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PRACTICALITY AND EFFECTIVENESS OF PTERYDOPHYTA DIVERSITY E-ENCYCLOPEDIA IN IMPROVING CRITICAL THINKING SKILLS

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Abstract
This represents an advanced Research and Development (R&D) study designed to evaluate the practicality and effectiveness of an e-encyclopedia which has been built and validated with very valid results. The fourteen students who formed up the research subjects. Pre-test and post-test questionnaires, observation sheets, and student response questionnaires were used as the study instruments. The study data analysis technique was descriptive quantitative through three stages, namely calculating the percentage value of practicality and effectiveness tests, Mann-Whitney U non-parametric test, and N-Gain (g) test. An average percentage value of 85.63% was attained with a very practical category in the practicality test analysis findings. With a percentage score of 81.13%, the effectiveness test analysis revealed a very strong response from the students. In contrast, there was a significant difference between the pre-test and post-test findings in terms of raising CTS by 0.78 with a high category, according to the effectiveness test analysis results using the Mann-Whitney U test and the N-Gain (g) test. The conclusion shows that Canvaflipedia to improve CTS is proven to be practical and effective, so it is suitable for use.

Keywords: critical thinking skill, effectiveness, LPB learning, practicality, Pterydophyta diversity

Introduction
ICT (Information and Communications Technology)-based learning is very important in the 21st-century era as the development of ICT is growing rapidly (Punggeti et al., 2024; Stumbrienė et al., 2024). Educators are required to follow innovative learning trends for students (Hakimi et al., 2024). In addition, educators are also required to have ICT competence in order to create learning according to the demands of the times (Elisa et al., 2023). According to Misran et al. (2024), educator challenges in the Industrial Revolution 4.0 era are increasing because education in this era must be focused on using ICT for learning. This is because 21st-century education aims to generate human resources who are proficient in ICT.

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Enhancing and optimizing Critical Thinking Skills (CTS) has become one in the 21st-century learning requirements that is equally crucial (Jia & Tu, 2024).

CTS is the ability to make inferences and analyses from the information obtained and present them in the form of a clear, directed, and rational perspective (Xiaolei & Teng, 2024). CTS encompasses the processes of interpretation, analysis, evaluation, explanation, sequencing, reasoning, comparison, questioning, inference, hypothesis formulation, assessment, testing, and generalization. (Normore et al., 2024). CTS has long been evaluated and considered an important indicator of educational quality and an important educational outcome (Cheng et al., 2024; Jamil et al., 2024). Various ways can be done in learning to improve students' CTS (Dewi et al., 2024). One way to do this is by implementing cutting-edge ICT-based models of learning, which are essential for 21st-century education.

Creating an inventive flipbook learning media model is a cutting-edge learning trend that can be implemented in the twenty-first century. Through a combination of animation and visual display of engaging learning materials, flipbook learning media helps students comprehend the material offered by educators more fully (Aprilia & Amma, 2024). Thus, using flipbook learning resources can boost students' enthusiasm and drive to learn (Yabashiru et al., 2024). Using flipbooks can help educators become more adept at creating visually appealing, economical, and efficient media while preserving the ability to employ contemporary ICT in accordance with 21st-century learning requirements (Bunari et al., 2024). The development of flipbook model learning media can be applied in all fields of learning, one of which is biology learning, especially Low Plant Botany (LPB) learning.

Biology learning in the 21st-century era is becoming increasingly interdisciplinary through the development of ICT. Integrative teaching is important in the 21st century because, generally, modern careers require interdisciplinary understanding to use CTS and problem-solving skills in dealing with complex problems (Laius & Presmann, 2024). Biology learning should not only provide a foundation of knowledge, but the optimization of CTS also needs to be improved in LPB courses (Jamil et al., 2024). So far, LPB learning has not been optimal in improving students' CTS because of the lack and difficulty of CTS development (Khasawneh, 2024). Minorsky (2024) stated that there is a need for more discussion of botanical material presented in current textbooks. As a result, many students need help understanding the material presented by educators, especially on the material of Pterydophyta diversity. Dewi and Carolina (2024) also mentioned the lack of variety in the usage of ICT and the utilization of learning material. By contrast, understanding media use is crucial (Marwah & Wally, 2024). Also, LPB learning by educators seems monotonous and not interactive, so students tend to get bored.

Hasanah et al. (2023) explained that the majority of educators only explain and give homework to students so that discussions and reciprocal relationships between teachers and students are minimal, which makes it more monotonous. Moreover, both educators and students in learning do not use ICT. Another obstacle that occurs a lot in integrating ICT into learning now is the inadequacy and limitations of digital resource facilities; besides that, many educators are less familiar with and need help in incorporating ICT in the learning curriculum, so many utilization of ICT in learning is not optimal (Rizki et al., 2024).

Several studies have been conducted in developing learning media to improve CTS, such as Nofrianto and Ansyah (2024) in developing LKPD on pollution material; Indriani et al. (2024) in developing mathematics modules; Fenanda et al. (2024) in developing LKPD for the ExPRession model; Syahfitri (2024) in developing e-modules based on local wisdom; Himawan et al. (2024) in developing PBL-based e-books; Karuru et al. (2024) in developing ICT-based learning models. One step in developing learning media to improve CTS that researchers still minimally carry out is developing an encyclopedia.

An encyclopedia is a non-textbook as a reference material that contains information and explanations about various scientific subjects arranged alphabetically (Aini et al., 2024; Pranriska & Manalu, 2024). Encyclopedias in learning have an important role as a structured and credible learning resource, as they provide a source of information and teaching aids that offer detailed explanations focused on a particular subject, making it easy to understand. In addition, the encyclopedia's contents are organized into categories based on letters, groups, or relevant topics. Along with the advancement of ICT, encyclopedias can now be developed digitally and packaged in an interactive flipbook model. The flipbook model packaging makes the encyclopedia easily accessible to readers anywhere and anytime to increase reading interest and make the learning experience more enjoyable. Therefore, the flipbook model encyclopedia provides effective and efficient learning, making learning more enjoyable and meaningful. Based on the urgency of research to develop encyclopedias, the research's novelty lies in the development of an interactive e-encyclopedia flipbook model based on Canva (Canvaflipedia), which combines ICT with the potential of Pterydophyta diversity material locally as an alternative LPB learning medium to enhance CTS. As a result, the study problem is stated as follows how the practicality and effectiveness of the e-encyclopedia of Pterydophyta diversity in LPB learning improve critical thinking skills? The problem is detailed in the subsequent research questions:

RQ1. How is the practicality of e-encyclopedia of Pterydophyta diversity in LPB learning to improve CTS?
RQ2. How is the effectiveness of e-encyclopedia of Pterydophyta diversity in LPB learning to improve CTS?

The research objectives to be achieved are: 1) to describe the level of practicality of e-encyclopedia of Pterydophyta diversity in LPB learning in improving CTS; 2) to describe the level of effectiveness of e-encyclopedia of Pterydophyta diversity in LPB learning in improving CTS.

Method

The study used is an advanced Research and Development (R&D) study where the research product has passed the validity test stage in the previous study and was declared very valid. Therefore, it only focuses on practicality and effectiveness testing in improving CTS. The research method used was conducted as a quasi-experiment. The study was designed using a one-group pre-test-post-test design, as Table 1 shows, which refers to Qolbi and Azhar (2022).

Table 1. One group pre-test-post-test design

Class	Pre-test	Treatment	Post-test
Experiment	O_1	X	O_2

Description: O_1 = Initial test (pre-test) for the experimental class
O_2 = Final test (post-test) for the experimental class
X = LPB learning using Canvaflipedia

The study subjects were 14 biology education students of PGRI Ronggolawe University class 2023. All subjects gave their informed consent for inclusion before they participated in the study. The selection of subjects is intended for biology education students who take LPB lectures on Pterydophyta diversity material.

Data collection instruments in the study were carried out in three stages, including 1) an observation sheet to measure the practicality of LPB learning through Canvaflipedia, which refers to Arifin et al. (2023) and Destri et al. 2023), which has been modified; 2) pre-test sheets and post-test sheets that follow the eight CTS indicators according to Ennis (2011), namely focusing on questions, analyzing arguments, defining terms, identifying assumptions, assessing credibility, observing, inferring and inducing and value judgments; 3) questionnaires to determine the effectiveness of learning through measuring student responses to LPB learning through the application of Canvaflipedia which refers to Fransisca & Yunus (2021) and Sriyanti (2023) which has been modified. The rating scale in the observation sheet and student response form uses a Likert scale with five points, ranging from 1 = strongly disagree to 5 = strongly agree, referring to Ponsiglione et al. (2022).

Practical data collection techniques were conducted through observation sheets by two observers. Effectiveness data collection went through two stages, namely: 1) student response sheets given to subjects after LPB learning through the application of Canvaflipedia; 2) quasi-experiment to find out how much the effectiveness of using Canvaflipedia in improving CTS through pre-test sheets given to subjects at the beginning of learning and post-test sheets given to subjects at the end of LPB learning.

The research data analysis technique is descriptive quantitative through three stages to describe the level of practicality and effectiveness of LPB learning through the application of Canvaflipedia in improving CTS. First, calculate the percentage value of practicality and effectiveness using Equation 1, which refers to Yudhistian and Cintamulya (2024).

$$NP = \frac{R}{SM} \text{ X } 100\% \qquad \text{Equation 1}$$

Description: NP = Percentage value sought or expected
R = Raw score obtained
SM = Ideal maximum score
100% = Fixed number

The results of the practicality percentage are then categorized according to Table 2, which refers to Yudhistian and Cintamulya (2024), while the percentage of effectiveness of student responses is categorized according to Table 3, which refers to Yudhistian and Cintamulya (2024) which have been modified.

Table 2. Interpretation of practicality percentage results

Interval (%)	Category
0-20	Very impratical
21-40	Impractical
41-60	Less practical
61-80	Practical
81-100	Very practical

Table 3. Interpretation of effectiveness percentage results

Interval (%)	Category	Level of Effectiveness
0-20	Very weak respone	Very ineffective
21-40	Weak respone	Ineffective
41-60	Moderately strong response	Less effective
61-80	Strong response effective	Effective
81-100	Very strong respone	Very effective

Second, in order to compare the pre-test and post-test results in LPB learning through the use of Canvaflipedia in improving CTS, the pre-test-post-test CTS scores are then examined using SPSS v25 through the Mann-Whitney U non-parametric test. The research hypothesis is as follows:

H0. There is no significant difference in pre-test and post-test results in improving CTS.

H1. There is a significant difference in pre-test and post-test results in improving CTS.

Whenever p is less than 0.05 ($p<0.05$), then H_1 is approved and the conditions for H_0 are refused. In contrast, if the significance value (p) is greater than 0.05 ($p>0.05$), then H_0 is accepted and H_1 is rejected (Adawiyah & Mahmuddin, 2024).

Third, if H_0 is accepted and H_1 is rejected, then proceed with the N-Gain test (g) to measure the significance of the difference in each CTS indicator before and after LPB learning through the application of Canvaflipedia in improving CTS using Equation 2, which refers to Hamimi et al. (2024) and categorized into Table 4 which refers to Nawawi and Wardhani (2023).

$$\text{N} - \text{Gain (g)} = \frac{\overline{\text{X}}\text{posttest} - \overline{\text{X}}\text{pretest}}{\overline{\text{X}}\,\text{max} - \overline{\text{X}}\text{pretest}} \qquad \text{Equation 1}$$

Table 4. The significance category of the increase in the N-Gain test score (g)

N-Gain (g)	Category
$g \geq 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Moderate
$g < 0{,}3$	Low

Findings and Discussion

The learning process was carried out in the LPB course, which began with an agreement contract with students as research subjects. The learning process was accompanied by two observers who were tasked with assessing the learning process. The researcher then provided learning material through Canvaflipedia, where students were formed into heterogeneous study groups and asked to study

the material presented in Canvaflipedia. They then discussed in groups according to their reading findings in Canvaflipedia for 30 minutes and presented the discussion results for 30 minutes. After presenting, each student was asked to fill out an individual test to evaluate their understanding of the material given within 45 minutes. At the end of the lesson, each student is asked to fill out a student response questionnaire.

The practicality of LPB learning through Canvaflipedia

The findings of the practicality test analysis related to LPB learning through Canvaflipedia by observers are shown in Table 5.

Table 5. Practicality test analysis of LPB learning through Canvafllipedia

Aspect	Observer		Total ($\sum$R)	$\overline{NP}$ (%)	Category
	I	II			
Ease of Display	4	5	9	90	Very practial
Efficiency of Learning Time	3.5	4	7.5	75	Practical
Presentation of Material	4.5	4.5	9	90	Very practial
Usability	4	4.75	8.75	87.5	Very practial
$\overline{X}$ Percentage				85.63	Very practial

Considering a very practical category, the practicality test results yielded an average percentage value of 85.63% overall. The percentage value obtained shows that all aspects of LPB learning through the application of Canvaflipedia are very practical to implement. In order to facilitate the distribution of learning materials and accomplish learning objectives, learning media must be considered practically (Handayani et al., 2024). Practical learning media can be useful for (1) clarifying the form of information presentation in improving the learning process and results; (2) enhancing focus, motivation for learning, and face-to-face communication between students and their classroom; (3) getting over the limits of time, space, and senses (Putri et al., 2024).

Canvaflipedia's ease of display in LPB learning received an average percentage value of 90% in an area that was highly useful. The ease of displaying Canvaflipedia in LPB learning shows that educators are not bothered by delivering material and accessing features in Canvaflipedia. Anywhere that a learning tool may be easily used, it is considered practical (Maasawet et al., 2023). The time efficiency aspect of LPB learning through Canvaflipedia obtained an average practicality score of 75% with a practical category. The Canvaflipedia’s practicality in the efficiency of LPB learning time shows that educators deliver the material in Canvaflipedia exactly according to the time so that learning can be carried out well. Effective learning time is the optimal time for students to absorb learning material effectively (Suranto & Pramitasari, 2024). The use of ICT in developing learning media helps improve learning efficiency in the modern era (Li, 2024).

An average percentage value of 90% was found for the Canvaflipedia material presentation in LPB learning, with a very practical category. Educators using LPB learning find it useful to deliver content on Canvaflipedia since the language is simply comprehensible, making it easier for students to absorb the subject. Learning media that is easy to understand can also create quality learning (Azhari et al., 2024). The usefulness of Canvaflipedia applied in LPB learning is

very practical with a percentage value of 87.5%. The practicality of Canvaflipedia from a practical standpoint demonstrates that it can help students in a number of ways, such as boosting their motivation and excitement, expanding their knowledge, increasing their level of engagement in their studies, and expanding the range of educational resources available to teachers in classrooms. Therefore, Canvaflipedia can be utilized in LPB learning as an alternate interactive learning media. Clear and simple-to-understand instructional materials and media are essential for inspiring learners to be motivated to learn (Oxana et al., 2023). Purwanto and Megawati (2024) explained that to catch students' attention, teachers can employ more variety in their lesson plans and alternate teaching resources.

Student response in the effectiveness of LPB learning through Canvaflipedia

Based on student responses, Table 6 displays the efficacy test analysis results for LPB learning with Canvaflipedia.

Table 6. Student responses in the effectiveness of LPB learning through Canvafllipedia

Aspect	Total ($\sum$R)	$\overline{NP}$ (%)	Response Category	Level of Effectiveness
Ease of Use	107	82.31	Very strong	Very effective
Learning Model	161	82.56	Very strong	Very effective
Presentation of Material	158	81.03	Very strong	Very effective
Effectiveness of Learning Time	103	79.23	Strong	Effective
Usability	157	80.51	Strong	Effevtive
$\overline{X}$ Percentage		81.13	Very strong	Very effective

Referring to Table 6, overall student responses in LPB learning through Canvaflipedia have a very strong response with a percentage value of 81.13%. The percentage number obtained suggests that Canvaflipedia is a highly successful tool for LPB learning. Appropriate approaches and media must be chosen in order to customize the application of effective learning media to students' needs (Listiani, 2024). Responses related to the ease of use of Canvaflipedia in LPB learning are very strong, with a percentage value of 82.31%. The value obtained shows that Canvaflipedia is very effective and easy to use in LPB learning. The very strong response given shows that students can easily access learning materials and features in Canvaflipedia. Sanulita et al. (2024) stated that as it will boost activity and passion for a more enjoyable learning experience, students must become proficient in using a variety of learning media.

The learning model used in LPB learning through Canvaflipedia has a very strong response, as evidenced by the acquisition of a percentage value of 82.56%. The percentage value shows how effective the LPB learning model using Canvaflipedia is. The very strong response given shows that the LPB learning model through Canvaflipedia makes students active and serious in understanding and listening to the material presented. So that students have more material delivered by educators, in order for the learning model to be efficient, educators must be adequate and master the technology used in learning media (Medina-Herrera et al., 2024).

The material presented by Canvaflipedia in LPB learning gave a very strong response with a percentage value of 81.03%. The percentage value obtained proves that the presentation of Canvaflipedia material is very effective in LPB learning.

The very strong response given shows that the delivery of material and access to LPB learning through Canvaflipedia is very structured and interesting. The very strong response given regarding the presentation of material on Canvaflipedia also shows that the appearance of the page, including size, font type, and background color, is very attractive so that it looks clear and comfortable to read. Fonts and display types in design are very important because, if they are appropriate, they can prevent the appearance of the material design from being difficult to understand (Andarukmi et al., 2024).

The effectiveness of LPB learning time through the application of Canvaflipedia provides a strong response, as evidenced by the percentage value obtained of 79.23%. The value obtained shows that the time efficiency of Canvaflipedia is effectively applied in LPB learning. The strong response given shows that the use of Canvaflipedia in LPB learning makes students interested in learning the material in it, so they can learn independently. Effective learning media can help teachers in delivering material so that students' understanding and motivation to learn increase (Zafrullah & Ramadhani, 2024).

Student responses regarding the usefulness of Canvaflipedia in LPB learning are strong, as evidenced by the acquisition of a percentage value of 80.51%. Therefore, the application of Canvaflipedia is effective in providing benefits to LPB learning. The strong response indicates that Canvaflipedia expands students' perspectives, inspires them to learn, and facilitates their application of the knowledge they gain to real-world situations. The advantages that students experience after learning, such as conceptual comprehension and material mastery, demonstrate the effectiveness of educational materials. The learning objectives attained increase with the degree of student comprehension. Effective learning resources can also boost students' drive to learn, which affects their engagement and learning outcomes (Wahyuni et al., 2024). A student's learning outcomes increase with their level of learning motivation (Sefira et al., 2024).

Effectiveness of LPB learning through Canvaflipedia in improving critical thinking skills

The results of the Mann-Whitney test analysis of the pre- and post-test scores acquired in LPB learning via Canvaflipedia are shown in Table 7.

Table 7. Mann-Whitney test results of pre-test and post-test scores

Statistics Test[a]	
	Pre-test & Post-test Score
Mann-Whitney U	14.500
Wilcoxon W	105.500
Z	-3.609
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

a. Grouping Variable: Pre-test and Post-test treatment
b. Not corrected for ties.

Table 7 indicates that the Mann-Whitney test analysis yielded a significant value (p) less than 0.05 (0.00<0.05), indicating the rejection of H_0 and acceptance of H_1. The findings of the pre-test and post-tests show a substantial difference in improving CTS, supporting the acceptance of hypothesis (H_1). The variations

between the pre-test and post-test results demonstrate how student learning outcomes change before and after using Canvaflipedia in LPB learning.

Table 8 displays the findings of the N-Gain test analysis of the pre-test and post-test scores acquired in LPB learning using Canvaflipedia.

Table 8. N-Gain test results of pre-test and post-test scores

Treatment	$\bar{X}$ Score	N-Gain	Category
Pre-test	41.83	0.78	High
Post-test	87.00		

Table 8 shows that there is a significant increase in student CTS through the application of Canvaflipedia in LPB learning, as evidenced by the acquisition of N-Gain test results of 0.78 with a high category. The average pre-test score, which was initially just 41.83, and the average post-test score, which grew to 87.00, demonstrate the tremendous increase in CTS. The high increase in student CTS is because, with Canvaflipedia, they can train critical thinking through observing, exploring, explaining, describing, and discussing between groups. The discussion was carried out by comparing species and finding similarities and differences between families so as to identify and classify the diversity between Pterydophyta species in the surrounding environment. CTS is the ability to understand information, identify logical relationships between the information, and examine the truth of arguments based on scientific truth and knowledge possessed (Selpiana & Munawir, 2024; Sofiani et al., 2024). In addition, CTS is the ability to think in analyzing assumptions, solving problems, evaluating arguments, supporting conclusions, and anticipating with probability (Nuryadi et al., 2024).

Students' increased CTS on the N-Gain test indicates that they have mastered each of the eight CTS indicators, namely focusing on questions, analyzing arguments, defining terms, identifying assumptions, assessing credibility, observing, concluding, and inducing value judgments. In line with Pamorti et al. (2024), who stated that it is crucial to hone the fundamental CTS abilities, like as interpretation, analysis, evaluation, inference, and explanation. Canvaflipedia has thus been demonstrated to have a beneficial effect on enhancing learning results in the form of student CTS levels that may be raised and taught. Improving CTS is one of the educational goals that must be developed universally (Marcos-Vílchez et al., 2024). Furthermore, the rise in CTS attained shows how effective the learning effects are (Nykyporets et al., 2024).

The learning outcomes that students have attained during the learning process provide insight into the caliber of learning (Mohzana et al., 2024). The quality of learning can be improved through various searches, one of which is through the application of Canvaflipedia, which has been proven to effectively improve learning outcomes, especially the level of CTS of students in LPB learning. Learning media serve as an instrument to assist students meet their learning goals and achieve them more easily. This means that learning that is done with the aid of learning media will result in better learning processes and outcomes than learning that is done without it (Sanulita et al., 2024). The developed Canvaflipedia has also been integrated with ICT and proven to effectively improve student CTS so that it can be easily applied in modern learning today. ICT can be used as a tactic to

improve CTS and overcome low motivation because it has many innovative elements that make learning more fun (Widarti et al., 2024).

Conclusion

The research can conclude that the level of practicality of Canvaflipedia in LPB learning is very practical. The level of effectiveness of Canvaflipedia in LPB learning through measuring student responses to improve CTS is very strong and very effective. Further, the findings of the N-Gain and Mann-Whitney tests demonstrate significant discrepancies between the pre- and post-test results in terms of improving CTS with a high category. Therefore, Canvaflipedia to improve CTS proved to be very practical and very effective, making it feasible to use in LPB learning. Research has improved CTS and has the potential to be used as a substitute learning medium for LPB educators, which is one way that it contributes to the field of education.

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