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Preliminary Study: Survey of Student Needs in Learning Plant Morphology towards a More Effective Learning Model

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ABSTRACT

Plant morphology plays a crucial role in biological education, yet it often faces challenges regarding the effectiveness of its learning models. Teaching plant morphology faces challenges in terms of limited practicum, traditional teaching methods, lack of use of technology, and limited direct observation in nature. This preliminary study aims to identify student needs in plant morphology learning. A survey method was used to collect data on student opinions, understanding, difficulties, and attitudes after completing the plant morphology course through a questionnaire using a Google Form-based. The sample selection used a purposive sampling technique, with 128 respondents consisting of Biology and Biology Education students at UAD. The study was conducted from December 2024 to January 2025.Research variables were measured using a Likert scale, along with binary yes/no options to assess respondents' agreement with various statements, as well as several open-ended questions. The results of the study showed that 58.6% considered plant morphology to be very important and 40.6% considered it important. However, students still find difficulties in learning plant morphology, particularly in the topics of flower parts, floral formulas, and floral diagrams (55.5%). The study found that students prefer environmental learning resources to better master the material. Practical and observational methods were selected by 84% of students as preferred learning. Furthermore, 90% of students emphasized the importance of outdoor learning experiences due to direct involvement with nature, and 86% expressed willingness to participate. Thus, it can be concluded that a learning model incorporating outdoor experiences is needed for plant morphology courses

Introduction

A critical step in developing a learning model is analysing student needs regarding the model, methods, and learning media they prefer. This stage is crucial as it identifies the issues and characteristics of plant morphology learning, such as students'

perceived importance of the subject and their preferred learning strategies. Understanding these aspects can help in designing innovative learning models that align with course objectives.

Plant morphology is fundamental in biological education and scientific research as it provides a strong foundation for understanding plant structure, form, and function. Using appropriate textbooks in this course enhances students' ability to identify plant species, as well-developed and validated textbooks have proven effective in improving identification skills (Liunokas & Billik, 2021). Additionally, implementing contextual-based learning can increase the interest of prospective biology teachers while strengthening their understanding of plant morphology concepts (Yulinda & Ilma, 2018).

Modern plant morphology is no longer limited to descriptive observation but also incorporates mathematical approaches to describe plant forms and architecture. This approach is essential for enhancing agricultural productivity and monitoring ecosystems with more efficient use of natural resources (Bucksch et al., 2017; Balduzzi et al., 2017). Concepts such as continuous morphology and process morphology offer a more inclusive perspective on plant form diversity compared to classical approaches, thereby inspiring further research in plant morphology and evolutionary development (Sattler & Rutishauser, 2023).

Despite its significance, plant morphology teaching often remains theoretical and lacks student engagement. Challenges in teaching this subject include traditional teaching methods and inadequate resources. Many students struggle with limited plant specimens for practical sessions, as well as inconsistencies between textbook illustrations and actual plants in their environment (Agustina & Mas'ud, 2022). Furthermore, inadequate laboratory facilities hinder optimal practical education (Kováčik & Vydra, 2023). The traditional teacher-cantered approach and lack of scientific inquiry in practical guides make learning less engaging and ineffective in developing students' scientific process skills (Fauziah et al., 2024a).

Additionally, effective visual reading strategies are not widely implemented, leading to poor student comprehension of plant morphology diagrams (Azmi et al., 2020). The use of educational applications based on information and communication technology (ICT) has potential to enhance student understanding, although its implementation remains limited (Bezerra-Silva et al., 2022). Low student motivation is often influenced by teaching methods that do not actively involve them. To align with professional development goals within independent campus learning, developing better teaching materials is essential (Fauziah et al., 2024b).

Thus, the effectiveness of plant morphology learning methods remains limited. Many students find lecture-based learning unengaging and difficult to grasp without sufficient practical experience. Therefore, a survey was conducted to understand student needs, explore learning methods, and identify requirements for more effective teaching approaches.

This preliminary study aims to identify student needs in learning plant morphology through a questionnaire-based survey. By understanding students' difficulties and preferences for an ideal learning model, this study provides a foundation for designing more innovative and effective teaching strategies. A well-developed learning model will not only enhance conceptual understanding but also boost student interest and motivation in studying plant morphology. Similar preliminary studies have been conducted (Fauziah et al., 2024b) to develop plant morphology practical guides.

The survey results provide a clear picture of student learning obstacles and preferred learning models. Thus, this research contributes to the development of more adaptive and relevant learning strategies. Based on this preliminary study,

further research is expected to develop and test innovative learning models, including blended learning, interactive digital media, and experience-based learning strategies. The findings also serve as an evaluation resource for lecturers and curriculum developers in designing more effective teaching methods, ensuring students gain a deeper understanding of plant morphology and its applications.

Method

This study employs a survey method to collect data on the challenges students face after taking a plant morphology course. The survey gathers information on student opinions, understanding, difficulties, and attitudes through a questionnaire. This preliminary study helps identify student needs in various aspects of plant morphology learning, serving as an initial data collection process for the development of a more innovative learning model for future plant morphology education. The study was conducted from December 2024 to January 2025.

Participants/Sample Selection

The sampling process used purposive sampling, where respondents were selected based on specific criteria. The criteria included students who had completed the plant morphology course and were still enrolled as active students, verified through their student ID numbers. The total number of respondents was 128 students, consisting of 42.2% Biology Education students and 57.8% Biology students, ensuring a representative dataset.

Data Collection Method

Data were collected using a Google Form-based questionnaire, which consisted of several sections: Demographic Data – This section gathered information such as students' study programs, academic semesters, and academic experiences related to plant morphology. Learning Challenges – This section contained questions about the difficulties students encountered, including concept comprehension, challenging plant morphology topics, limited learning resources, and the effectiveness of teaching methods used by lecturers. Learning Model Preferences – This section identified students' preferred learning models, methods, and instructional media, such as the use of digital technology, experience-based learning, and outdoor learning approaches.

The study variables were measured using a Likert scale, where questionnaire items were rated on a scale from 1 to 4 or higher. Additionally, binary yes/no questions were used to assess students' agreement with specific statements. The questionnaire also included several open-ended questions, allowing students to provide more detailed insights into their experiences and expectations regarding plant morphology learning.

Data Analysis

The collected data were analysed quantitatively using descriptive statistics, including percentages and averages. Meanwhile, data from the open-ended questions were also analyzed descriptively to identify general patterns in student answers. This analysis aimed to identify general patterns in student responses, enabling conclusions about areas requiring improvement in plant morphology education.

The results were then interpreted to provide recommendations for developing a more effective learning model that aligns with student needs. Through this method, the study aims to offer clear insights into the challenges and preferences of students in plant morphology learning, serving as a foundation for designing more innovative and efficient learning strategies.

Results and Discussion

Plant Morphology is a fundamental discipline for students studying plant diversity, systematics and taxonomy, plant anatomy, and applied sciences such as forestry, agriculture, and pharmaceutical

biology. Sattler & Rutishauser (2023) state that morphological concepts are utilized in plant evolutionary developmental biology (evo-devo) and other botanical disciplines, making plant morphology relevant across these fields. Many plant biologists still rely on classical morphology, which posits that vascular plants, including flowering plants, have only three mutually exclusive organ categories: roots, stems, and leaves. In biological studies, plant morphology is considered essential for the advancement of other scientific disciplines. This is supported by a survey of biology and biology education students, where 58.6% deemed this subject very important, 40.6% considered it important, and only 1% found plant morphology less important. Notably, no students considered it unimportant.

Challenges in Learning Plant Morphology

The challenges faced when studying plant morphology are illustrated in the figure below.

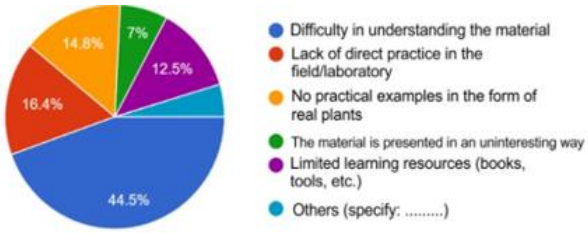

Figure 1. Challenges in Learning Plant Morphology

According to the diagram, the primary challenge in learning plant morphology is the difficulty in understanding the material (44.5%). This indicates that many students struggle with complex morphological concepts, including scientific terminology, plant structures, and distinguishing characteristics between species. These difficulties may arise due to a lack of interactive teaching methods and limited visual references that facilitate student comprehension.

Additionally, the lack of hands-on field/laboratory practice (16.4%) is the second most significant obstacle. Plant morphology requires direct observation to understand the form, structure, and function of plant organs. Limited laboratory facilities or insufficient opportunities for field practice hinder students' understanding, aligning with Garcia et al. (2022), who found that science students struggle with learning without laboratory activities.

Another contributing factor is the absence of practical examples using real plants (14.8%). The lack of tangible plant specimens makes it difficult for students to connect theoretical concepts with real-world applications. Furthermore, limited learning resources (12.5%) pose a challenge. The scarcity of reference books, visual aids such as microscopes or digital applications, and restricted internet access hinder students' comprehension of plant morphology. Studies suggest that enhancing learning resources through innovations such as encyclopaedias (Putri & Agustin, 2023), contextual-based textbooks (Yelianti et al., 2021), and e-Plant Book applications (Maghfiroh et al., 2023) can improve learning outcomes. Moreover, environmental-based learning resources are crucial, as students benefit from direct experiences with living plants. This approach helps address the issue of unengaging materials, which was identified as a challenge by 7% of students.

Frequency of Difficulties in Learning Plant Morphology

The frequency at which students experience difficulties in plant morphology is shown in the figure below.

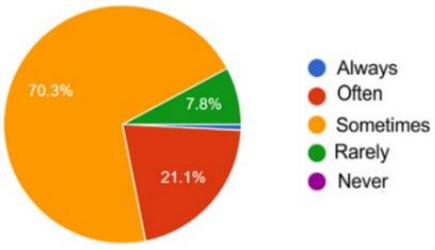

Figure 2. Frequency of Difficulties in Learning Plant Morphology

According to the diagram, 70.3% of students reported occasionally facing difficulties in understanding plant morphology, while 21.1% stated they

frequently experienced difficulties. Only 7.8% indicated rare difficulties, and no students selected "always" or "never" as responses. As a solution, making lessons more engaging and consistent through practical sessions can significantly improve understanding. Agustina & Rahmat (2019) found that laboratory practical helped 91% of students become familiar with plants and specimens used in lessons. The use of digital technology, such as augmented reality (AR), can also make plant morphology learning more interactive and realistic by allowing students to interact with 3D plant models (Lismaya et al., 2024). Additionally, outdoor learning in campus gardens could provide students with deeper insights into plant morphology through direct observation and analysis.

Topics Considered Difficult

The most challenging topics in plant morphology are illustrated in the figure below.

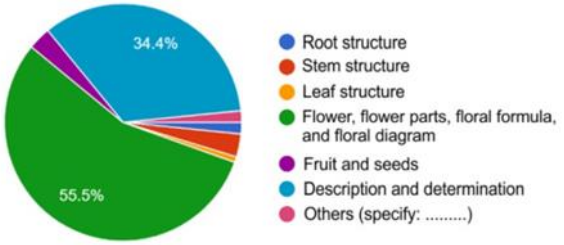

Figure 3. Topics in Plant Morphology Considered Difficult by Students

The most challenging topic, as indicated in the figure, is "Flowers, flower parts, formulas, and diagrams," which was difficult for 55.5% of students. This suggests that understanding floral structures, symbolic representations in flower formulas, and diagrammatic presentation remains a challenge. The complexity of flower parts, their varied structures, and the necessity of understanding specialized symbols contribute to these difficulties. Similar findings were reported by Gh & Anugra (2023), where 66.7% of Biology students at Universitas Negeri Makassar struggled with floral morphology.

Plant description and determination (34.4%) was another challenging topic. The difficulty in plant determination arises from the extensive use of scientific terminology, the complexity of recognizing specific morphological traits, and the precision required in using identification keys. This topic encompasses all aspects of plant morphology, from leaves to flowers, fruits, and seeds, making it particularly difficult for students who have not yet mastered foundational concepts. Even a single misinterpretation can lead to incorrect plant identification and determination. Learning difficulties are influenced by both internal and external factors and can be identified through signs such as challenges in reading, writing, and calculating (Habsy et al., 2023). Furthermore, motivation and teacher quality also play significant roles in student learning outcomes (Rambe, 2024).

Meanwhile, topics such as leaf structure were found to be the least difficult, with only one student selecting it as a challenging topic. This suggests that leaf morphology is the most easily understood concept among plant morphology topics. An essential strategy for learning plant morphology includes careful observation of plant forms, understanding and memorizing concepts, rereading material, and using annotations or markers in texts, as these factors significantly enhance comprehension (Azmi et al., 2020).

Suitable Learning Resources for Plant Morphology

The most effective learning resources for plant morphology are illustrated in the figure below.

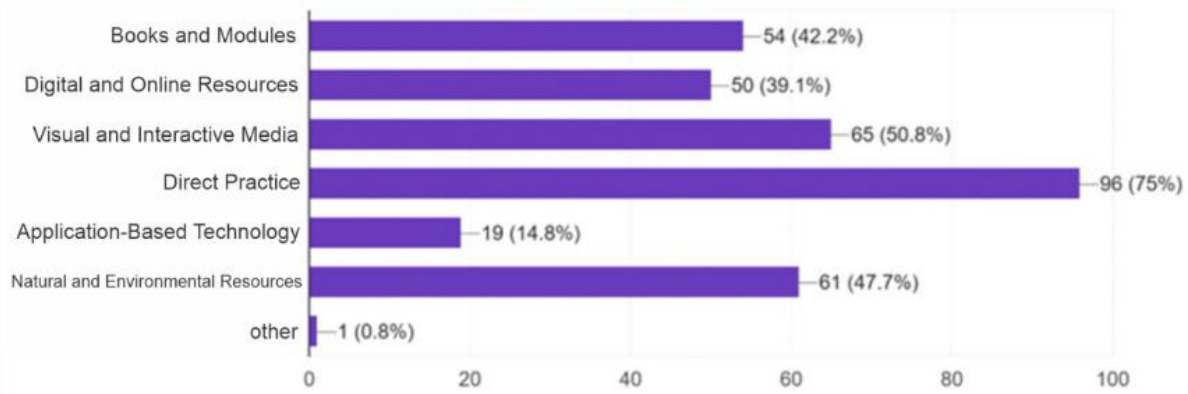

Figure 4. Suitable Learning Resources for Plant Morphology

According to the graph, the most effective learning resource is hands-on practice, chosen by 95 out of 128 respondents (75%). This finding indicates that students find it easier to understand plant morphology when they can observe, touch, and directly examine plant structures in the field or laboratory. Additionally, visual and interactive media were preferred by 50.8% of respondents, followed by natural sources and the surrounding environment (47.7%). This highlights that students grasp concepts better when presented with visual, tangible, and experiential learning approaches. Meanwhile, printed books and modules (42.2%) and digital/online resources (39.1%) remain widely used, though they are perceived as less effective compared to practical methods.

Suitable Learning Media for Studying Plant Morphology

The most suitable learning media for studying plant morphology are shown in the figure below.

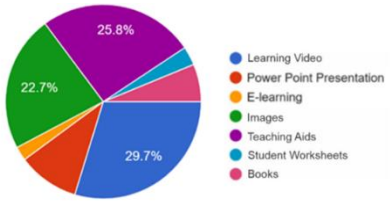

Figure 5. Suitable Learning Media for Studying Plant Morphology

According to the diagram, learning videos (29.7%) and teaching aids (25.8%) are the two most preferred media for effectively understanding plant morphology. Images also hold a significant percentage (22.7%), indicating that visual media plays a crucial role in facilitating comprehension. Meanwhile, media such as Power Point presentations, e-learning, student worksheets, and books have lower percentages, suggesting that text-based and theoretical approaches are less favoured compared to more interactive and visual methods. These findings align with research by Masing et al. (2024), which states that the learning media commonly used in plant morphology education include printed media, audio media, and audiovisual media.

Student Worksheets (LKM)

Student worksheets (LKM) can be utilized during plant morphology practical sessions. 77.3% of students have used student worksheets, while 22.7% have not, mainly because some programs do not offer a plant morphology laboratory course. The LKM includes theoretical explanations, step-by-step practical instructions, observation result sections, and evaluation questions. When asked what activities should be included in the student worksheets, respondents provided the following answers:

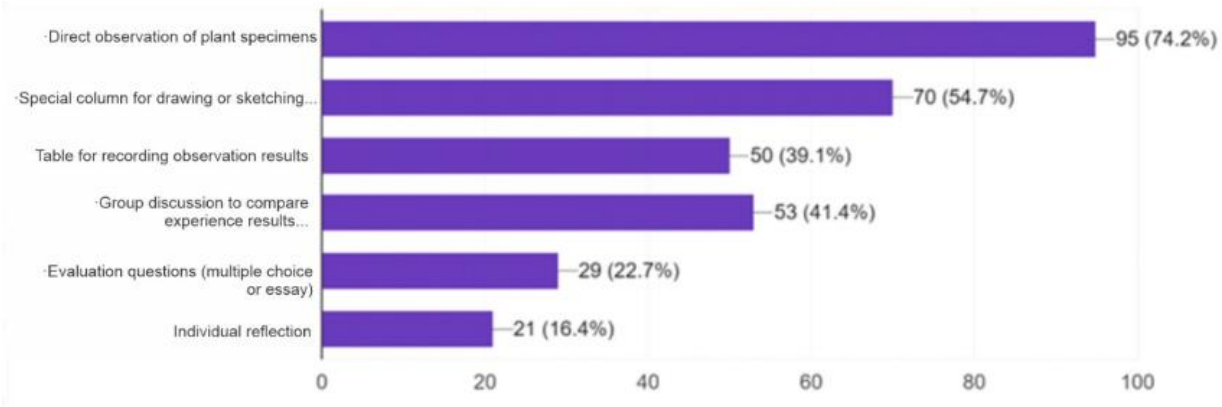

Figure 6. Activities Included in Student Worksheets for Plant Morphology

According to the survey results displayed in the diagram, 74.2% of respondents believe that direct observation of plant specimens should be a mandatory activity in student worksheets (LKM). This indicates that students prefer a hands-on learning experience, allowing them to explore plant morphology through direct empirical observation. Observing specimens firsthand enhances their understanding of plant structures.

The function of the practical guide is to direct students or practitioners in carrying out practical activities such as what steps or work procedures must be carried out in a practical topic or material (Agustina, 2016). The use of student activity sheets (LKM) is considered effective in engaging students and improving learning outcomes. Sartika (2022) found that the observation method using word-square LKS was effective in teaching biological classification and improving student learning outcomes. Additionally, Maryati et al. (2018) found that LKS describing the morphological diversity of five mango (*Mangifera indica*) varieties was deemed valid and of high quality, as it contained detailed plant morphology characteristics. Another study by Tamara et al. (2022) highlights that LKPd (Student Activity Sheets) help students document and analyse plant morphology characteristics effectively.

Furthermore, 54.7% of students emphasized the importance of sketching plant parts in student worksheets. Drawing helps students identify detailed morphological features more accurately and improves memory retention. Studies suggest that image-based and sketch-based learning methods significantly enhance students' comprehension and retention of plant morphology concepts.

Other important elements in the LKM include observation result tables (39.1%) and group discussions for comparing observations (41.4%). Tables allow students to systematically organize observation data, while group discussions facilitate deeper understanding through perspective sharing and result verification. Observation-based discussions have been proven to enhance critical thinking and problem-solving skills in science education. Additional activities, such as evaluation questions (22.7%) and individual reflections (16.4%), received lower preferences but still play essential roles in reinforcing understanding. Evaluation questions assess students' individual comprehension, while self-reflection helps improve metacognitive awareness of their learning processes.

Effective Teaching Methods for Plant Morphology

The most suitable and effective teaching methods for understanding plant morphology are shown in the figure below.

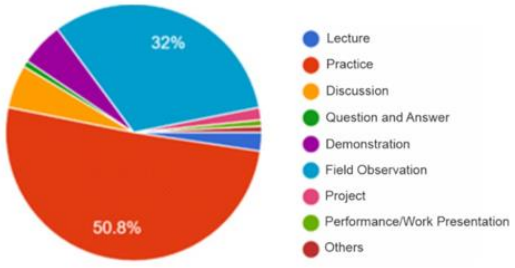

Figure 7. Teaching Methods for Plant Morphology

According to the survey results, practice or practical activities (50.8%) and field observations (32%) are the most preferred teaching methods for learning plant morphology. This suggests that hands-on laboratory experiments and field observations are the dominant methods. These results align with the characteristics of plant morphology, which require real-world observation of plant structures to understand their form, function, and variations in depth.

Other methods, such as discussions, lectures, demonstrations, projects, Q&A sessions, and performance assessments, had lower responses. However, demonstrations and project-based learning remain relevant as they provide direct experiences and a deeper understanding of plant structures and functions. These findings align with Zulfriman et al. (2024), who stated that outdoor learning is both an effective and enjoyable method. The study recommended outdoor learning as an alternative teaching strategy to optimize students' learning processes and outcomes.

When analysing student satisfaction with plant morphology learning without using practical and field observation methods, only 9.4% of students reported being "Very Satisfied", indicating that a small proportion found traditional teaching methods effective. However, 3.8% of students felt dissatisfied, suggesting that learning methods should be further tailored to student preferences, such as: Increasing classroom interactivity, implementing experience-based learning (practical sessions and field observations), Using learning models emphasizing direct experience, Providing more opportunities for discussion and independent exploration

Challenges Related To 21st-Century Learning

The main challenges students face in learning plant morphology concerning 21st-century competencies are illustrated in the figure below.

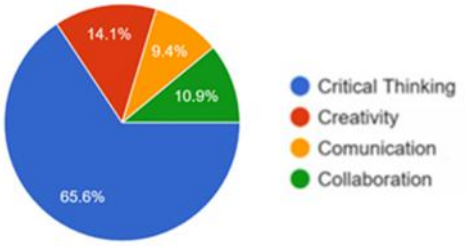

Figure 8. Challenges in 21st-Century Learning for Plant Morphology

According to the diagram, the primary challenge is critical thinking (65.6%). This suggests that most students struggle with analyzing, evaluating, and interpreting information related to plant morphology concepts in depth. To improve critical thinking skills in plant morphology, learning methods that involve interpretation, analysis, inference, and explanation should be implemented, such as LKPD-based learning (Kustiani et al., 2020).

Additionally, creativity (14.1%) was also a significant challenge. This may be linked to students' limited ability to develop innovative approaches in understanding and applying plant morphology concepts. STEM-based LKPD (Agustina et al., 2021) could help overcome this issue. Meanwhile, communication (9.4%) and collaboration (10.9%) had lower percentages, indicating that while some difficulties exist in group discussions or teamwork, the primary issue remains critical thinking.

The lack of critical thinking skills in plant morphology learning may stem from several factors, such as: Lecture-based teaching that emphasizes memorization over analysis, Limited field experience, Minimal integration of digital technology in learning. Implementing visual and contextual learning media can help students better understand plant morphology concepts. Learning models with step-by-step instructional methods and experience-based learning conducted outside the classroom can

encourage students to think more critically (Lismaya & Widiantie, 2017).

Outdoor Learning Model

The survey results indicate that 60.2% of the 128 Biology and Biology Education students at UAD have never participated in outdoor learning activities. However, 86% of students expressed willingness to engage in outdoor learning, showing that students are highly interested in conducting real-world plant morphology observations.

When asked about the importance of outdoor learning experiences in understanding plant morphology, the responses were as follows:

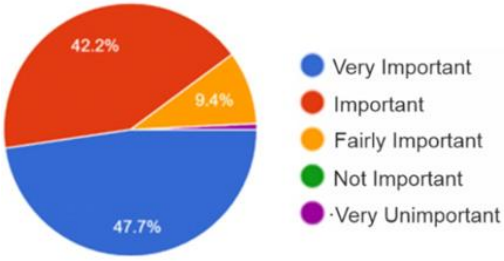

Figure 9. Survey on the Importance of Outdoor Learning in Plant Morphology

Based on the questionnaire results shown in the diagram, most students consider outdoor learning experiences to be very important in understanding plant morphology material. The survey results show that 47.7% of students rated outdoor learning as "Very Important" and 42.2% rated it as "Important", meaning that over 89% of students consider direct field experiences essential. Only 9.4% rated it as "fairly Important", while no students considered it "not important" and “very unimportant”. Outdoor learning enhances plant morphology comprehension by providing direct observations of plant structures in their natural habitats. Studies show that meaningful learning experiences occur through direct interaction with learning objects, improving concept retention (Zulfriman et al., 2024). Thus, the results of this questionnaire confirm that experiential outdoor learning is a very important need in understanding plant morphology, so that more active learning models based on real observations need to be applied more widely in the curriculum.

Some things that students find interesting regarding outdoor learning the responses are as follows:

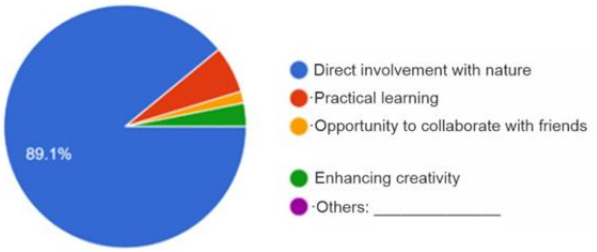

Figure 10. Questionnaire Results Regarding Interesting Points of Outdoor Learning in Plant Morphology

Based on the questionnaire results shown in the diagram, the most interesting aspect for students in the outdoor learning model is direct involvement with nature, with a percentage of 89.1%. Showing that most students are interested in learning through direct interaction with the natural environment, which allows them to observe and understand the object of study in real terms.

In addition, although in smaller proportions, some students also value other aspects of outdoor learning, such as practical learning, opportunities to collaborate with friends, and increased creativity. Practical learning allows students to apply theories learned in class in real contexts, while collaboration with friends can improve communication and collaboration skills. Increased creativity is also an added value, as students are encouraged to think innovatively in solving problems faced in the field. Rose et al., (2024), explained that the importance of innovative biology learning lies not only in increasing conceptual understanding, but also in developing students' skills in critical, creative, and collaborative thinking.

Several studies have been conducted related to outdoor learning, including the benefits of outdoor learning for significant health and well-being, improving mental health, well-being, and increasing physical activity (Mann et al., 2021), improving

breathing, memory and developing skills (Chrysomalidou et al., 2024). Overall, these findings confirm that outdoor learning is highly relevant and preferred by students in plant morphology education. Integrating this method into the curriculum can enhance engagement, understanding, and skill development.

Student input on experiential outdoor learning

In this preliminary study, students gave impressions and input on learning outside the classroom or room, including that learning outside the classroom is very exciting, because students can study plants directly, hold, and see directly, making it easier for students to observe plants. The experience of learning outside the classroom (Experiential Outdoor Learning), especially on plant morphology material, needs to be applied in the learning process, because direct observation in nature/the surrounding environment will increase students' understanding of the theory given by the lecturer and provide a different learning atmosphere, not only in the classroom, so it is very good to help the process of understanding plant parts directly (not through pictures).

Learning can be made as interesting as possible, and packaged in such a way as to attract students' interest Made more fun and not tense. Learning outside the classroom is very important in plant morphology material, because many students do not understand and are less focused if it is only explained with presentations in class using ppt. Learning outside the classroom can be used as a solution to solve a problem if the morphology material discussed is too difficult for students to understand, for example material on flower structure, description and determination. Activities outside the classroom can be fun, learning becomes more varied, especially if there is a reflection session after outdoor activities. Learning outside the classroom is expected to continue to implement explanations from lecturers first, then students can observe directly related to the material presented.

Conclusion

The analysis of the Student Needs Survey on Plant Morphology Learning indicates that 99% of students consider plant morphology an important course. However, students still face difficulties in learning plant morphology, particularly in the topics of flower parts, floral formulas, and floral diagrams (55.5%). Students prefer environment-based learning resources to enhance their understanding of the material. Practical sessions and observations were chosen by 84% of students as the most effective methods for plant morphology learning. Additionally, 90% of students emphasized the importance of outdoor learning experiences due to direct engagement with nature, and 86% expressed their willingness to participate in outdoor learning activities. Based on these findings, it can be concluded that a learning model incorporating outdoor experiences is needed for the plant morphology course to enhance student understanding and engagement.

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