



Development of an E-Encyclopedia of Fish Diversity in Rawa Pening Lake to Improve Critical Thinking Skills

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Abstract

The purpose of this study is to develop an e-encyclopedia based on local potential to improve students' critical thinking skills. The research method used is Research and Development (R&D) with the Borg and Gall development model. This study involved 60 grade X students consisting of 32 students from SMA Islam Sudirman Bringin and 28 students from SMA Negeri 1 Bringin. Based on the results of the validation analysis by material experts and media experts, the average validation of material experts was 0.94 and media experts was 0.93, which is included in the very valid category so it is suitable for use in learning activities. The improvement of students' critical thinking skills was analyzed using the N-Gain test per indicator with an average of 0.69 in the moderate category. The results of the field test indicate that the e-encyclopedia is effective in improving students' critical thinking skills. This study also contributes to the development of science education through the utilization of local potential as a contextual and innovative learning resource that supports 21st-century skills-based biology learning.

How to Cite

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INTRODUCTION

Indonesia is an archipelagic nation, with three-quarters of its territory covered by waters, boasting the second-longest coastline in the world after Canada. Indonesia's vast waters contribute approximately 30% of the world's marine fisheries needs. One of the greatest potentials in Indonesian waters is fishery resources. Indonesian waters are known to be home to various types of fish with high economic value (Suwondo & Guritno, 2015). This potential needs to be optimally utilized not only in the economic field but also in education as a contextual learning resource relevant to students' lives.

One of the inland waters with significant fisheries potential is Rawa Pening Lake. This lake is located in Semarang Regency, and is flanked by four sub-districts: Tuntang District, Bawen District, Ambarawa District, and Banyubiru District (Piranti, 2019). Furthermore, the Rawa Pening Lake area is also surrounded by three mountains: Mount Merbabu, Mount Telomoyo, and Mount Ungaran. These geographical conditions make Rawa Pening Lake an aquatic ecosystem rich in biodiversity, especially various types of freshwater fish. The presence of these fish species in Rawa Pening Lake not only has ecological and economic value, but also has the potential to become a learning resource based on local potential for students.

Utilizing local potential in learning is one way to create a contextual and meaningful learning process. Learning that is connected to the surrounding environment can help students grasp concepts more concretely. The topic of biodiversity, specifically the diversity of fish species in Lake Rawa Pening, can be used as a relevant learning resource. By utilizing this local potential, students not only learn the concept of biodiversity theoretically but also learn to recognize, observe, and directly understand the forms of biodiversity found in their surroundings.

Integrating local potential into learning enables students to understand learning materials in everyday life, and facilitates the achievement of learning objectives. Situmorang (2016) explains that local potential in the surrounding environment can be used as a reference in developing teaching materials. The preparation of teaching materials must be in accordance with established competencies, learning objectives, information alignment, and accuracy.

Initial survey results indicate that the utilization of local potential in learning is still sub-optimal. Teaching materials used in schools are

generally general in nature and do not integrate local resources within the students' immediate environment. This situation results in students being less familiar with the biodiversity of their own region, including the diversity of fish species found in Lake Rawa Pening.

The rapid development of science and technology in the 21st century has undoubtedly impacted various aspects of life, including education. According to Nisa et al. (2018), 21st-century learning emphasizes not only the delivery of material and concepts but also the development of student skills. These skills are generally referred to as the 4Cs, which include creativity, critical thinking, communication, and collaboration. One of the skills essential to buffer against the rapid flow of 21st-century learning is critical thinking. Critical thinking begins with an individual's ability to critique and assess existing situations, conditions, and phenomena, as well as the ability to make rational decisions to solve problems (Kustandi, 2017).

Based on interviews with biology educators in grade X of SMA Islam Sudirman Ambarawa and SMA Negeri 1 Bringin, it was stated that students' critical thinking skills are still relatively low, both in terms of the courage to ask questions or express their opinions. Students are also less active in learning. This indicates that the learning that occurs is quite passive and one of the causes is the lack of critical thinking skills of students. Furthermore, students recognize that their knowledge of local potential in their surroundings is still limited and needs to be improved. Therefore, innovative teaching materials are needed that can integrate local potential with the development of students' critical thinking skills.

One digital teaching material supplement that can be developed is an e-encyclopedia. An e-encyclopedia is a digital teaching material that contains information systematically, attractively, and easily accessible through electronic devices (Sufiya et al., 2019). The e-encyclopedia contains material on fish species diversity linked to local potential in the local area. This allows learning to be more contextual and digitally based. Although Lake Rawa Pening has great potential as a learning resource, the development of a teaching supplement in the form of an e-encyclopedia of fish species in Rawa Pening has never been done to date.

Previously developed teaching materials generally still focus on discussing the Lake Rawa Pening ecosystem in general. This research was conducted by Ayyubiy et al. (2025) on the development of an e-booklet on the Lake Rawa Pen-

ing ecosystem. Previous research conducted by Hanifah (2015) focused solely on utilizing Rawa Pening as a learning resource using a scientific approach. However, the development of an e-encyclopedia specifically highlights the diversity of fish species in Lake Rawa Pening and is aimed at improving critical thinking skills.

The development of an e-encyclopedia is expected to serve as a means of introducing local potential to students, fostering awareness and concern for the environment. By presenting information about fish species, their characteristics, habitats, and ecological and economic roles, students can gain a more meaningful learning experience. Furthermore, the features within the e-encyclopedia can be designed to encourage students to engage in analysis, data interpretation, problem-solving, and evaluation, thereby optimally developing critical thinking skills. The urgency of this research lies in the need to develop e-encyclopedia teaching materials based on local potential that are able to support 21st century learning, especially in improving the critical thinking skills of high school students, especially in class X.

METHOD

The type of research used in this study is Research and Development (R&D). The development model used by the researcher in this study is the development model according to Borg and Gall, adapted by Sugiyono. The research and development model development consists of 10 steps, namely (1) potential and problems; (2) data and information collection; (3) product design; (4) design validation; (5) design revision I; (6) product trial; (7) product revision; (8) usage trial; (9) product revision; (10) final product creation.

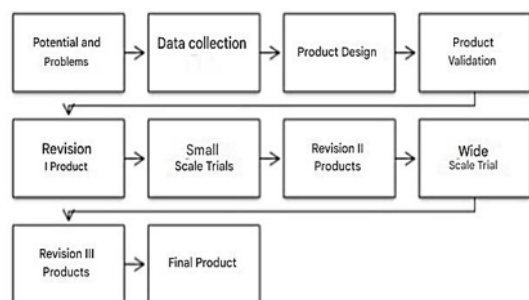


Figure 1. Borg and Gall Model Development Research Scheme According to Sugiyono (2017)

This research was conducted at SMA Negeri 1 Bringin and SMA Islam Sudirman Bringin. The subjects of the small-scale research involved 15 class X students from SMA Islam Sudirman,

and the large-scale research involved 60 class X students from 32 students from SMA Islam Sudirman Bringin and 28 students from SMA Negeri 1 Bringin.

The data obtained from this study are both qualitative and quantitative. Qualitative data were obtained from suggestions/comments from validators, media experts, and material experts. Information obtained from the validators was used as evaluation material to improve the developed e- encyclopedia. Quantitative data were obtained from pretest and posttest results, which will be analyzed using the N-gain index to determine the effectiveness of the e-encyclopedia product on critical thinking skills.

Encyclopedia Validity Test

Validity testing was conducted to determine the validity of the developed e- encyclopedia. This test was conducted by media experts and subject matter experts. The instrument used was a Likert scale. The e-encyclopedia validation data was analyzed using V-Aiken. The V-value represents the validator's agreement index regarding the suitability of an item with the indicator to be measured using that item. V-Aiken analysis was proposed by Azwar (2012).

$$V = \frac{\sum (r_i - l_o)}{[n (c - 1)]}$$

Information:

- V : Aiken's V formula
- r : the number given by the appraiser
- l_o : lowest validity assessment number
- c : the highest validity assessment number
- n : many experts & practitioners
- i : integers from 1,2,3 to n

The validation results from media experts and material experts were then interpreted using score interpretation as in Table 1.

Table 1. Classification of Aiken Validity Coefficients (V)

Aiken Validity Coefficient Value	Validity
$0 < V \leq 0.4$	Less Valid (Low)
$0.4 < V \leq 0.8$	Fairly Valid (Medium)
$0.8 \leq V \leq 1$	Very Valid (High)

Analysis of the Effectiveness of E- Encyclopedias on Critical Thinking Skills

This test was conducted to determine the effectiveness of the e- encyclopedia on students' critical thinking skills. Students were given questions related to Critical thinking skills were as-

sessed before (pretest) and after (posttest) using the e- encyclopedia, after which the data were analyzed by the researcher. Next, the pretest and posttest data were analyzed using the N-gain index, which aims to determine the increase in pretest and posttest scores. This data analysis technique will be explained in the description below.

The N-gain test is used to obtain a neutral N-gain value, this is done to eliminate the assumption that the posttest value The largest one shows the best results. The N-gain formula that will be used and proposed by Hake (1999).

$$\langle g \rangle = \frac{\% \langle Sf \rangle - \% \langle Si \rangle}{\% \langle Smaks \rangle - \% \langle Si \rangle}$$

Information:

Sf : Final score (posttest)

Si : Initial score (pretest)

Smax : Maximum score achieved

The N-gain index results obtained were then interpreted using the following score interpretation criteria as in Table 2.

Table 2. N-Gain Criteria

N-Gain Value	Criteria
$g > 0.7$	Tall
$0.3 \leq g \leq 0.7$	Currently
$g < 0.3$	Low

(Hake, 1999)

After knowing the level of the resulting gain index, the next step is to interpret the N-gain score percentage to determine whether it is effective or not. Determining the effectiveness of using locally developed e- encyclopedia products on critical thinking skills is based on Table 3 as presented by (Widoyoko, 2016).

Table 3. N-Gain Score Effectiveness Interpretation Criteria

Percentage (%)	Criteria
$80 < X \leq 100$	Very effective
$60 < X \leq 80$	Effective
$40 < X \leq 60$	Quite effective
$20 < X \leq 40$	Less effective
$X < X \leq 25$	Very less effective

RESULT AND DISCUSSION

In general, the Borg and Gall development model can be divided into three development stages, namely (1) the identification and data collection stage; (2) the development stage; and (3) the testing stage by validators and large and small

scale testing.

The first stage carried out in this research was to analyze the problems that exist in the environment around Rawa Pening Lake. Initial observations aimed to identify problems that included learning activities at SMA Negeri 1 Bringin and SMA Islam Sudirman Bringin. In relation to learning activities, it appears that students are not yet accustomed to developing critical thinking skills, which is reflected in the simple nature of the practice questions. Students still have low self-confidence. The next activity is to analyze the potential of Rawa Pening Lake. The lake's fish biodiversity can be optimized as a learning resource to create contextual and engaging learning for students. It is known that students' knowledge of local potential in the surrounding environment is still low and needs to be improved, while teaching materials containing local potential are also still very limited.

The second stage is the development of an e-encyclopedia teaching supplement. After analyzing the potential and problems within Lake Rawa Pening, product development was planned. The product developed in this research is an e-encyclopedia on fish species diversity, compiled based on the local potential of Lake Rawa Pening. This e-encyclopedia was designed using the Canva and Heyzine Flipbooks applications, featuring features that support the improvement of students' critical thinking skills

The next third stage is the media validation stage which is developed by expert media and material validators. The developed e-encyclopedia product was then submitted to the validator along with an assessment questionnaire to determine the level of validity of the product. The following summarizes the validation results by the subject matter expert validator.

Table 4. Validation Results by Material Experts

No	Aspect	Aiken's V	Information
1	Content Eligibility	0.93	Very Valid
2	Characteristics	0.93	Very Valid
3	Presentation	0.93	Very Valid
4	Linguistics	0.95	Very Valid
Average		0.94	Very Valid

Table 4 shows that four aspects were assessed for feasibility in material validation: content, characteristics, presentation, and language. Validation results by expert material validators sho-

wed an average score of 0.94, categorized as very valid. Digital teaching materials are considered valid if they achieve a V-Aiken score of 0.87 or higher (for five validators on four scales) (Mendoza et al., 2022).

Thus, it can be concluded that the developed e-encyclopedia can be used as a learning resource in classroom activities. This is consistent with research by Jayanti et al. (2017) that found that encyclopedias can be used as learning resources. In addition to material validation, media expert validators also conducted validation. The following summarizes the validation results by the media expert validators.

Table 5. Validation Results by Media Experts

No	Aspect	Aiken's V	Information
1	Presentation	0.98	Very Valid
2	Graphics	0.89	Very Valid
3	Appearance	0.95	Very Valid
4	Use	1.00	Very Valid
Average		0.93	Very Valid

From the validation calculations by the media experts above, it can be concluded that in terms of presentation, graphics, appearance, and use of supplements, the average validation score reached 0.93, categorizing it as very valid. Similarly, with material validation, digital teaching materials are considered valid if they achieve a V-Aiken score of 0.87 or higher (for five validators on four scales) (Mendoza et al., 2022).

Thus, the media validator's overall assessment of the e-encyclopedia of fish diversity in Lake Rawa Pening falls into the very good or very suitable category. This aligns with the research by Priatama et al. (2021) that found the Android-based encyclopedia of fish diversity in Lake Kerinci suitable for use as a learning resource. The validation results provided suggestions and improvements, and the researchers made several revisions based on the suggestions and feedback provided by media experts. They then refined the learning media to ensure it was deemed suitable for use as a learning resource.

The revised product was then piloted on students at the school. The pilot test was conducted on 60 10th-grade students at SMA Negeri 1 Bringin and SMA Islam Sudirman Bringin. This field trial aimed to determine the effectiveness of the e-encyclopedia in improving critical thinking skills. Improvement in critical thinking skills was assessed based on pretest and posttest scores. Students were given a pretest before using

the e-encyclopedia, and then after the learning activities using the e-encyclopedia, students were given a posttest. The pretest-posttest data used in this study were analyzed using N-Gain (Pertiwi, 2022). The following are the results of the N-gain test of critical thinking skills.

Table 6. Results of the N-gain Test of Critical Thinking Skills

Critical Thinking Indicators	Average Pretest Score	Average Posttest Score	N-gain	Criteria
Providing a simple explanation	44.22	82.78	0.69	Currently
Building basic skills	42.17	80.50	0.66	Currently
Conclude	40.67	81.00	0.68	Currently
Provide further explanation	39.67	80.33	0.67	Currently
Setting strategy and technique	39.17	85.67	0.76	Tall
N-Gain Total			0.69	Currently
N-Gain Score (%)			69.21	Effective

Overall, there was a significant increase in each indicator of students' critical thinking skills. Based on the results of the N-gain analysis, an average N-gain value of 0.69 was obtained, with a moderate criterion. The N-gain value results differ from the results of research conducted by Erawati et al. (2020) who obtained a level of effectiveness of the critical thinking test on encyclopedia media of 0.75 with a high criterion. The difference in the results of this study is due to several factors such as limited time to use the e-encyclopedia which is too short, differences in students' initial abilities and initial adaptation to digital media.

This shows that critical thinking skills cannot be developed through just one or two activities, but rather require continuous practice so that students' critical thinking skills can be trained and developed optimally. Nevertheless, the improvements achieved have been shown to be effective in enhancing critical thinking skills, as measured by increased achievement of critical thinking indicators. Students who are trained to answer questions, particularly those involving analysis and evaluation, will encourage critical thinking and the application of knowledge in new contexts (Zulkifli, 2017).

CONCLUSION

The developed learning media utilizes the local potential of the surrounding environment, namely the diversity of fish species in Lake Rawa Pening. It is presented in the form of a teaching supplement and adapted to the biodiversity material in the learning curriculum. Based on validation results by material expert and media expert validators, the validation results for the material experts showed an average of 0.94 and for the media experts an average of 0.93, categorized as very valid. Digital learning materials are declared valid if they achieve a V-Aiken value of 0.87 or higher (Mendoza et al., 2022). This learning media can also strengthen students' critical thinking skills with an average N-Gain value of 0.69. From the field test results, it can be concluded that the e-encyclopedia is effective in improving critical thinking skills.

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