E-SW to Improve Students' Naturalistic Intelligence on Freshwater Ecosystem Material

Sri Wulandari*, *Suwondo* Suwondo, and *M. Ulil* Hac D

University of Riau, Master of Biology Education, Pekanbaru, Riau, Indonesia

Abstract. The practice activities carried out in the ground area do not fully recognize the environment with the blended learning process. This development research aims to produce E-Student Worksheet (E-SW) teaching materials that can increase students' naturalistic intelligence on freshwater ecosystem materials for aquatic ecology courses at the Biology Education Study Program, FKIP University of Riau. Development research using the ADDIE model Students measured parameters by validity, practicality, and naturalistic intelligence assessed. Data collection was carried out through field observations, interviews, and the dissemination of questionnaires. The trial subjects consist of 1 material expert, 1 educational expert, and 1 media expert, a small group trial of 15 students and a large group trial of 35 students. The data is analysed by the descriptive method. The results showed that the validity of the Electronic E-SW was very valid with an average value of 95.67% based on the aspect of display quality 94.64%, software aspects 93.75%, usage aspects 95.31%, content and material feasibility aspects 95 .67 %, and linguistic feasibility aspect 95.83%. The practicality of E-SW is relatively practical, with an average value of 78.96% based on the aspect of use 79.08%, the aspect of time efficiency of 77.43%, and in the aspect of benefits of 79.23%. The Naturalistic Intelligence of students using E-SW increased from 64.02 (good) to 83.18 (very good). E-SW is very suitable to be used as teaching material for practicum activities in aquatic ecology lectures. The implications of this research are expected to be an alternative to E-SW teaching materials in the lecture process by blended learning or face-to-face.

1 Introduction

Aquatic Ecology is a compulsory course in Semester 5 of the Outcome Based Education (OBE) curriculum at Merdeka Learning Merdeka Campus (MBKM) in 2020. The course, with the code BIO3126, carries 3 credits. The Learning Outcomes of Graduates (CPL) in the Biology Education Study Program for Aquatic Ecology are divided into 4 domains: attitude, knowledge, general skills, and special skills [1].

Aquatic Ecology is a complex subject that studies various typologies and interactions within aquatic ecosystems. It examines the characteristics and interactions of flowing (lotic) and stationary (lentic) waters, including the physical, chemical, and biological factors and their relation to water quality. Aquatic Ecology lectures are similar to field practicum activities, but due to the COVID-19 pandemic, their effectiveness has been reduced in the

* Corresponding author: sri.wulandari@lecturer.unri.ac.id

cognitive, affective, and psychomotor domains. To overcome these obstacles, Furman Shaharabani and Yarden suggest innovating pedagogic competencies in designing and developing teaching materials [2].

Teaching materials need to be adjusted to the objectives of the Aquatic Ecology course. The course aims to explain the characteristics and classification of freshwater ecosystems, understand their relation to water quality, and develop methods and data analysis skills based on observations. Nature-based learning is an integral part of Aquatic Ecology courses, and one activity involves using naturalistic intelligence-based learning.

According to Gardner, naturalistic intelligence is the ability to identify, classify, and manipulate environmental elements, objects, animals, or plants [3]. Individuals with Naturalistic Intelligence have a high sensitivity and appreciation for the natural environment. It is the eighth branch of Gardner's multiple intelligences model.

Analysis of online Aquatic Ecology lectures revealed that students' naturalistic intelligence averaged 64.17%, falling within the "good" category but with room for improvement. Additionally, there is a need to develop naturalistic intelligence indicators based on existing MFIs. Interviews with Aquatic Ecology lecturers highlighted the necessity of creating specialized teaching materials utilizing available resources on the Riau University campus, especially for field practicum activities.

Mayer's research shows that students generally enjoy using technology, and their enjoyment correlates with perceived learning success [4]. Mobile devices can be utilized as teaching materials due to their high mobility, blended configuration, private ownership, interactivity, collaboration, and instant features [5]. Android devices, in particular, have advantages such as small screens, longer battery life, multiple teaching material presentation, simple menu navigation, and high connectivity [6]. These features make Android a flexible and effective alternative for learning. Research by Willemse confirms that mobile devices have the potential to facilitate real-time communication and responses from students, ushering in a new era of learning [7].

Despite the widespread use of Android devices among students (95.13%), their utilization for educational purposes remains suboptimal, with only 82.93% using them for social teaching materials, 68.29% using the internet, and 29.27% for reading biology material. Wi-Fi facilities on campus and internet packages support the smooth running of these activities. Considering these factors, the researchers conducted a study titled "E-SW to Improve Students' Naturalistic Intelligence in Freshwater Ecosystem Materials."

2 Methodology

2.1 Research Approach

This research follows the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation) for its development.

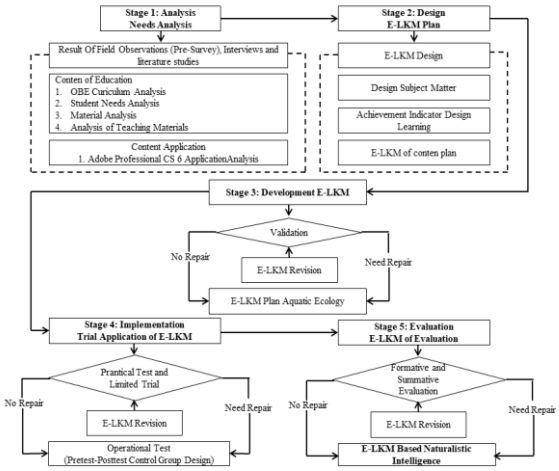

Fig. 1. Development Flow of ADDIE Model Electronic Student Worksheet.

2.2 Research Location and Timeframe

The research took place at Riau University's Department of Mathematics and Natural Sciences Education, within the Biology Education Study Program. The research was conducted from September to November 2021.

2.3 Data Types and Sources

The data obtained for this study consists of primary and secondary data. Primary data is collected directly from the data source, while secondary data is gathered from previous studies. Primary data includes a naturalistic intelligence assessment based on the values obtained from the naturalistic intelligence questionnaire during the E-SW operational trials. Secondary data consists of supporting information collected from relevant sources such as journals, research reports, books, and other reliable sources that contribute to answering the research questions.

3 Results and Discussion

3.1 Validity Test of Aquatic Ecology E-SW

Based on the validation results by expert validators for each assessment indicator, the Aquatic Ecology E-SW has been validated in every important aspect. **Fig. 2** presents the validation values of the Aquatic Ecology E-SW.

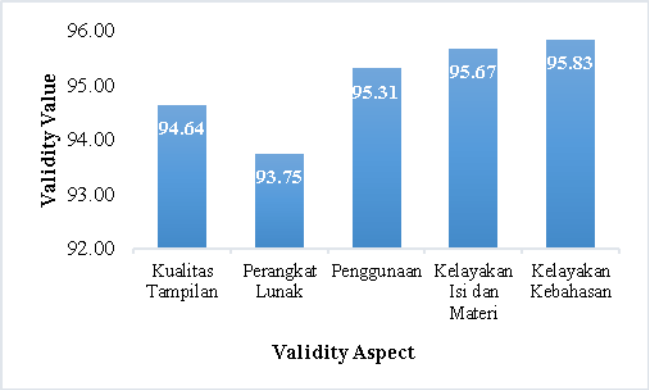

Fig. 2. Validation Value of E-SW Aquatic Ecology.

Overall, the validation results classify the Aquatic Ecology E-SW as very valid (95.04%). The assessed aspects include display quality, software, use, feasibility of content and material, and linguistic feasibility. The highest validation values are observed in the feasibility of the content and material aspect (95.67%) and the linguistic feasibility aspect (95.83%). The software aspect has the lowest validation value of 93.75%. However, overall, all aspects are considered very valid. The validated SW will be implemented to assess the achievement of the results of MFI development. According to Yuni et al. (2020), the components in the SW are expected to create an interactive, inspiring, fun, challenging, and motivating learning atmosphere for students. The SW should also provide sufficient space for initiative, creativity, and independence, catering to students' talents, interests, and abilities, as well as their physical and psychological development.

3.2 E-SW Practicality Test of Aquatic Ecology

In general, students reported numerous benefits of using the aquatic ecology E-SW, including its accessibility anytime and anywhere. This feature greatly facilitates learning, as students can easily open the application on their Android phones to review and engage with aquatic ecology lectures. **Fig. 3** presents the overall results of student assessments regarding the practicality of the developed E-SW.

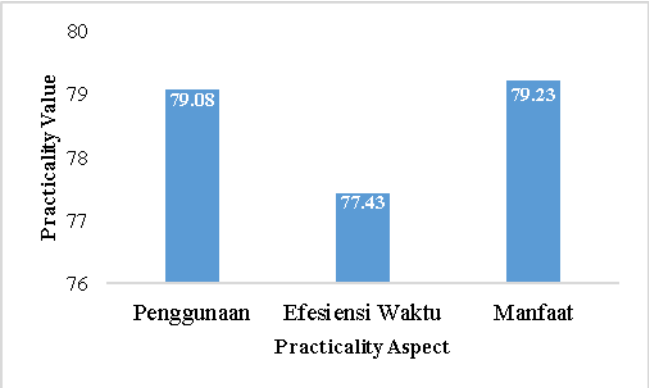

Fig. 3. Practicality Value of E-SW Aquatic Ecology.

The practicality test results indicate an average assessment of 78.96% in the Practical category for the developed E-SW. The aspect with the highest value is the benefit aspect (79.23%), reflecting the advantages perceived by students in terms of accessibility and practicality, which make field practicum activities easier. Yuni et al. (2020) mentioned that an appealing appearance of the SW can help focus students' attention and make learning enjoyable. On the other hand, the aspect with the lowest value is time efficiency (77.43%) in the Practical category. This is attributed to the E-SW's focus on engaging students in each activity, which may require more time. Regarding ease of use, the E-SW scores 79.08% in the Practical category, indicating that students find it user-friendly with the help of buttons, menus, relevant text, and images tailored to their level. Readability is important for maintaining interest in learning, improving memory, and fostering reading habits [8]. Overall, the Aquatic Ecology E-SW can be considered practical and smoothly operated. However, researchers need to provide guidance to ensure successful implementation during lecture activities.

The practicality assessment conducted by the lecturers demonstrates that the E-SW is highly practical in all aspects, with an average value of 94.12%. The aspects assessed include use, time efficiency, and benefits. Overall, the lecturers' assessment of the practicality of the E-SW is excellent. Aquatic ecology lecturers confirm that the E-SW can be used and tested with students.

3.3 Increasing Naturalistic Intelligence of Students in Experiment Class

The implementation of the Aquatic Ecology E-SW also involved assessing the enhancement of students' naturalistic intelligence abilities. This assessment was carried out using a questionnaire before and after the experiment in two classes: the control class and the experimental class. **Table 1** presents the results of the study.

Table 1. Students' Naturalistic Intelligence Based on the Perception Questionnaire Value of Naturalistic Intelligence.

No	Class	Before Experiment		After Experiment	
		Score	Criteria	Score	Criteria
1	Control	60.6 7	pretty good	67.5 4	well
2	Experiment	64.0 2	well	83.18	very good

The experimental results show an increase in students' perceptions of naturalistic intelligence in the Aquatic Ecology E-SW. The average value of the naturalistic intelligence perception questionnaire increased more in the experimental class compared to the control class. In the experimental class, the value of naturalistic intelligence increased from 64.02% (good criteria) to 83.18% (very good criteria). In the control class, the mean value increased from 60.67% (good criteria) to 67.54% (good criteria). The enhancement of naturalistic intelligence can be attributed to the effective understanding of Aquatic Ecology material through the use of the naturalistic intelligence-based E-SW.

The data on the increase in naturalistic intelligence scores in the control and experimental classes were analyzed using graphs to interpret the overall criteria for enhancing students' naturalistic intelligence. **Fig. 4** presents the results of the analysis.

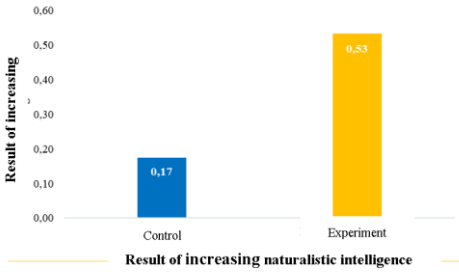

Fig. 4. The Results of the Analysis of Increasing Naturalistic Intelligence in the Control and Experiment Class.

The analysis indicates a greater increase in naturalistic intelligence in the experimental class compared to the control class. The increase in naturalistic intelligence in the experimental class is moderate (0.53), while the control class shows a low increase (0.17). These findings demonstrate that learning with the Aquatic Ecology E-SW leads to better improvement in naturalistic intelligence compared to learning without it. The integration of naturalistic intelligence indicators in the E-SW's activities helps students focus and develop their existing naturalistic intelligence. Through integrated activities and indicators, students have the opportunity to explore and enhance their naturalistic intelligence abilities in relation to aquatic ecology. This includes their competence in identifying living creatures in nature. In contrast, the control class's existing SW lacks integration with naturalistic intelligence indicators, although previous SW activities indirectly addressed naturalistic intelligence. With the development of the Aquatic Ecology E-SW, student competencies, especially in naturalistic intelligence, can be further improved. Utari et al. (2019) revealed that naturalistic intelligence is related to perspective, and a person's perspective on nature develops through the learning process in the classroom. The Aquatic Ecology E-SW can play a role in fostering and concentrating students' naturalistic intelligence abilities.

4 Conclusion

Based on the results of data analysis and discussion, the following conclusions can be drawn: the integration of the E-SW Freshwater Ecosystem Materials into Aquatic Ecology Course activities leads to an increase in students' Naturalistic Intelligence. In the experimental class, students' naturalistic intelligence using the E-SW Aquatic Ecology increased from 64.02% to 83.18%, showing a moderate increase (0.53). On the other hand, in the control class, without using the E-SW, naturalistic intelligence increased from 60.67% to 67.54%, indicating a low increase (0.18).

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