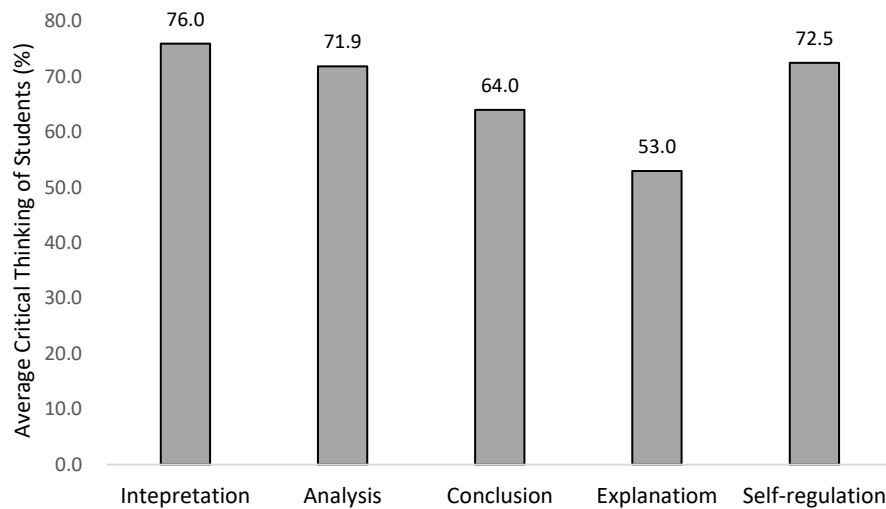

Figure 4. Students' critical thinking skills in all aspects

The self-regulation stage has a relatively high score because during the pandemic students have been forced to study independently and manage their learning activities. The content of the teaching materials trains students to learn independently through their interaction in answering and solving problems; being actively involved in watching to learning videos; completing quizzes; completing mini-research; and being skilled at making crafts from plastic or paper waste. This independence is crucial for students to compete and achieve good results.

4. Conclusion

Based on the study findings, it can be concluded that eco-literacy-based interactive teaching materials are valid based on the experts' opinions, have a validity index of 93%, student acceptance of 83.2%, and can be used to develop students' critical thinking skills by an average of 71.3. Eco-literacy-based interactive teaching materials can therefore be used as a source of learning in environmental theme learning and students' critical thinking skills can be continuously honed and developed.

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