

Development of Pteridophyta E-Teaching Materials in the Bantarbolang Natural Reserve With a Scientific Approach to Train Critical Thinking Skills

Bagus Adi Bayu✉, Margareta Rahayuningsih, Andin Irsadi

Science Education Program, Graduate program, Universitas Negeri Semarang, Indonesia

Article Info	Abstract
Article History : June 2023 Accepted August 2023 Published December 2023	The Bantarbolang Nature Reserve as a conservation area is not widely recognized, and has not been utilized in learning. Students also need learning that can train critical thinking skills. Students also have low critical thinking skill. The research objective was to analyze the richness of pteridophyte species in the Bantarbolang Nature Reserve. Analyze the characteristics, validity and effectiveness of e-teaching materials for Pteridophytes in training students' thinking skills. This research includes Research and Development (R&D) research using the 4D model which includes four stages, namely Define, Design, Develop, and Disseminate. The research uses pretest and posttest instruments to measure the effectiveness of products on critical thinking skills. The research was conducted in class X MA Al-Hikmah, Mijen, Semarang. The research results showed (1) Pteridophyta richness in the Bantarbolang Nature Reserve, which 14 types of ferns were found, from 6 different families. (2) The characteristics of the Pteridophyta E-teaching materials in the Bantarbolang Nature Reserve have advantages, such as providing contextual examples of images, presented by collaborating scientific approaches and process skills, and displayed in electronic form which makes it easier to use. (3) Validity of the E-Pteridophyte teaching materials in the Bantarbolang Nature Reserve, obtained an assessment score from material experts of 94.38%, and an assessment score from media experts was 98.30. (4) The effectiveness of E-teaching materials on students' critical thinking skills obtained an N-gain score of 0.70, meaning the high category, and obtained an Effect size score of 0.49, which means the medium category, thus showing effective results.
Keywords: E-Teaching Materials; Diversity; Bantarbolang Nature Reserve; Scientific Approach	

✉ correspondence :
Faculty of Mathematics and Natural Sciences
Universitas Negeri Semarang
E-mail: bayu24bagus@students.unnes.ac.id

INTRODUCTION

The Independent Curriculum demands diverse learning, according to the needs and characteristics of students, and emphasizes 21st Century skills. Teachers must have the ability to develop innovative teaching materials (Dwi, 2014). Limitations related to time and production costs are a problem for teachers in developing teaching materials. In fact, teaching materials are an important suggestion in helping complete learning outcomes (Nurcholis, 2017). The learning process will be more effective when there are teaching materials that guide students so that the teacher's role becomes a facilitator (Gloria et al., 2017). Teaching materials are an important component for education in its learning process activities (Hadi, 2015).

The Bantarbolang Nature Reserve area has the potential for a diversity of living creatures that has not been optimized for learning, this is supported by the results of observations and interviews with Bantarbolang Nature Reserve BKSDA officers. The environment has the potential to be used as a learning resource or medium for students and is not widely recognized by the public that Pemalang has a nature reserve conservation area. The potential of Bantarbolang Nature Reserve can be seen from the presence of several species of ferns with epiphytic habitats (Laely et al., 2020). Apart from that, a diversity of wild flower plants is also found in Bantarbolang CA (Fitria et al., 2019).

The surrounding potential can be utilized in developing teaching materials according to their needs (Parmin, 2012). One of them is developing teaching materials based on the results of exploration in conservation areas. Researchers explored the richness of pteridophyte species in Bantarbolang Nature Reserve, which was then developed into teaching material for the diversity of living creatures for high school students in class X.

The development of books, teaching materials or modules has standards and categories which are grouped into three main aspects, namely suitability of content, language and graphics (Eskawati, 2012). The current digital era also influences students' learning methods and habits, including electronic media for learning. Teaching materials in electronic format have many advantages, such as being environmentally friendly,

cheaper, easily accessible anywhere or anytime (Doering et al., 2012).

Technological developments help facilitate human life, including the learning process which utilizes technology in developing various teaching materials (Sugianto et al., 2017). Students are already accustomed to technological facilities in learning activities such as access to learning videos and other online learning applications (Kay & Lauricella, 2016). According to (Rahmanita, 2020) media or platforms for technology-based learning will increase student independence in learning. Because students are supported by various facilities and prefer learning using technology, it is necessary to develop electronic-based teaching materials, namely using the flipbook application.

Developing teaching materials also requires a strategy in preparing and presenting them, one of which is a scientific approach, which is in line with the current Merdeka curriculum. The scientific approach is a learning process designed in such a way that students can actively construct their understanding concepts with the stages of the learning process (Liana, 2020). Learning process skills with a scientific approach include observing, classifying, measuring, predicting, explaining and concluding (Musfiqoh, 2015).

The scientific approach encourages students to think in solving problems and finding ideas for solutions to problems (Hosnan, 2014). The results of teacher interviews stated that the textbooks used never systematically emphasized scientific steps or stages in learning. Scientific application with stages of scientific thinking through the process of dancing, serving, observing, creating and trying in the learning process, so that students will be active in developing their understanding concepts (Asmiyunda et al., 2018). A scientific approach will guide students in creating a link between the knowledge he has and its application in life (Noviyanti, 2017).

The 21st century education currently taking place encourages and emphasizes skills in the learning process. Students must have self-control, critical thinking skills and master technology (Perignat, 2019). The problem found based on the results of observations and interviews, is that students' critical thinking skills are at a deficient level, and requires learning that encourages students' critical thinking skills. The importance of critical

thinking is because in the present and future there will be an explosion of information and challenges to technological development (Potter, 2010).

Developing electronic-based teaching materials through a flip book application, and resulting from exploration in the Nature Reserve with a scientific approach is expected to help students' learning process and introduce them widely to the Bantarbolang Nature Reserve conservation area. It is hoped that the electronic teaching materials developed can train students' critical thinking skills. The aim of the researchers is to find out the various types of Pteridophyta in CA Bantarbolang, to know the characteristics of electronic teaching materials, to analyze the validity of e-teaching materials and to analyze their effectiveness in training students' critical thinking skills.

METHODS

The research was carried out at MA Al-Hikmah, Mijen, Semarang. The subjects in the research were class a small-scale trial was carried out with 12 students in MA class X2. Large class trials were carried out on all students in class X1 using the revised E-teaching material products.

Instrument in research used in this research was a questionnaire and cognitive questions. The questionnaire instrument is used to determine the validity of the product, from the assessment of media and material experts, as well as teacher and student responses. The instrument to determine the effectiveness of the product on students' critical thinking skills uses pre-test and post-test questions that implement and refer to critical thinking indicators.

The critical thinking indicators used refer to expert indicators which are then modified. These indicators include: Interpretation; Analysis; Inference; Evaluation; Strategy and Tactics. The indicators used to determine the level of product validation refer to BSNP. Indicators in the questionnaire for material expert validation include: Appropriateness of the content; Feasibility of presentation; Language appropriateness, Scientific Aspect. Indicators of media expert validation include: Overall design and appearance.

The type of research used is research and development, the 4D model from Thiagarajan, S., &

et al 1974 in (Trianto, 2010). This development research was previously carried out first by field research, in the form of exploration in the Bantarbolang Nature Reserve, to search for Diversity Living Creatures, Pteridophyta Division, then research and development which includes four stages, namely Define, Design, Develop, and Disseminate.

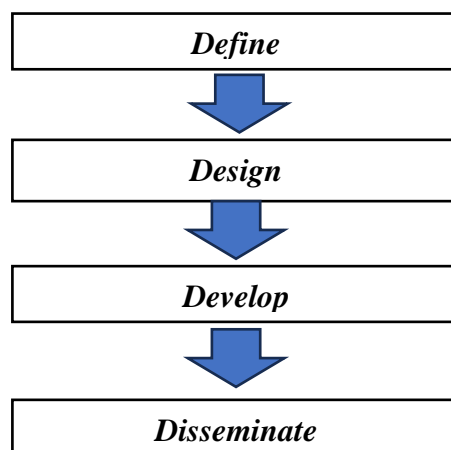


Figure 1. 4D Model Development

Define, at this stage the researcher carries out a series of activities a). Analysis of the problems and potential that exist in the surrounding environment, namely the Bantarbolang Nature Reserve, b). Analysis of student needs at school c) Analysis of student characteristics, related to the level of students' critical thinking skills. Analysis looks at scores, interviews and observations at school.

Design, At this stage the researcher carries out the design necessary for the research, from learning tools, worksheets, research instruments, and analyzes qualitative data from exploration results in the Bantarbolang Nature Reserve and determines the systematics of the teaching materials to be developed. So that the initial design of the E-teaching material is obtained.

Develop, at this stage the E-teaching material product developed by researchers will carry out a series of testing stages, including media expert validity testing and material expert validation testing, with qualified and competent validators, then improvements will be made based on suggestions from the validator. Valid product results can then be continued for small-scale trials to determine the practicality of e-teaching materials when used in learning.

Disseminate, at this stage the researcher conveys the results of the development of E-teaching materials widely after carrying out large-scale tests by measuring the effectiveness of using E-teaching materials. Dissemination of this research was carried out by publishing the research results in scientific articles.

RESULTS AND DISCUSSION

Diversity of Living Creatures in Bantarbolang Nature Reserve

Based on the results of exploration during field research in the nature reserve, regarding the

diversity of living creatures which focused on the Pteridophyta division (ferns) in the Bantarbolang Pemalang Nature Reserve, there were 14 species of ferns found, which were divided into 6 families, from 3 different orders. The results of exploration or natural exploration in the Bantarbolang Nature Reserve area can cover three levels of diversity of living creatures, including gene diversity, species diversity and ecosystem diversity. Overall, the results of the exploration of the diversity of living creatures in the pteridophyte division can be seen in the table

Table 1. Diversity Living Creatures of the Pteridophyta Division in the Bantarbolang Nature Reserve

No.	Ordo	Family	Spesies
1.	Hymenophyllales	Denstaedtiaceae	<i>Microlepia spelunca</i> <i>Elaphoglossum penninsulare</i>
2.	Polypodiales	Thelypteridaceae	<i>Cyclosorus sp</i> <i>Thelypteris acuminata</i>
		Polypodiaceae	<i>Pteris biaurita</i> <i>Pteris ensiformis</i> <i>Pyrrosia lanceolata</i> <i>Locogramme avenia</i> <i>Drynaria quercifolia</i> <i>Adiantum coudatum</i> <i>Stenochleanapalustris</i>
3.	Schizeales	Pteridaceae	<i>Lygodium cirratum</i>
		Dryopteridaceae	<i>Lygodium flexosum</i>
		Lygosiaceae	<i>Lygodium longifolium</i>

Characteristics of Pteridophyta E-Teaching Materials in the Bantarbolang Nature Reserve

E-Pteridophyte teaching materials in the Bantarbolang Nature Reserve developed using Microsoft Word and Microsoft Power Point applications, which are made in PDF form, which will later be converted into Flipbook format. The fonts used are Times New Roman and Arial, with variations in color and font size. This E-Teaching Material consists of several parts as follows: 1) Title or identity of the E-Teaching Material; 2) E-Teaching Materials Editorial; 3) Foreword; 4) Description of E-Teaching materials; 5) Learning outcomes; 6) Instructions for Using E-Teaching Materials; 7) Table of contents; 8) Main discussion material 9) Student worksheets; 10) Practice Questions; 11) Evaluation of learning; 12) Glossary;

13) Bibliography; and 14) Author biography. Electronic Pteridophyta Teaching Materials can be illustrated as in Figure 2.

The display design in the E-teaching materials provides a variety of contextual images resulting from exploration at Bantarbolang nature reserve. Students' curiosity will be triggered by a variety of images and the latest information in teaching materials (Mulyati et al., 2016)



Figure 2. E-teaching materials view

E-Pteridophyte teaching materials in the Bantarbolang nature reserve for the diversity of living creatures have different characteristics, from the systematics used in the learning process, namely collaborating between scientific approaches and process skills in the Merdeka curriculum. Students' conceptual understanding is better when the learning process uses a scientific approach, compared to traditional learning (Asmiyunda, 2018). It is hoped that the scientific approach will help students' learning process, because it will encourage students to actively construct their understanding through a series of processes of observing to concluding and being able to communicate the ideas or strategies they find (Aisy et al., 2020)

E-Teaching materials are developed in electronic format in Flip Book form according to students' needs. Research conducted by Rockinson et al., (2012) shows that learning using electronic book media has a better level of affective and psychomotor learning outcomes. The learning process that utilizes multimedia such as video, images, audio, will help students visualize understanding concepts (Desna, at al., 2015). E-teaching materials with their advantages will help and simplify the student learning process.

Validity of Pteridophyta E-Teaching Materials in the Bantarbolang Nature Reserve

The pteridophyte e-teaching materials in the Bantarbolang Nature Reserve were validated by material experts and media experts, to determine the level of validity of the e-teaching materials.

Table 2. Material Validation Results

Aspect	Percentage	Category
Content Eligibility	96.43	Very Valid
Feasibility of Presentation	95.00	Very Valid
Language Eligibility	91.67	Very Valid
Scientific Average	94.44	Very Valid
Average	94.38	Very Valid

Based on data obtained from material experts developing Pteridophyta E-teaching materials, it shows a percentage of 96.43% for the suitability aspect of the content, 95.00% for the suitability aspect of presentation, 91.67% for the language aspect and a percentage of 94.44% for the scientific aspect. So the average percentage obtained from material experts is 94.38%, which shows that the E-teaching material product is very valid. E-teaching materials in the valid category can be used in the learning process (Jannah et al., 2018).

The materially valid category is obtained from objective assessments from competent material experts. The content of the research results must be able to visualize the material, thereby helping students' conceptual understanding and learning interest, because students' curiosity can be triggered by a variety of the latest information in teaching materials (Mulyati et al., 2016). Information from research results will encourage students to become more familiar with contextual information and will design themselves to become scientists (Dyah & Suarsini, 2016).

Table 3. Media Validation Results

Aspect	Percentage	Category
Design Comprehensive View	96.59	Very Valid
Average	100.00	Very Valid
Average	98.30	Very Valid

E-teaching materials were also validated by media experts who showed a percentage of 96.59% for the design aspect, and 100% for the overall appearance aspect. So the overall average percentage is 98.30%, which means that the E-teaching materials are very valid. The display design is presented in attractive and simple colors without being excessive, with material that is concise but content, and supported by pictures of plants

resulting from exploration. The use of image media in the learning process will increase students' understanding (Khadijah, 2019).

The systematic presentation in E-teaching materials combines a scientific approach with Merdeka curriculum process skills. Scientific accommodates the process of helping students' understanding with a constructive thinking process. A scientific approach can also train critical and creative thinking skills (Wardani et al., 2021). Students with critical thinking skills will be able to identify strategies and make the right decisions in solving problems (Shalihin et al., 2019).

Table 4. Student Response

Assessment Components	Percentage
Material Feasibility	88.33
Language	91.67
Implementability	87.78
Presentation View	86.67
Average	88.61

Based on the research results, student responses had a percentage of 88.33% for the appropriateness component of the material, a percentage of 91.67% for the linguistic component, a percentage of 87.78% for the implementation component and a percentage of 86.67% for the display component of the presentation of E-teaching materials. So the average student response percentage is 88.61%, which means that E-teaching materials are in the very good category. Student responses are an important part of development, to see the ease with which e-teaching materials can be used by students who will apply them in learning.

Table 5. Teacher Response

Assessment Components	Percentage
Material Aspects	93.33
Language	90.00
Overall View Aspect	92.00
Average	91.78

The research results show that teacher responses have a percentage of 93.33% for the material aspect, 90.00% for the language aspect, and 92.00% for the overall appearance aspect, so that the average response from teachers is 91.78%, which means E-Materials teaching pteridophytes received responses from practitioners or teachers in the very

good category. Biology teachers' responses to E-teaching materials produce suggestions regarding the use of language and terms in E-teaching materials which are expected to be more communicative. Communicative language will help make it easier for students to understand the content of the material from teachers regarding E-teaching materials (Yuliani & Herlina, 2015).

Effectiveness of Pteridophyta Teaching E-Materials in the Bantarbolang Nature Reserve

Table 6. The Improvement of Critical Thinking Skills

Pretest Average	Posttest Average
23.84	76.34
<i>N-gain: 0.70 (High Category)</i>	
<i>Effect size: 0.49 (Medium Category)</i>	

Researchers conducted large-scale tests to determine the improvement of critical thinking skills through Pretest and Posttest, which will later be calculated using N-gain, to see its effectiveness. The N-gain obtained was 0.70 which is included in the high category. The research results also showed that the effect size obtained was 0.49 in the medium category, meaning that the effectiveness of the pteridophyta e-teaching materials was large in the large category, so it could be said to be effective.

Measuring critical thinking skills uses Pretest and Posttest questions which describe critical thinking and can measure stages of thinking skills. Pretest are used to determine students' level of knowledge and thinking skills regarding the material (Pratama et al., 2016). Students' critical thinking skills can be measured through formative assessments with multiple choice questions (Aripin, 2018). Large-scale trials were carried out on 31 students in one class, namely class X MA Al-Hikmah.

The discussion of Pteridophyta material, in the biodiversity chapter, is supported by the results of research on the richness of Pteridophyta species in the Bantarbolang Nature Reserve, and is presented in pictures with a brief description of each type of Pteridophyta found. The Pteridophyta e-teaching material also contains student worksheets, with various activities, including asking students to look for ferns in the environment, then identify their characteristics and determine the type of Pteridophyta found. A series of learning processes

and activities experienced by students will support the formation of understanding regarding the diversity of living creatures, especially Pteridophyta

The learning process encourages students to connect the knowledge they have with the surrounding environment. E-teaching materials facilitate students to analyze and identify problems to train analytical thinking skills. The results of the pretest and posttest scores show an increase in scores after the learning process with Pteridophyta E-teaching materials in the Bantarbolang Nature Reserve. The learning process designed in E-teaching materials emphasizes the thinking process, making it easier for students to understand and train critical thinking skills.

The pretest and posttest results show an increase, this shows that e-teaching materials are effective in improving students' critical thinking skills and understanding of concepts. Other research also explains that contextual learning will help students classify observed objects, making it easier for students to understand concepts (Afifah et al., 2017).

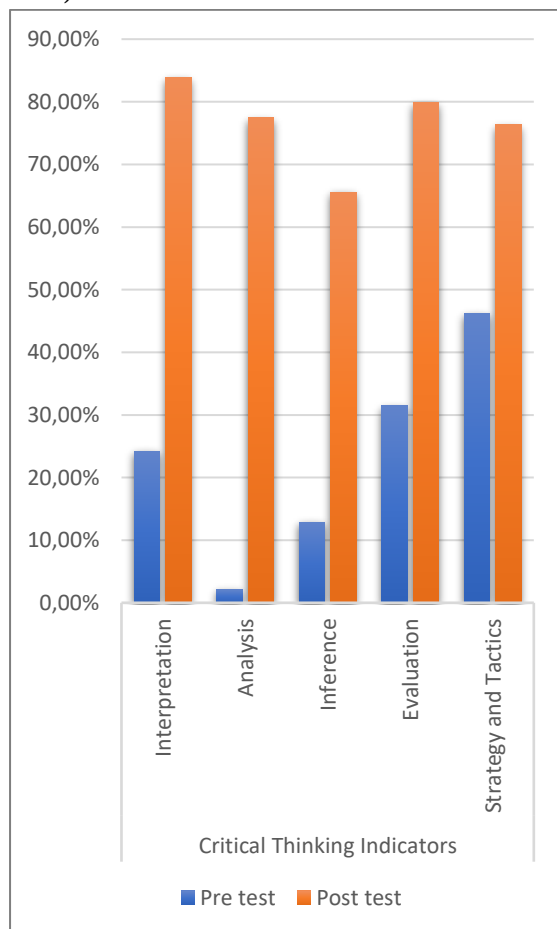


Figure 3. Pre-test and Post-test Results

The results show that students at the beginning before learning had a percentage of critical thinking skills in the interpretation aspect of 24.19%, the analysis aspect of 2.15%, the inference aspect of 12.90%, the evaluation aspect of 31.45% and the strategy and tactics aspect of 46.24%, so that the average student has critical thinking skills at 23.39% and is in the low category. This is supported by previous research from (Syafitri et al., 2021) which stated that the critical thinking skills of students in Indonesia are still at a low level, and need to be improved.

The low critical thinking skills of students are caused by many factors, one of which is the habit of students who focus on memorizing concepts and learning material, without forming an understanding process (Agnafia, 2019). After the learning process with Pteridophyta E-Teaching Materials was implemented in the classroom, the researchers then conducted a posttest to determine changes in students' critical thinking skills. The results show that students at the end of learning have a percentage of critical thinking skills in the interpretation aspect of 83.87%, the analysis aspect of 77.42%, the inference aspect of 65.59%, the evaluation aspect of 79.84% and the strategy and tactics aspect of 76.34%, so that the average student has critical thinking skills at 76.61% and is in the high category.

CONCLUSION

The diversity of pteridophyte types in the Bantarbolang Nature Reserve, found 14 types of ferns, from 6 different families. The diversity of ecosystems in the Bantarbolang Nature Reserve includes river, forest and teak forest ecosystems. E-Pteridophyta teaching materials in the Bantarbolang Nature Reserve have advantages, such as providing contextual examples of images, presented by collaborating between scientific approaches and process skills, and displayed in electronic form which makes it easier to use. So that it can be effectively used for critical thinking skills and facilitate students' understanding. The validity of Pteridophyta E-teaching materials in the Bantarbolang Nature Reserve, obtained an assessment score from material experts of 94.38%, so it is in the very valid category, and an assessment score from media experts was 98.30%, so it is in the

very valid category. The effectiveness of E-teaching materials on students' critical thinking skills obtained an N-gain score of 0.70, meaning the high category, and obtained an Effect size score of 0.49, which means the medium category, thus showing effective results on critical thinking skills with the application of E. -Teaching materials.

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