World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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Development of biology textbooks based on the potential of the mangrove habitat to improve the eco-literacy skills of students in the topic of ecosystems

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World Journal of Advanced Research and Reviews, 2024, 24(02), 2527–2534

Publication history: Received on 16 October 2024; revised on 25 November 2024; accepted on 27 November 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.24.2.3596

Abstract

The objective of this study was to develop and evaluate the efficacy, practicality, and validity of biology textbooks based on mangrove habitat potential in enhancing the eco-literacy competencies of X IPA high school students with respect to ecosystem materials. This research is of a developmental nature, employing the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) as a framework for its methodology. The results demonstrated that the textbooks developed are valid and suitable for incorporation into the learning process, with the objective of enhancing students' eco-literacy skills with respect to ecosystem material. The results of the teacher observation analysis indicate that the textbooks developed are of an exemplary quality. The effectiveness of the course books in enhancing students' eco-literacy skills was evaluated through the N-Gain calculation. The N-Gain test yielded a result of (g) ≥ 0.7, indicating a high level of improvement. This suggests that students have developed a robust understanding of the interconnections between environmental concepts and ecosystem material.

Keywords: Textbook; Eco-literacy Skills; ADDIE Model; Textbook Development

1. Introduction

Mangroves are defined as forests that grow in proximity to coastal areas and river mouths. Mangrove ecosystems play a significant role in maintaining ecological balance in coastal areas. The roots of mangrove plants are particularly robust, forming intricate networks that bind sediment and prevent coastal abrasion. Furthermore, mangrove forests act as a natural buffer, protecting the land from the impact of storms and tidal waves.

It would be ideal if the environment were always sustainable, given the high degree of dependence humans have on it. However, the reality is that this is not the case. At this time, there is an ecological crisis or environmental damage. This crisis gives rise to instability within the ecological system, which in turn gives rise to disruption of energy and material exchange. This, in turn, has an impact on the survival of existing organisms (Wahid, 2016). The majority of the ecological crisis can be attributed to human activity. Those with limited environmental literacy are often unaware of the potential consequences of their actions on the natural world. It is therefore incumbent upon the younger generation to alter their perspective on this ecological system.

One strategy for modifying the outlook of the younger generation with regard to ecological systems is to enhance their eco-literacy. Eco-literacy is defined as the capacity to comprehend the natural systems that sustain life on Earth (Nugraha, 2015). The concept of eco-literacy was first introduced by Fritjof Chapra (2002) as a challenge to the prevailing approach to modernization. It is defined as a state of environmental literacy that aims to enhance people's understanding of the significance of global ecology, facilitating a balance between societal needs and the Earth's capacity to sustain them.

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The enhancement of ecoliteracy can be achieved through educational initiatives, whereby educators can utilize instructional materials pertaining to the subject matter. As posited by Widodo and Jasmin, coursebooks play a pivotal role in the learning process. They are a repository of learning tools, comprising material, methods, boundaries, and evaluation criteria (Kelana and Pratama, 2019). Textbooks serve as a primary conduit for directing all learning activities and can be utilized as a reference for students in their engagement with the learning process.

The initial observations conducted at SMAN 1 Marisa revealed that the learning process at the school was conducted using a contextual learning approach. This approach enables teachers to link the material taught with real-world situations, facilitating a more meaningful and engaging learning experience for students. However, it was observed that the teachers did not employ the available technology as a learning medium. The lecture method is the predominant pedagogical approach employed by teachers in the classroom, with textbooks from the library serving as the primary source of information. The content of the source book is still considered to be particularly limited, especially in the case of biology textbooks available in the library. The material on the mangrove ecosystem is not presented in a coherent or detailed manner, and the images provided are not particularly engaging. This situation further impairs students' understanding of eco-literacy, which appears to be severely limited.

In light of these observations, the researchers conducted a study entitled "Development of Biology Textbooks Based on The Potential of Mangrove Habitat in Improving Students' Eco-literacy Skills in The Topic of Ecosystem." The objective of this study was to assess the validity, practicality, and efficacy of the developed biology textbook in enhancing the eco-literacy abilities of class X IPA students, particularly at SMAN 1 Marisa.

2. Methods

This research is of the type designated as development research (Research & Development/R&D). The development model employed is the ADDIE model, which comprises five stages: analysis, design, development, implementation, and evaluation. The subjects of this study were biology teachers and students of class X IPA at SMAN 1 Marisa. Data were collected from the subjects using instruments such as interviews, observations, and questionnaires/questionnaire documents. The data were then analyzed using descriptive analysis techniques. Qualitative data were converted into quantitative data and categorized based on a Likert scale.

Table 1 Likert Scale

Score	Criteria
5	Excellent
4	Good
3	Fair
2	Poor
1	Very Poor

3. Results

3.1. Results of Validity Analysis of Textbooks Based on Mangrove Habitat Potential to Improve Students' Eco-literacy Skills in The Topic of Ecosystem

To validate the developed biology textbooks, a multidisciplinary team was assembled, comprising material experts, media experts, and linguists, to ensure a comprehensive and rigorous evaluation process. The results of the validity test of the developed biology textbooks are illustrated in Figure 1.

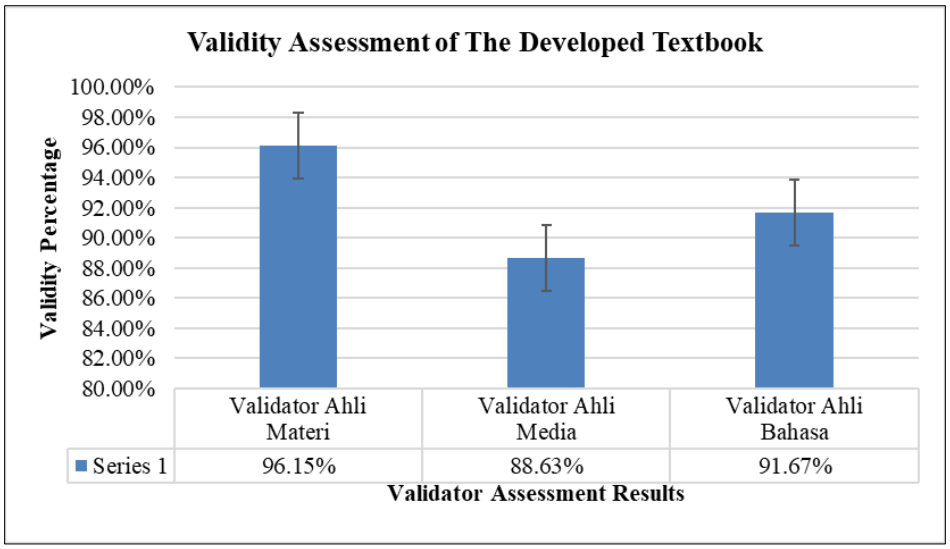

Figure 1 Graph of the Teaching Book Validation Assessment

The total score, as determined by material experts, was 100 out of 104 (96.15%). Validation by media experts yielded a total score of 39, corresponding to the maximum possible score of 44 (88.63%). Validation by linguists yielded a total score of 44 out of the maximum score of 48 (91.67%). In accordance with the validation criteria outlined in Table 2, it can be concluded that the developed biology textbooks meet the requisite standards of validity. This signifies that textbooks based on mangrove habitat potential are suitable for incorporation into the learning process.

Table 2 Textbook Validation Criteria

Score	Criteria
81% - 100%	Very Valid
60% - 80%	Valid
41% - 61%	Fair
21% - 40%	Less Valid
0% - 20%	Not Valid

3.2. Results of Practicality Analysis of Textbooks Based on Mangrove Habitat Potential to Improve Students' Eco-literacy Skills in The Topic of Ecosystem

3.2.1. Results of teacher assessment analysis

The assessment was conducted by the observer, in this case, the biology teacher at SMAN 1 Marisa. The results of the assessment of the quality and applicability of the coursebooks were evaluated based on several indicators, including material coverage, material accuracy, material currency, physical appearance, and writing criteria. The overall score obtained was 65, which is the highest possible score of 68 (95.58%). In light of these findings, it can be concluded that the overall practicality criterion score falls within the excellent category.

3.2.2. The results of the learner questionnaire analysis

The learner response questionnaire comprised 10 questions in the small group test and 15 questions in the large group test. The small group test was completed by 14 respondents, while the large group test was completed by 30 respondents. The calculation of student response criteria in the small group test yielded a total score of 484, with the highest possible score being 560 (86.42%). The calculation of student response criteria in the large group test yielded a total score of 1571, with the highest possible score being 1800 (87.27%). In light of these findings, it can be concluded that the criteria for student responses to coursebooks fall within the "very practical" category.

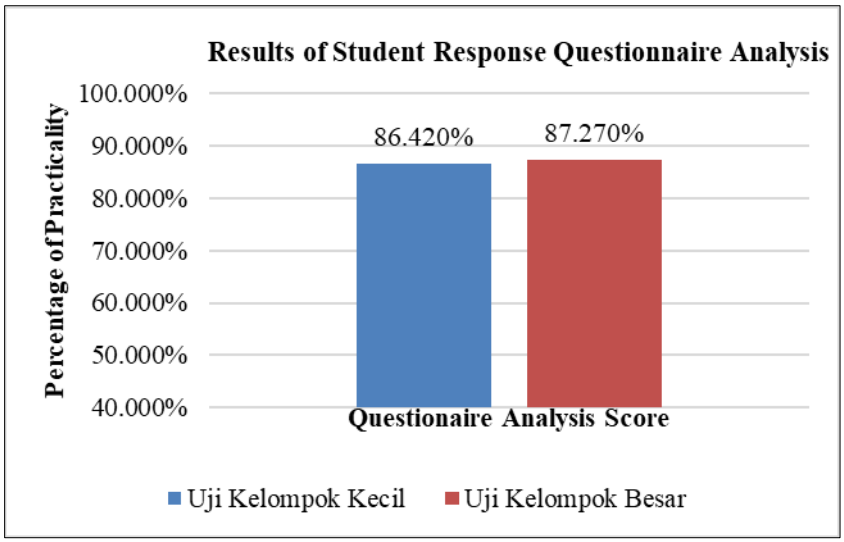

Figure 2 Chart of Student Response Questionnaire

3.3. Results of Efficacy Analysis of Textbooks Based on Mangrove Habitat Potential to Improve Students' Eco-literacy Skills in The Topic of Ecosystem

Analysis of the effectiveness of coursebooks was carried out by giving *pretests* and *posttests* to students. Furthermore, the difference between the *pretest* and *posttest* results was determined to see whether or not there was an increase in student learning outcomes and categorized according to the *N-Gain* classification as listed in table 2.

Table 3 Classification of Mean *Gain* Calculations (Hake Equation)

No.	Gain	Category
1	(g) ≥ 0,7	High
2	0,3 ≤ (g) < 0,7	Medium
3	< g > < 0,3	Low

3.3.1. Small group test results

The pretest results for the small group trial yielded an average score of 45.71, while the average posttest score was 83.92. The increase in the mean pretest and posttest scores was quantified using the N-Gain test. The N-Gain test yielded a value of 0.71. In accordance with the N-Gain classification outlined in Table 3, it can be concluded that the N-Gain value falls within the high category. This signifies an enhancement in students' eco-literacy abilities, which suggests that they possess a profound comprehension of the interconnections between environmental concepts and ecosystem components.

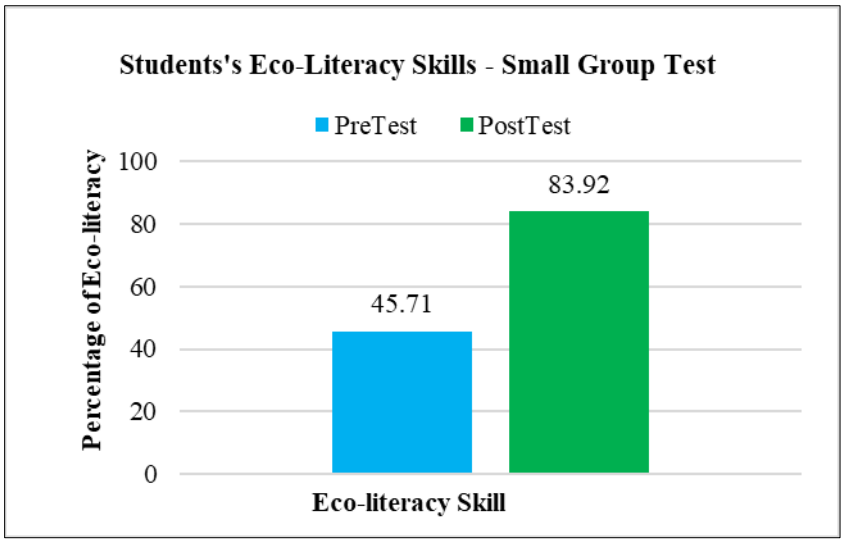

Figure 3 Graph of Student Eco-literacy Results - Small Group Test

3.3.2. Large group test results

The pretest results from the large group trial yielded an average score of 55.83, while the average posttest score was 88.16. The increase in the average pretest and posttest scores was quantified using the N-Gain test, which yielded a value of 0.73. According to the N-Gain classification presented in Table 3, this value falls within the high category. This indicates that students exhibited enhanced ecoliteracy skills, suggesting a profound understanding of the interconnections between environmental concepts and ecosystem processes.

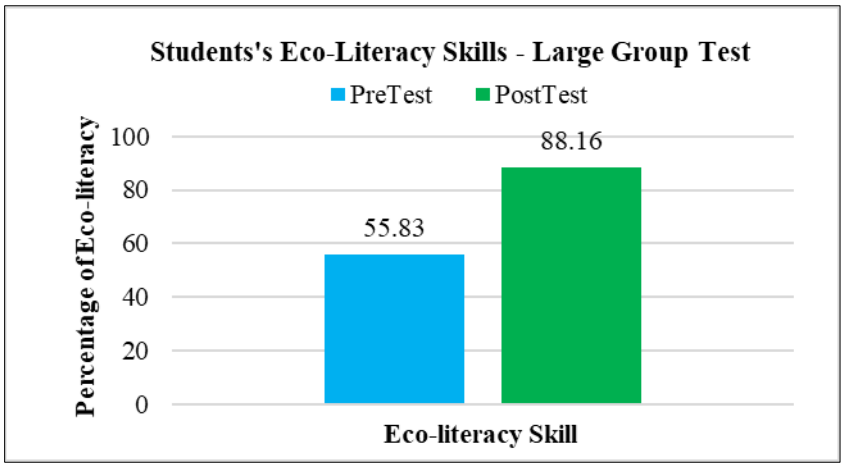

Figure 4 Graph of Student Eco-literacy Results - Large Group Test

4. Discussion

4.1. Validity of Textbooks Based on Mangrove Habitat Potential to Improve Students' Eco-literacy Skills in The Topic of Ecosystem

The validity of the teaching book assessment instrument was evaluated by material, media, and language expert validators, who determined that the product development process was aligned with the competencies of students and the selection of appropriate learning, namely contextual learning based on the potential of mangrove forest habitats. This resulted in a highly valid category score. Input and suggestions from validators are employed by researchers in the reconstruction of the teaching book with the objective of enhancing its quality.

Input from the material expert included the suggestion of including references and bibliographies. This is based on the fact that in the teaching book developed, it is necessary to strengthen the material with relevant sources so that students can find references to ecosystems as a whole and avoid misconceptions in understanding a concept about ecosystems.

The input of the media expert indicated the necessity of incorporating learning objectives pertaining to ecosystem problem-solving and the development of practice questions aligned with the eco-literacy curriculum. Additionally, the involvement of students in learning activities was adjusted through the incorporation of contextual activities, wherein students were introduced directly to the potential of mangrove habitats in their immediate surroundings. This approach was designed to facilitate students' identification of environmental issues in their communities, thereby stimulating the development of literacy skills to address such problems.

The linguist validators have indicated the necessity for adjustments to the writing systematics utilized in the teaching book, which are deemed to be both effective and accurate. This is based on the premise that the Teaching Book requires systematic writing in order to be properly understood by students as the intended users of the Teaching Book.

Practicality of Textbooks Based on Mangrove Habitat Potential to Improve Students' Eco-literacy Skills in The Topic of Ecosystem

4.2. Teacher assessment analysis

The assessment of the quality and applicability of the Teaching Book was based on the analysis of several indicators, namely material coverage, material accuracy, material recency, physical appearance, and writing criteria. The overall practicality criteria score was found to be in the range of >80, which is considered to be in the very good category.

The following aspects were observed: material coverage in relation to learning outcomes (CP), the presentation and sequence of mangrove ecosystem material content, and the accuracy of image reviews on each material. Other aspects observed included the accuracy of the material, which entailed the accuracy of the data and facts presented in the textbook, the suitability of the illustrations to the material presented, the presentation of concepts and definitions of words, the accuracy and suitability of the references used, and the accuracy of terms. It is recommended that textbooks utilize authentic, contextual data sources and facts, as well as pertinent literature references, to prevent the formation of misconceptions regarding the deeper conceptualization of the subject matter. The following aspects were observed with regard to the textbooks developed: the recency of the material, the physical appearance, and the writing criteria. It is intended that the textbooks developed will stimulate students' interest in literacy.

4.3. The learner response questionnaire analysis

The results of the overall student response calculation indicate that the textbooks developed are highly practical. The results of the student responses indicate a favorable response to the learning process and the textbooks developed. This is because, in the learning process, students engage in direct observation activities and problem-solving related to the potential of mangrove habitats in ecosystem material.

The manner in which material is presented can enhance students' motivation to comprehend the concept of ecosystems independently within their groups, thereby facilitating the acquisition of knowledge and fostering collaborative learning. According to students, the advantages of textbooks based on mangrove habitat potential are readily comprehensible and stimulate engaging and enjoyable learning experiences. They are presented with direct observation activities outside the classroom and are encouraged to recognize the correct concept in a material in order to enhance interest and develop environmental literacy skills.

4.4. Efficacy of Textbooks Based on Mangrove Habitat Potential to Improve Students' Eco-literacy Skills in The Topic of Ecosystem

The efficacy of the developed textbooks was evaluated through the administration of pre- and post-tests, which were designed to assess the enhancement of eco-literacy competencies. The increase in the average pretest and posttest scores was measured using the normality gain (N-Gain) test. The results indicated a high level of improvement, with a value of (g) ≥ 0.7 for both small-group and large-group tests. This signifies an enhancement in students' eco-literacy abilities, which suggests that students possess a profound comprehension of the interconnections between environmental concepts and ecosystem components.

In accordance with Capra's (2014) perspective, ecology can be defined as the study of the interconnections that bind the diverse members of the Earth's ecosystem. The term "literacy" is defined in this context as the ability to process

information and to interpret it in a meaningful way. However, it can also be interpreted as a state of awareness. As stated in the Bulletin of the Navigators by Neolka (2018), awareness represents the primary capital for individuals seeking advancement.

The following are some contributions that can be explored from eco-literacy teaching materials:

- Forming students' attitudes and concerns with various phenomena in the field context that are detrimental to the environment
- Forming an understanding of the necessity to continually reposition the relationship between humans and their environment, cultivate a positive self-concept, and establish environmental ethics and morals
- Engage more actively with their communities from an earlier age, with the aim of developing a deeper comprehension of the environment and becoming an environmental activist

In light of the preceding opinions, it can be posited that eco-literacy is a concept that encompasses an individual's awareness of the significance of environmental stewardship. Those who have achieved the level of eco-literacy are acutely aware of the vital importance of protecting and caring for the Earth, its ecosystems, and the natural environment as a place of life and development. In consequence of this awareness, humans establish patterns and lifestyles that are in harmony with the environment. Subsequently, humans utilize this awareness to inform their actions across all aspects of life, ultimately fostering a culture of sustainability that permeates all members of society, leading to the creation of a sustainable society.

5. Conclusion

This study aims to evaluate the efficacy of biology textbooks developed to enhance the eco-literacy skills of class X IPA students, with a particular focus on their effectiveness at SMAN 1 Marisa. The findings indicate that the textbooks developed are valid and suitable for use in the learning process to enhance students' eco-literacy skills with regard to ecosystem material. The results of the teacher observation analysis indicate that the textbooks developed are of an exemplary standard. The efficacy of the coursebooks in enhancing students' eco-literacy abilities is evaluated through the calculation of N-Gain. The N-Gain test yielded a (g) ≥ 0.7 result, which falls within the high category. It can thus be concluded that students' eco-literacy skills have increased, indicating that they have a high level of understanding of the relationship between environmental concepts and ecosystem material.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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