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Development of an Electronic Dictionary of Monocotyledon Plant Classification for Jambi University Biology Education Students

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Abstract: This study aims to develop an Electronic Dictionary of Monocotyledon Plant Classification for Biology Education students at Jambi University. The primary issue faced by students is the lack of interactive learning media to facilitate their understanding of monocotyledon plant classification. To address this issue, the Research and Development (R&D) method was used, applying the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). In the needs analysis stage, observations and interviews were conducted to identify gaps in traditional learning materials. In the design stage, the e-dictionary was developed using Macromedia Flash 8 Pro, focusing on presenting taxonomic descriptions and interactive visual elements. Validation was carried out by content and media experts, resulting in improved scores from 75% to 89.06% for content experts, and from 62.50% to 87.50% for media experts. In the implementation stage, the e-dictionary was tested on 40 students, yielding a satisfaction score of 83.34%, with an independent evaluation from lecturers scoring 93.75%. The study demonstrates that the e-dictionary is effective in enhancing students' understanding of monocotyledon classification. Recommendations for future research include developing Augmented Reality (AR) features and adapting the tool for other biology education content. This e-dictionary is expected to contribute to more interactive and flexible biology learning.

Keywords: Electronic Dictionary, Monocotyledoneae, Plant Classification

Introduction

Incorporating information technology into education has transformed how teachers deliver information to students, making the process more efficient, accessible, and interactive ((Fajarwati et al., 2016; Rostiana, 2023). In the field of biology, particularly taxonomy, the integration of technology plays a crucial role. Taxonomy involves the discovery, description, and classification of organisms based on shared characteristics, providing an organized system for understanding biological diversity (Ohl, 2015). On Earth, the vast number and diversity of plant species can be overwhelming, and classification systems simplify this complexity by grouping plants based on their characteristics and assigning names to each group. This is particularly important in understanding and studying plant biodiversity (Corlett, 2016).

One such classification system focuses on Monocotyledoneae, a group of seed plants characterized by having a single embryonic leaf, or cotyledon. This group includes 12 orders such as Liliales, Arales, and Zingiberales, each composed of various families (Sufyadi et al., 2021). Monocotyledons are important not only for their evolutionary relationships but also for their ecological significance and economic value.

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However, traditional learning tools, like printed dictionaries, used to assist in the classification of plants, are often static, difficult to use, and lack interactivity. Printed dictionaries are typically large and heavy, presenting mostly text without engaging the learner, leading to a lack of motivation in students (de la Torre-Neches et al., 2020; Zhang & Ma, 2023). This calls for modern educational tools that cater to the evolving needs of students.

The development of an electronic dictionary (e-dictionary) for plant classification offers a promising solution to this problem. By digitizing plant classification resources, the e-dictionary makes the material more engaging and accessible to students. This digital tool can incorporate interactive features like images, taxonomic descriptions, and Latin names, which can help simplify complex information and make learning more effective (Halimatusyadiyah et al., 2022; Turcotte et al., 2022). The benefits of using an e-dictionary extend beyond convenience. It is portable, easy to use, and can be accessed anytime, anywhere, providing flexibility in learning. These features are especially relevant in light of the global shift to online education due to the COVID-19 pandemic, which has disrupted traditional classroom-based instruction. The e-dictionary offers a solution that allows students to continue learning independently, even in remote settings.

Despite the crucial role monocotyledons play in biology education, there has been little focus on using digital tools to facilitate their classification. Previous studies on monocot classification have not explored the use of electronic dictionaries as an educational resource. This study seeks to address this gap by developing an e-dictionary tailored for the classification of monocotyledonous plants, specifically aimed at biology education students at Jambi University. The e-dictionary will serve as a comprehensive learning tool, providing detailed classifications and characteristics of monocots, a group that includes around 60,000 known species, many of which have yet to be classified (Sender et al., 2018). The morphological traits of monocots, such as parallel leaf venation and distinct stomatal arrangements, are key to their identification and classification (Frolov & Enushchenko, 2022). By integrating these traits into an interactive digital format, students will find it easier to master plant classification.

This research has several key objectives. It aims to design a functional e-dictionary for monocot classification and evaluate its effectiveness in the classroom by gathering responses from both lecturers and students. This evaluation will help determine whether the e-dictionary improves student engagement and learning outcomes. Additionally, the research will assess the overall feasibility of using the e-dictionary as a learning tool in biology education. The study will provide valuable insights into how digital tools can be integrated into the curriculum to enhance students' understanding of plant classification.

The significance of this research extends beyond improving plant classification education. Monocots are one of the two major groups of angiosperms, encompassing economically important plants such as rice, wheat, and maize. These plants play essential roles in ecosystems and agriculture, making their study crucial for students pursuing careers in biology, agriculture, and environmental science. The development of an e-dictionary supports the broader goal of promoting biodiversity studies in educational programs (Roy & Khan, 2020). By providing students with an accessible and comprehensive resource, the e-dictionary helps foster a deeper understanding of plant taxonomy, ecological relationships, and the importance of biodiversity conservation.

Furthermore, the research aligns with the growing trend of using digital tools in education. The use of electronic resources in the classroom has been shown to enhance student engagement and improve learning outcomes, particularly in subjects that involve complex classification systems (Kurniawan et al., 2019). The e-dictionary represents a shift towards modernizing biology education, making it more interactive and accessible to students. This aligns with the objectives of the biology education program at Jambi University, which seeks to enhance students' scientific literacy and practical skills through innovative teaching methods (Saharudin et al., 2021).

The development of an electronic dictionary for monocotyledon plant classification represents a significant advancement in educational resources. By offering a modern, interactive tool for understanding plant taxonomy, the e-dictionary addresses the challenges posed by traditional learning materials and supports the increasing digitalization of education. This research not only fills a gap in the current literature but also provides practical solutions for improving biology education through the integration of technology. By equipping students with a flexible and engaging resource, the e-dictionary helps foster a deeper understanding of plant diversity and classification, ensuring that students are better prepared for careers in the biological sciences.

Method

Types of Research

This research follows the Research and Development (R&D) approach, focusing on the creation and testing of a specific product, in this case, an Electronic Dictionary of Monocotyledonous Plant

Classification for Biology Education students at Jambi University (Sugiyono, 2019). The development process employed the ADDIE model, a framework commonly used in instructional design that includes five stages: Analysis, Design, Development, Implementation, and Evaluation.

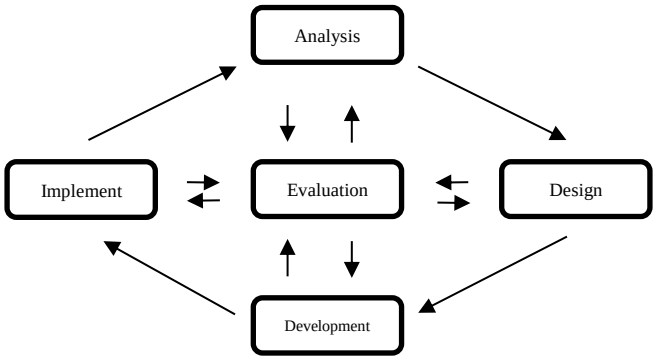

Figure 1. ADDIE Chart

Each stage of the ADDIE model was systematically applied in this study:

Analysis: In this stage, a needs assessment was conducted to identify the challenges students faced in learning monocotyledon plant classification. This included a review of existing learning materials and discussions with lecturers to determine gaps in current instructional tools.

Design: Based on the analysis, the design phase focused on creating the structure and interface of the e-dictionary. Considerations included content organization, user interface design, and incorporation of multimedia elements such as images and taxonomic descriptions.

Development: This stage involved the actual creation of the e-dictionary using Macromedia Flash 8 Pro. The prototype included detailed taxonomic information, images, Latin names, and descriptions of monocotyledonous plants. This version was subjected to several iterations based on feedback from validators.

Implementation: The e-dictionary was piloted with students and lecturers. Feedback was gathered through questionnaires and assessment scores to measure the tool's usability and educational impact.

Evaluation: At this final stage, the e-dictionary was evaluated based on user feedback and performance data. Revisions were made to address any shortcomings, ensuring that the product was effective and aligned with the educational objectives.

Research Subjects and Objects

The research involved 40 undergraduate students from the Biology Education Study Program at Jambi University, aged between 18 and 22 years. The gender distribution was 60% female and 40% male. These students were selected because they had either completed or were currently enrolled in the Plant Taxonomy course, ensuring their familiarity with the subject matter. The inclusion criteria required that participants had basic knowledge of plant taxonomy, specifically monocotyledonous plants, to ensure that they could effectively use and evaluate the e-dictionary. There were no exclusion criteria related to age or gender, as long as the students met the course requirement.

In addition to the student participants, three lecturers who specialize in plant taxonomy were included. Their role was to validate the content of the e-dictionary, ensuring that it aligned with academic standards and the curriculum. Their feedback was also critical for refining the tool's educational effectiveness.

Data Types and Sources

This research utilized both primary and secondary data. Primary data were gathered through questionnaires completed by students and lecturers, which assessed the usability, educational value, and overall effectiveness of the e-dictionary. The primary data also included the validation scores from expert validators two material experts and two media experts who evaluated the e-dictionary's content and interface. Secondary data consisted of existing literature on monocotyledon plant classification and the biology education curriculum at Jambi University. These data sources helped ensure that the e-dictionary content was accurate and aligned with current pedagogical practices. Curriculum guidelines and previous studies on the effectiveness of digital learning tools in biology were also used to inform the design and development stages.

Data Collection Techniques

Data were collected through a combination of quantitative and qualitative methods. Quantitative data were gathered from assessment scores provided by the validators, lecturers, and students, who rated the e-dictionary based on criteria such as content accuracy, usability, and educational impact. These scores were processed using a percentage formula to gauge satisfaction and effectiveness:

$$persentage = \frac{total\ score\ obtained \times 100\%}{maximum\ score} \quad (1)$$

Qualitative data were obtained from open-ended questions in the questionnaires and in-depth feedback from the lecturers. The questionnaires were designed with a combination of Likert-scale questions (for quantitative data) and open-ended questions (for qualitative insights). The administration of the questionnaires took place after the students and lecturers had used the e-dictionary over a period of one

week. Student responses focused on the tool's ease of use and its role in enhancing their understanding of plant taxonomy, while lecturer feedback centered on the alignment of the e-dictionary with the curriculum and its pedagogical soundness.

Qualitative data from the open-ended responses were transcribed manually. These data were then coded and categorized into themes related to the usability, content quality, and overall learning experience provided by the e-dictionary.

Data Analysis Techniques

The analysis of the collected data was carried out using both descriptive and inferential approaches. For the quantitative data, descriptive statistics were used to calculate the mean, percentage, and standard deviation of the assessment scores. The percentage formula was applied to assess overall satisfaction levels from students, lecturers, and validators. The software SPSS (Statistical Package for the Social Sciences) was employed for quantitative data analysis, particularly for calculating the means and standard deviations of the Likert-scale responses.

For the qualitative data, a thematic analysis approach was adopted. The qualitative data from the open-ended questions were first transcribed, after which a coding process was applied. Specific codes were assigned to recurring themes, such as "usability issues" or "content accuracy." These codes were then grouped into broader categories that informed the interpretation of the findings.

Result and Discussion

Needs Analysis

The development of the E-dictionary for Monocotyledonous Plant Classification was initiated with a thorough needs analysis. This stage involved conducting observations and pre-research activities to identify the primary challenges faced by Biology Education students at Jambi University in learning and classifying monocotyledon plants. Based on these observations, it was found that traditional learning materials, such as printed dictionaries and textbooks, were static and lacked interactivity, which made it difficult for students to engage with complex biological concepts. Additionally, the need for more flexible and accessible learning tools was highlighted, particularly given the increasing shift towards online learning due to the COVID-19 pandemic. The goal of the needs analysis was to develop a more engaging and interactive learning medium to facilitate students' understanding of plant classification.

During this phase, interviews with lecturers and students revealed a gap in the current educational resources, specifically in their ability to integrate multimedia elements such as images, taxonomic descriptions, and visual aids. This feedback informed the subsequent design and development stages of the e-dictionary, ensuring that it would address the identified learning challenges.

Design Stage

Following the needs analysis, the design stage focused on the creation of the e-dictionary's structure and interface using Macromedia Flash 8 Pro. The primary objective was to develop an educational tool that was not only informative but also visually appealing and user-friendly. The design incorporated a range of interactive features, such as taxonomic descriptions, images of monocotyledonous plants, and their corresponding Latin names. Careful attention was given to the selection of fonts, images, and color schemes to ensure the e-dictionary was both engaging and aligned with the material being taught.

Macromedia Flash was chosen for its ability to integrate multimedia content effectively, creating an interactive learning experience. Research supports the use of this software in education, demonstrating its capacity to improve conceptual understanding and problem-solving skills across various subjects (Amelia et al., 2021; Firdaus et al., 2022). For example, the integration of animations and visual elements in physics and mathematics education has been shown to enhance student engagement and retention of complex concepts, a finding that was instrumental in shaping the design of the e-dictionary.

Validation Stage

The validation process for the e-dictionary was carried out in two stages, involving both material and media experts.

1. Material Expert Validation: In the first stage, the content was reviewed by two experts in plant taxonomy. The initial validation yielded a score of 75%, placing the e-dictionary in the "good" category. However, the experts provided suggestions for improvement, particularly regarding the accuracy of taxonomic descriptions and the inclusion of additional visual aids. After revisions were made, the second stage of validation resulted in a score of 89.06%, indicating that the content was now suitable for use in an educational setting.
2. Media Expert Validation: Concurrently, two media experts assessed the usability and design of the e-dictionary. In the first stage, the media experts awarded a score of 62.50%, suggesting that improvements were needed, particularly in terms of

navigation and user interface design. Revisions were made based on this feedback, leading to a second-stage score of 87.50%, which signified that the e-dictionary was ready for field testing.

The validation results are summarized in Figure 1, which illustrates the improvements made between the first and second stages for both material and media experts. The graphical representation highlights the progression from initial feedback to final validation, demonstrating the iterative nature of the ADDIE model.

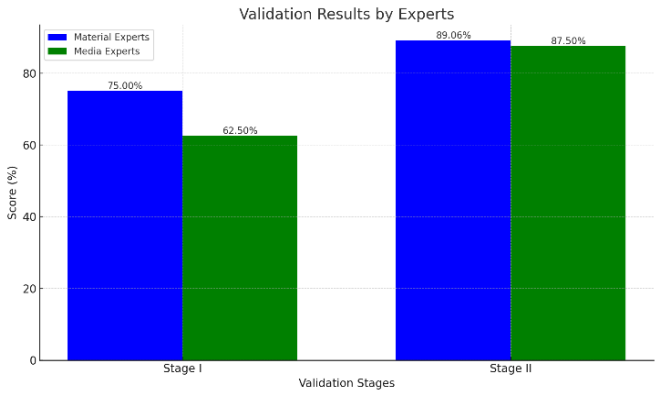

Figure 1. The validation results are summarized

Implementation Stage

The implementation of the e-dictionary in the Plant Taxonomy course at Jambi University showcased a modernized approach to biology education. During its trial phase, 40 students aged 18 to 22 assessed its usability, content accuracy, and educational value over a one-week period. Feedback gathered through questionnaires revealed a high level of acceptance, with an overall student assessment score of 83.34%, categorizing the tool as "very good." Additionally, the course lecturer evaluated the e-dictionary with a score of 93.75%, emphasizing its strong curriculum alignment and effectiveness in enhancing students' understanding of monocotyledon classification. These findings demonstrate the e-dictionary's potential to transform how students engage with complex biological content, particularly through its ease of use and relevance.

E-dictionaries, as innovative digital tools, play a significant role in fostering active learning in biology education. The interactive nature of the e-dictionary aligns with (Sumarno, 2023) argument that digital tools promote active engagement, an essential factor in mastering specialized terminologies and intricate classifications. In the context of plant taxonomy, the e-dictionary facilitated immediate access to relevant information, enabling students to apply theoretical knowledge in practical learning scenarios. This approach is supported by (Kalizhanova et al., 2020), who emphasize the value of embedding linguocultural components in electronic dictionaries, aiding students' contextual understanding of complex terms and fostering deeper comprehension.

The success of the e-dictionary can also be attributed to its usability and thoughtful design. As noted by ((Ningsih & Nikmah, 2023), usability issues such as navigation difficulties and performance delays can undermine the effectiveness of digital tools. The e-dictionary for the Plant Taxonomy course addressed these challenges by incorporating user-friendly interfaces and optimizing performance. These features ensured smooth navigation and efficient access to content, enhancing students' overall learning experience. Moreover, the accessibility of the e-dictionary, allowing students to use it anytime and anywhere, mirrors findings by (Karami & Riasati, 2023) that digital tools gained increased acceptance during the COVID-19 pandemic for their adaptability to hybrid and remote learning contexts.

The tool also supported personalized learning by enabling students to explore specific topics of interest within plant taxonomy, such as ecological roles or classifications of plant families. This aligns with (Melnyk et al., 2020) observation that digital resources encourage students to delve into related concepts, promoting individualized learning pathways. Furthermore, (Dziemianko, 2012) notes that digital dictionaries foster collaborative learning by facilitating real-time sharing of resources and insights. In the case of the e-dictionary, these collaborative aspects enriched group-based learning activities, allowing students to develop a shared understanding of complex biological concepts.

The development of the e-dictionary adhered to the ADDIE model, emphasizing iterative design and continuous validation. Feedback collected during the validation stages led to significant improvements in both content and usability, which is consistent with (Zare, 2013)(Mustofa, 2012) emphasis on the importance of ongoing evaluation in ensuring that educational tools meet learning objectives. The iterative approach taken in this study demonstrates how feedback from experts and users can refine digital learning tools to maximize their effectiveness in education.

When compared to traditional printed dictionaries, the e-dictionary offers substantial advantages. (Zare, 2013) argues that electronic dictionaries enhance vocabulary acquisition through features like audio pronunciations and interactive definitions, making them more effective for modern learners. In this study, students benefited from the multimedia elements of the e-dictionary, such as images and animations, which facilitated deeper engagement with the subject matter. These findings align with those of (Rezaei & Davoudi, 2016), who highlight the ability of interactive tools to

promote better retention and understanding of complex information.

The e-dictionary's development platform, Macromedia Flash, contributed to its success by enabling the integration of multimedia elements that enhanced student engagement. As (Amelia et al., 2021) and (Firdaus et al., 2022) note, Flash-based learning media effectively bridge the gap between abstract concepts and student comprehension through visual and interactive features. In the context of plant taxonomy, these multimedia elements helped clarify hierarchical relationships among monocotyledonous plants, making the learning process more accessible and enjoyable for students.

Despite its successes, the study identified certain limitations that should be addressed in future research. One significant limitation was the relatively small sample size of 40 students, which restricts the generalizability of the findings. (Chinna & Dada, 2013) suggest that larger and more diverse samples are essential for validating the effectiveness of educational tools across different learning environments. Additionally, while the study focused exclusively on plant taxonomy, further research could explore the applicability of the e-dictionary to other areas of biology education, such as genetics or ecology.

Future iterations of the e-dictionary could incorporate advanced features to enhance its educational value further. For instance, Augmented Reality (AR) functionalities could provide three-dimensional visualizations of plant structures, offering students a more immersive learning experience. This approach aligns with (Yamada, 2019) discussion of the evolution of handheld electronic dictionaries, which emphasizes the need for specialized content tailored to the needs of specific disciplines. Expanding the e-dictionary's scope to include dicotyledons or other plant groups could also broaden its utility in biology education.

The e-dictionary's development and implementation underscore the transformative potential of digital tools in education. By integrating usability, active learning, and personalized experiences, it exemplifies a modern approach to teaching complex scientific concepts. The findings affirm the importance of iterative design and validation processes in creating effective educational resources, echoing broader trends in digital education research.

In conclusion, the e-dictionary for monocotyledon classification demonstrated its value as a learning tool by aligning with active and personalized learning principles and addressing usability concerns. Its development adhered to best practices in educational technology design, as highlighted by (Mustofa, 2012), and its multimedia features proved effective in engaging students and enhancing their understanding of plant taxonomy. While further research is needed to expand its applications and validate its effectiveness in diverse settings, the e-dictionary represents a significant advancement in digital biology education. By leveraging technology to overcome traditional learning challenges, it provides a robust model for future innovations in educational practice.

Conclusion

The development of the Electronic Dictionary of Monocotyledon Plant Classification has proven to be effective in enhancing the understanding of Biology Education students at Jambi University. By applying the ADDIE model, the dictionary successfully addressed the limitations of traditional learning media, which are often static and non-interactive. Validation from content and media experts showed significant improvements, with final scores of 89.06% and 87.50%, respectively. Testing with 40 students also yielded a high satisfaction rate, with a score of 83.34%, and lecturers gave an evaluation score of 93.75%. This demonstrates that the e-dictionary is not only engaging and easy to use but also well-aligned with the curriculum.

For further development, several recommendations are proposed. First, adding Augmented Reality (AR) features could provide 3D visualizations of plant structures, enhancing the interactive learning experience. Second, expanding the content to cover other biology topics, such as dicotyledon plant classification or genetics, could increase the utility of the e-dictionary across various subjects. Additionally, testing the e-dictionary in other universities or at lower educational levels, such as high schools, could assess its adaptability to broader educational environments. Further research could also explore the long-term impact of using the electronic dictionary on student learning outcomes

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Author Contributions

Muswita led the research methodology, conducted the study, and was responsible for writing the original manuscript draft. Upik Yelianti contributed to field data collection, participated in data analysis, and assisted in manuscript revisions. M. Erick Sanjaya supported field data collection, contributed to data analysis, and provided critical revisions to the manuscript. Ali Sadikin & Asni Johari provided oversight and guidance throughout the research process and contributed to the final review of the manuscript. All authors have reviewed and approved the final version of the manuscript

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Conflicts of Interest
The authors declare no conflict of interest.

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