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Validity of Canvaflipedia: E-Encyclopedia of Morphological Pteridophyta Diversity Based on Local Potential in Problem-based Learning

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Abstract

Background: The need for e-encyclopedia development due to the low utilization of ICT in developing e-encyclopedias makes students lazy and less interested in studying the morphological diversity of Pteridophyta based on local potential. Therefore, the development of Canvaflipedia addresses the above problems as a learning medium that is more interactive and easily accessible to students, and can be applied in the PBL model of learning. This study aims to design and test the validity of an electronic encyclopedia related to the morphological diversity of Pteridophyta based on local potential in PBL learning. **Methods:** The type of research used is an R&D study with a 4D (Define, Design, Develop, and Disseminate) model, but the research only reached the development stage, which focused on validity testing by three validators using a validation sheet as a research instrument. Data was collected by compiling the results of the validation sheet and analyzed descriptively and quantitatively to interpret the validity results obtained. **Results:** The findings of the material expert validation test analysis showed a very valid category with an average value of 91.11%. By contrast, the results of the media expert validation test analysis showed a very valid category with an average value of 87.70%. **Conclusions:** Based on these results, the Canvaflipedia developed is very valid for application in PBL learning.

Keywords: morphological; Pteridophyta; validity; e-encyclopedia; PBL.

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Introduction

Given the rapid advancements in science and ICT in the 21st century, PBL (Problem-Based Learning) is one of the advanced learning models that can be utilized today, playing a vital role in encouraging educators to integrate it as a learning innovation (Ayuningtyas & Kuswandi, 2024; Fauziah & Asrizal, 2023). PBL focuses on presenting and solving problems contextually through a series of studies of theories, concepts, principles, and complex activities (Adawiyah & Mahmuddin, 2024; Asri et al., 2024; Hamimi et al., 2024; Maksum et al., 2024; Riyanto et al., 2024; Sari et al., 2024). The PBL model requires students to think independently and be responsible for solving problems by integrating and organizing the information obtained. Therefore, the PBL model of learning has many advantages in stimulating problem-solving skills and enhancing critical thinking evaluation (Gonzalez-Argote & Castillo-González, 2024; Zhang et al., 2024). In implementing the PBL model of learning, the teacher, as a mediator, must provide learning media that enhance the understanding of concepts included in the PBL model of learning (Dzikrika et al., 2024). One of them is through the development of an e-encyclopedia.

E-encyclopedia is a learning media organized alphabetically or by specific categories

that contain a particular field of science, accompanied by attractive images or illustrations in electronic form (Mardin et al., 2024; Nurdiansyah et al., 2021). The encyclopedia serves as a medium that is not just a tool and material, but also allows students to gain knowledge (Aprilianti et al., 2024). According to Pastuti & Iskandar (2023), an e-encyclopedia is a digital repository of scientific terms accompanied by concise definitions. An e-encyclopedia can be an interactive learning medium integrated with the internet, eliminating the need for printing to support the PBL model of learning (Kumalasari et al., 2023; Yunita et al., 2022). This is because the e-encyclopedia provides comprehensive knowledge sources in various subjects, enabling students to participate actively and become more motivated in the learning process by solving problems (Astuti et al., 2021). In addition, e-encyclopedias also support independent learning among students, allowing them to explore topics of interest and find information relevant to their needs (Erawati et al., 2020). The e-encyclopedia also provides various perspectives and viewpoints on a topic, which can encourage students to think critically, analyze information, and increase their interest in learning the content (Fitriani, 2020; Hermanto et al., 2021; Rachma & Wardhani, 2022). One of the materials that can be used in developing an e-encyclopedia is the morphological diversity of Pteridophyta based on local potential. This existing local potential can be effectively applied in the PBL model of learning.

With over 13.500 species worldwide, ferns are a vascular plant category that are thought to be the earliest dominating plants without seeds or flowers but with spores. Ferns are divided into four distinct classifications: Polypodiopsida, Marattiopsida, Psilotopsida, and Equisetales. According to morphology, ferns' bodily parts are separated into roots, stems, and leaves. Ferns grow on the remains of dead plants (saprophytes) and are found linked to other plants (epiphytes) (Yudhistian & Wulandari, 2024).

Several studies have been conducted in developing e-encyclopedias, such as Siregar et al. (2024) developed an e-encyclopedia related to the Odonata order; Nurhayati & Kusuma (2023) developed a local wisdom-based e-encyclopedia; Saputri et al. (2024) developed an encyclopedia of Dayak weaving plants; Utami et al. (2023) developed a smart e-encyclopedia based on Lepidoptera diversity as a biology learning resource; Ayuningtyas & Kuswandi (2024) developed an e-encyclopedia related to Pteridophyta diversity to improve student literacy; Pastuti & Iskandar (2023) developed an encyclopedia of human respiratory system material for elementary school students; and Aini et al. (2024) developed an encyclopedia related to local vegetables as a biology learning media.

So far, the development of an e-encyclopedia related to the morphological diversity of Pteridophyta based on local potential has been minimal. This is based on a study by Masyitoh et al. (2020), who stated that there is a lack of learning media in schools that integrate local potential in an easily accessible electronic format. Additionally, there is a lack of research that utilizes the local potential in the form of the morphological diversity of Pteridophyta. This is because local potential is regional and not innovative, so it is minimally used in learning and is often neglected. Ghosh et al. (2022) stated that the fern group is less studied, and many new species have yet to be discovered. Rosyidah et al. (2023) also added that most local potential fades with the development of ICT. In fact, Pteridophyta is a family of plants with high biodiversity and great local potential.

Another problem is that limited access to ICT in some schools hinders the development of this electronic encyclopedia, which hinders students' understanding of the complex concepts of pteridophyta morphological diversity. Zulfah & Putriyani (2021) also stated that innovation in developing an e-encyclopedia still needs improvement. ICT can be utilized to make innovations in developing e-encyclopedias (Ratminingsih & Subiantoro, 2023).

The need for e-encyclopedia development and the low utilization of ICT in developing e-encyclopedias make the e-encyclopedia less exciting and interactive for students, resulting in a decline in student engagement and interest in studying the

morphological diversity of Pteridophyta based on local potential. Therefore, the novelty of this research lies in utilizing local potential in the form of existing Pteridophyta morphological diversity to be integrated with 21st-century ICT developments in the form of Canva software with a flipbook format to create a more interactive and accessible learning medium for students in the form of Canvaflipedia (Canva-based flipbook format electronic encyclopedia) to be applied in the PBL learning model. The novelty of this research lies in its aim to address the gaps in previous studies, which have minimally utilized the local potential of Pteridophyta diversity and the limited use of Canva and flipbook formats in developing e-encyclopedias. This aligns with Ayuningtyas et al. (2024), who note that ICT also makes the e-encyclopedia very easy for students to use, enabling them to learn anywhere and supporting students' potential in achieving their educational outcomes.

Based on several studies that have been conducted and the need for learning media in the form of an e-encyclopedia, the problem formulations in this study are: 1) how to design an e-encyclopedia of morphological diversity of Pteridophyta based on local potential in PBL learning?; 2) what is the level of validity of the product e-encyclopedia of morphological diversity of Pteridophyta based on local potential in PBL learning. The research objectives to be achieved are: 1) to design an e-encyclopedia related to the morphological diversity of Pteridophyta based on local potential in PBL learning; 2) to test the validity of e-encyclopedia products related to the morphological diversity of Pteridophyta based on local potential in PBL learning.

Methods

The research type is a Research and Development (R&D) study. The research outcome built in this instance is a Canvaflipedia of Pteridophyta morphological diversity. The 4D model (Define, Design, Develop, Disseminate) is used in this study, as shown in Figure 1 (Kurnianto & Mundilarto, 2023).
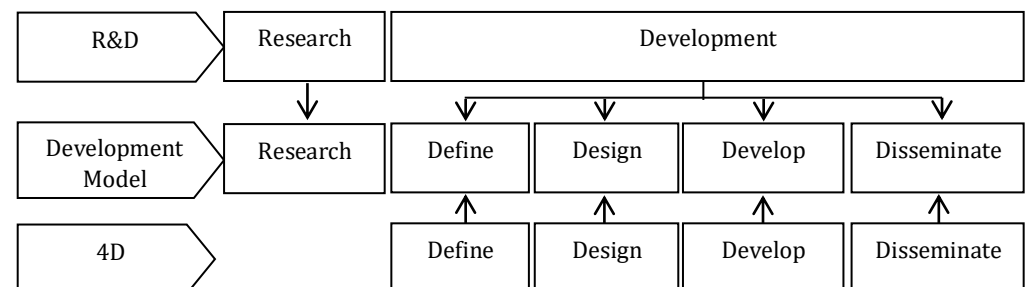
Figure 1. Diagram of combination between R&D and 4D

The study process begins with the Define stage, which includes a series of analytical activities, such as initial and final analysis, learner analysis, task analysis, concept analysis, and the formulation of specific objectives. After that, the process continues to the Design stage, where activities focus on script preparation, media and format selection, and preliminary design. The final stage is the development stage, which includes expert validation testing, development testing, and final product packaging. In this study, the research product only reached the development stage, with a primary focus on product validity testing. Further research will be conducted to disseminate the findings and evaluate the practicability and effectiveness of the research product when applied to the PBL learning model.

Instrument

The research instrument uses the validation sheet method via Google Form. Three components are included in the material expert validation sheet: material (content), presentation (layout), and language, as referred to by Astarini (2022). Meanwhile, the media expert validation sheet consists of three aspects: didactics, construction, and

technical, as referred to by Astarini (2022). The rating score used in the validity sheet is a five-point Likert scale, as referenced in Ponsiglione et al. (2022), in Table 1.

Table 1. Rating scale on the validation sheet

Score	Criteria
5	Strongly agree
4	Agree
3	Undecided
2	Disagree
1	Strongly disagree

Data collection

The data collection technique was completed by submitting the developed product and validation sheet to three validators. The three validators were biology education lecturers who were experts in the fields of plant diversity and learning media. There are two kinds of data obtained in this study: (1) qualitative data in the form of exposure to revisions of criticisms and suggestions related to research products by validators; (2) quantitative data in the form of scores of expert validation test results by validators. The quantitative data from the three validators were then recapitulated using Microsoft Excel for further analysis.

Data analysis

Equation 1 was used to measure the validity level of the research outcome, an e-encyclopedia of Pteridophyta morphological diversity content, as part of the descriptive and quantitative data analysis technique, which refers to Aini et al. (2024).

$$p = \frac{\sum_{t-1}^{4} xi}{\sum_{j-1}^{4} xj} \times 100\% \qquad (1)$$

Description: p = Percentage of validity

∑xi = Sum of the answer scores according to the validator

∑xj = Sum of the highest answer scores

The obtained validity percentage results are then categorized in Table 2, which refers to Aini et al. (2024) as a basis for deciding to revise research products.

Table 2. Interpretation of validity percentage results

Percentage (%)	Criteria	Description
80-100	Very valid	No revision
66-79	Valid	No revision
56-65	Moderately valid	No revision
40-55	Less valid	Revision
30-39	Not valid	Revision

Result

The development results at each stage show that the objectives regarding the material restrictions on the developed Canvaflipedia are analyzed at the define stage. The initial analysis revealed the need for more learning media development that utilizes local potential in the surrounding environment as a learning resource for students in the classroom. Besides, most learning media are only developed in printed form and are not integrated with ICT, so students quickly get bored using them. This is based on an analysis of learner characteristics, which shows that high school students experience difficulties learning the morphological diversity of Pteridophyta; they require assistance in understanding the material and recognizing each species of Pteridophyta. Therefore, teachers expect the development of Canvaflipedia to serve as an alternative learning medium for application in the PBL model of learning. PBL model learning can support the achievement of 21st-century skills, especially students' critical thinking skills (Anggraeni et al., 2023; Haniko et al., 2023; T. S. H. Wulandari et al., 2024).

Task analysis in PBL learning is adjusted to the applicable Kurikulum Merdeka in Indonesia. According to Verawati et al. (2022), the development of the education unit curriculum involves the creation of learning tools, one of which is the development of learning media. By developing learning media in the form of Canvaflipedia, it is hoped that it will provide an understanding and knowledge of the morphological diversity of Pteridophyta based on local potential. Concept analysis aims to identify and systematically compile concepts relevant to the Kurikulum Merdeka in high school biology subjects. The learning media, in the form of Canvaflipedia, a product of this research, is specifically aimed at high school students who take biology subjects, intending to learn and understand various species of Pteridophyta based on local potential, as studied through morphological characteristics.

The material text used in developing this Canvaflipedia is based on the results of previous research by Yudhistian & Wulandari (2024) and combined with several recent references. The media design features a base color combination of dark green and beige. The initial design of the developed Canvaflipedia consists of a front cover section, as shown in Figure 2a; preface section, as shown in Figure 2b; table of contents section, as shown in Figure 2c; species list section, as shown in Figure 2d; material presentation section as shown in Figure 2e; bibliography section as shown in Figure 2f; glossary section as shown in Figure 2g; back cover section as shown in Figure 2h.

(a)   (b)   (c)   (d)

(e)   (f)   (g)   (h)

Figure 2. The initial design of the Canvaflipedia: (a) front cover; (b) preface; (c) table of contents; (d) species name list; (e) presentation of material; (f) bibliography; (g) glossary; (h) back cover

Table 3 presents the analysis and interpretation of the material expert validation test findings obtained from the validator.

Table 3. Material expert validation test results on Canvaflipedia

Aspects	Validator Score			Sum (∑xi)	Mean (p%)	Criteria	Description
	I	II	III				
Material (content)	4.2	4.6	4.2	13.1	87.33	Very valid	No revision
Presentation (layout)	4.5	4.75	4.75	13.95	93	Very valid	No revision
Language	4.4	4.6	5	13.95	93	Very valid	No revision
Average Percentage					**91.11**	**Very valid**	**No revision**

Additionally, Table 4 analyzes, interprets, and presents the media expert validation test results that were collected from the validator.

Table 4. Media expert validation test results on Canvaflipedia

Aspects	Validator Score			Sum (∑xi)	Mean (p%)	Criteria	Description
	I	II	III				
Didactics	4.33	4.33	4.33	12.53	83.56	Very valid	No revision
Construction	4	5	3.67	14.13	94.22	Very valid	No revision
Technical	4.2	4.8	4.8	12.8	85.33	Very valid	No revision
Average Percentage					**87.70**	**Very valid**	**No revision**

Table 5. Exposure to revisions by material expert validators on Canvaflipedia

Revised Sections	Before Revision	After Revision
Front Cover	Does not yet contain the name of the author	There is already the name of the author
Preface	Different font types and sizes	The font type and size are the same and consistent
Table of contents	The table of contents is written inconsistently in Indonesian	The table of contents is written consistently in Indonesian
Bibliography	Different font types and sizes	The font type and size are the same and consistent
List of image references	Placed on the same page as the bibliography	Placed on a separate page from the bibliography

Table 6. Exposure to revisions by media expert validators on Canvaflipedia

Revised Sections	Before Revision	After Revision
Species image	There are several pictures of species that are not clear	Some species images have been changed to be clearer
	There are no images of comparative species from the literature yet	There are already images of comparison species from the literature
Morphological image	The picture of the morphological characteristics of each species is not appropriate.	The picture accurately depicts the morphological characteristics of each species.

In addition to providing an assessment score for the Canvaflipedia, the validator also highlighted its strengths and weaknesses, suggesting revisions and improvements to the Canvaflipedia. The advantages shown by the validator, namely stating that overall, the Canvaflipedia developed is good and very descriptive for readers; the suggestions given by the material expert validator for the Canvaflipedia are presented in full in Table 5.

The suggestions given by media expert validators on the Canvaflipedia are presented in full in Table 6.

Discussion

Table 3 displays an average score of 91.11% for the material expert validation test results overall, with a very high validity category. This indicates that the material presented on Canvaflipedia has been thoroughly tested and deemed highly valid for classroom learning. This is in line with the findings of Fauziah et al. (2023), who obtained highly valid results (90.71%) in terms of content for the validity of modules based on local potential. This indicates that locally based content is highly effective in the context of diversity education, as it enhances the relevance and contextualization of learning, promotes meaningful understanding and critical thinking, and fosters student motivation and engagement. Validity itself refers to the effectiveness of a study; this refers to the extent to which the findings can effectively answer the questions formulated (Putri et al., 2024). The highly valid category is obtained because learning media development is strengthened by theoretical and empirical studies (Budiarso et al., 2022; Hanum et al., 2023). The three validators' validation test findings on the material aspect (content) yielded a value of 87.33%. This indicates that the material presented is titled Canvaflipedia. Canvaflipedia contains a variety of images that stimulate students. Images can help students understand abstract concepts of material more efficiently and avoid misconceptions (Astuti et al., 2024; Mahrini et al., 2024; Novriandami et al., 2023). Canvaflipedia also contains material that can inspire students to learn independently. The subject matter presented on Canvaflipedia is also very adequate for use as an alternative learning media, and the coverage of the material presented on Canvaflipedia already represents each subject matter. Educators can utilize learning media to enhance students' understanding and motivation in learning materials (Warmi et al., 2024). Additionally, utilizing learning media can offer variations in the teaching and learning process (Kuntadi & Hidayat, 2023).

Three validators scored 93% on the presentation aspect (layout) of the validation test results. This demonstrates that the material presented in Canvaflipedia has been organized coherently and systematically. The images presented are also organized by topic, and the font and size of the writing used are clear and do not interfere with the presentation. Additionally, the layout of the material is also very proportional. This follows what states that the material must be accurate, coherent, and systematic to prevent students from experiencing misconceptions (Utari et al., 2024). In the language aspect, the validation test value obtained by the three validators was 93%. This shows that the language used in Canvaflipedia is communicative, transparent, and easily understood by readers; the sentences used are also very effective and efficient. Learning media that declares a valid language is the primary tool when learning media is used for self-learning. Therefore, the language used in learning media must be easy to understand and align with the material taught (Septianti et al., 2022). The communicative language will make it easier to read each sentence (Indryani et al., 2023; Jesisca et al., 2023). In addition, the words or terms used are also exact and consistent. Writing scientific names in Canvaflipedia also follows applicable guidelines, namely binomial nomenclature.

As indicated in Table 4, the media expert validation test results yielded an average score of 87.70% with a very valid category. This is in line with the findings of research by Wulandari et al. (2024), which obtained highly valid results (95%) in terms of media for the validity of e-modules with Canva design and flipbook format. This indicates that media with Canva design and flipbook format have high effectiveness in the context of diversity education due to their visual appeal, ease of use, rich graphical elements, and multimedia integration, which provides an interactive and engaging reading experience. Utami et al. (2022) explain that a learning media assessment is considered valid if: (1) the validator classifies the assessment as good or excellent; (2) the validator selects the option that is worth using without revision or worth using with revision; and (3) the

indicators included in the learning media validation sheet, which were created by carefully considering factors that determine the validation of learning media, specifically the material expert validation sheet and the media expert validation sheet. This indicates that the media displayed on Canvaflipedia has been thoroughly tested and deemed highly valid for classroom learning.

The validation test results, as evaluated by the three validators on the didactic aspect, yielded a value of 83.56%. Didactics was the aspect of the media with the lowest score compared to the others because some terms were difficult for students to understand, requiring a high level of critical thinking. Consequently, the stimuli provided to students were not optimal for understanding complex concepts related to the morphological diversity of Pteridophyta. Nevertheless, the exceptionally high score obtained from the didactic aspect indicates that Canvaflipedia offers various stimuli for students to discover concepts. Additionally, Canvaflipedia utilizes easy-to-understand and straightforward sentences, encouraging students to learn the material thoroughly. In addition, the material in Canvaflipedia also dramatically facilitates students' ability to propose new concepts of thought. Students who can understand learning concepts and apply them correctly in everyday life can significantly improve their science literacy skills, which are essential for students in the 21st century (Astuti et al., 2022; Dirman & Mufit, 2022).

The validation test results, as evaluated by the three validators on the construction aspect, yielded a value of 94.22%. This demonstrates that Canvaflipedia offers highly interactive content for students to digest; it is also equipped with supporting images to enhance the material. Additionally, Canvaflipedia is helpful for students in understanding the concepts presented. The validation test results, as evaluated by the three validators on the technical aspect, yielded a value of 85.33%. This demonstrates that the Canvaflipedia utilizes fonts and font sizes that are precise and consistent; the images listed in the Canvaflipedia are also prominent, attractive, and relevant to the topic of the material. The color composition used in Canvaflipedia is also very appropriate and appealing, with a harmonious combination of text, images, and colors. The media display on learning media must be made as clear and well-designed as possible, ensuring that the principles of visual design are still met.

Additionally, the consistency of each component in the learning media also makes it easy to use (Diastuti & Guspatni, 2024). Canvaflipedia is also packaged and is very accessible to students. This can be an innovation for teachers utilizing Canvaflipedia to attract student interest and motivation. The media presented is not in the form of words or text alone but consists of a combination of text, images, and animation (Nurjanah et al., 2023).

Canvaflipedia has been validated and then packaged in flipbook format. With the flipbook format, it is hoped that high school students can access the Canvaflipedia, which has been developed quickly. The flipbook format was chosen because it offers a more interactive and exciting feel, and access is also easy and flexible. Additionally, the flipbook is designed to replicate the experience of turning the pages of a physical book, making it feel more intuitive and familiar to high school students. The flipbook format can help students obtain information similarly to a traditional paper book, utilizing digital flipping technology that can be combined with various animations to foster their interest in learning. This makes the learning process easier for students, allowing them to access the content anytime and anywhere online (Pramita & Yulkifli, 2023).

The main advantage of Canvaflipedia lies in its innovative and interactive design, which combines the Canva platform with a flipbook format. This medium was developed specifically as an e-encyclopedia on the morphological diversity of Pteridophyta, with content drawn from local potential. Combining local content with modern technology makes Canvaflipedia a promising alternative learning resource. Its use can enhance students' digital literacy while supporting the achievement of science learning outcomes in the Merdeka Curriculum. However, despite its potential, there is a fundamental

challenge in implementing Canvaflipedia, which heavily relies on stable internet connectivity to access the flipbook format.

Conclusions

The research concludes that the design and validity test results of Canvaflipedia, using the 4D model, are highly valid. This proves that Canva's innovative technology and flipbook, in terms of media and materials in Canvaflipedia, are very valid for application in PBL learning, as defined by the define, design, and develop analysis used. This research implies that Canvaflipedia can be used as an innovative learning solution, an alternative learning resource, or a learning medium by teachers in biodiversity education, particularly for Pteridophyta plant material, to enhance students' understanding and bridge the complex morphological concepts of Pteridophyta for high school students in the Merdeka Curriculum. Further research is needed to test the practicality and effectiveness of Canvaflipedia in biodiversity education, particularly in the context of fern plant material using the PBL model.

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Declaration statement

The authors reported no potential conflict of interest.

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