Uncovering Botanical Literacy Profiles in Higher Education: Cognitive, Affective, and Psychomotor Domains

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Abstract

This study aims to examine differences in botanical literacy levels between male and female students, as well as changes in literacy before and after participating in a botany course. Botanical literacy was assessed across three domains: cognitive (knowledge), affective (appreciation), and psychomotor (skills). Data were collected through online questionnaires and tests measuring the three literacy domains. Descriptive statistics were used to compare results by gender and before and after the botany course. Gender-based analysis revealed that female students scored higher in the cognitive domain, while male students outperformed females in psychomotor skills. Comparisons of literacy scores before and after the botany course showed relatively stable results across all domains, with no statistically significant differences. However, a positive trend was observed, indicating the program's beneficial impact on students' botanical literacy. These findings highlight the importance of learning approaches that consider gender differences and emphasize hands-on activities to improve comprehensive botanical literacy.

Keywords: botanical literacy; gender differences; learning outcomes; three domains

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INTRODUCTION

Botanical literacy is a crucial aspect of understanding plant diversity and its applications in various fields of life (Sari et al., 2023). A strong grasp of botanical literacy can foster a more scientifically informed society that appreciates the importance of plants in ecosystems and daily life (Stocum, 2015; Uno, 2009). Botanical literacy encompasses not only knowledge of various plant types but also curiosity and the ability to identify and comprehend the role of plants in the surrounding environment, including local flora (Beasley et al., 2021).

Direct experience in studying and interacting with plants can strengthen botanical literacy and mitigate the phenomenon of 'plant blindness' or insensitivity to the presence of plants (Wells et al., 2021). This phenomenon is then known as Plant Awareness Disparity (PAD), which refers to the tendency of individuals to overlook or be unaware of the existence and importance of plants in life (Marcos-Walias et al., 2023). Plant blindness refers to people's tendency to ignore and undervalue plants in their environment, which can negatively impact both the environment and human well-being (Bobo-Pinilla et al., 2024). This botanical illiteracy is often caused by a lack of interest, limited exposure to plant science, and minimal direct experience in learning about plants (Uno, 2009).

Knowledge gaps concerning plants are observed across various community groups, underscoring the necessity for enhanced botanical education to address Plant Awareness Disparity (PAD) more broadly (Linderwell et al., 2024). One factor that contributes to disparities in botanical literacy is gender. According to da Silva Ribeiro Gomes et al. (2024), there are differences between males and females in their knowledge of medicinal plant species, with each gender possessing a distinct composition of knowledge. This disparity reflects the heterogeneity of knowledge and the unique roles played by males and females within local medicinal systems. For instance, women tend to be more involved in the collection and utilization of local food plants for household consumption, while men play a greater role in the commercialization aspects of plants (Nunes et al., 2018).

In the context of higher education, strengthening botanical literacy is crucial for producing graduates who possess a deep understanding of biodiversity, especially in Indonesia, which is rich in local flora. Botanical literacy not only plays a role in raising awareness about the importance of plants in life but also serves as a key to addressing global challenges such as food security and environmental sustainability. Trinder et al. (2025) emphasize the need for new, more structured and transparent approaches in botanical teaching in higher education so that graduates possess skills relevant to future needs. Nevertheless, to date, studies on the botanical literacy profiles of university students, particularly those considering gender factors and changes in abilities before and after participating in botanical courses, remain limited and require further attention in botanical education research. In line with Peter Batke et al. (2020), there is still a lack of detailed quantitative data to determine the exact causes of this trend.

The urgency of this research lies in the importance of understanding how educational programs, particularly botany courses, influence the enhancement of students' botanical literacy. Courses that involve numerous practical activities and field excursions require special attention so that students can still achieve the planned learning outcomes (Auffret et al., 2022). Although botanical literacy has received increasing attention in science and biology education, empirical studies examining changes in students' botanical literacy before and after participation in university botany courses remain limited. Existing studies have predominantly focused on measuring students' botanical knowledge, plant identification skills, or attitudes toward plants at a single point in time rather than evaluating learning gains resulting from formal botanical instruction (Parsley et al., 2022; Uno & Bybee, 1994). Consequently, evidence regarding the effectiveness of botany courses in improving students' botanical literacy is still insufficient, particularly in the context of Indonesian higher education.

Another important research gap concerns gender differences in botanical literacy. Previous educational studies have suggested that gender may influence learning experiences, environmental attitudes, and science-related competencies; however, investigations specifically addressing gender-based differences in botanical literacy remain scarce. As a result, little is known about whether male and female students benefit equally from botany education and whether instructional interventions contribute similarly to the development of botanical literacy across gender groups (Zelezny et al., 2000).

Furthermore, the concept of Plant Awareness Disparity (PAD), formerly known as plant blindness, has gained increasing attention because it describes the tendency of individuals to overlook plants in their surroundings and underestimate their ecological

importance (Parsley, 2020; Parsley et al., 2022). While PAD has recently been investigated among Indonesian preservice biology teachers and was found to be associated with plant identification ability, research integrating PAD with broader dimensions of botanical literacy remains very limited (Putra, Diana Hernawati, et al., 2025). Moreover, no previous study has examined changes in botanical literacy and potential gender differences following participation in a university botany course while simultaneously considering the implications of PAD in the Indonesian higher education context.

Therefore, this study aims to evaluate changes in botanical literacy among Indonesian university students following participation in a botany course, investigate potential gender differences in botanical literacy outcomes, and provide empirical evidence that contributes to understanding botanical literacy development in relation to Plant Awareness Disparity. The findings are expected to support the development of more effective botanical learning strategies, inform curriculum improvement, and contribute to efforts to reduce Plant Awareness Disparity among university students.

METHODS

This study is a descriptive survey research with a cross-sectional approach, aiming to explore the botanical literacy profiles of university students in Indonesia. The research sample consisted of 382 students from various universities across Indonesia, selected using an accidental sampling technique. The research instruments were questionnaires and multiple-choice tests designed to measure three main domains of botanical literacy according to Arif et al. (2025): the cognitive aspect, which includes knowledge of plant biology, plant diversity and classification, and plant ecology and its relationship with the environment; the affective aspect, which involves appreciation for plants and nature, environmental concern and plant conservation, and motivation to engage in sustainable practices; while the psychomotor aspect encompasses plant identification skills and gardening and cultivation skills.

The instruments were distributed online via Google Forms between January 6 and January 17, 2025. The cognitive domain consisted of 35 multiple-choice questions designed to assess three key aspects: Plant Biology Knowledge, Plant Diversity and Classification, and Plant Ecology and Its Environmental Relationships.

The affective domain was measured using a questionnaire comprising 20 statements that evaluated students' appreciation of plants and nature, environmental concern and plant conservation, as well as motivation to engage in sustainable practices. Similarly, the psychomotor domain was assessed using another set of 20 statements aimed at measuring plant identification skills and competencies in gardening and cultivation.

The collected data were analyzed using descriptive statistics by calculating the average scores for each domain and examining the distribution of botanical literacy categories among students. These categories were determined based on students' botanical literacy profiles in Indonesia, differentiated by gender as well as by conditions before and after taking botany-related courses. The classification of botanical literacy levels refers to the science literacy categories presented in Table 1.

Table 1. Categories of Botanical Literacy

No	Score Interval	Category
1	81-100	Very high
2	61-80	High
3	41-60	Medium
4	21-40	Low
5	0-20	Very Low

Source: (Jufrida et al., 2019)

RESULTS AND DISCUSSION

The results of the descriptive analysis indicate that the average levels of botanical literacy across the cognitive, affective, and psychomotor domains varied in terms of achievement levels. In the cognitive domain, the mean score was 46.403, which falls within the moderate category. The affective domain showed a similar trend, with a mean score of 41.866, also classified as moderate. In contrast, the psychomotor domain recorded the highest average score of 74.487, placing it in the high category. These findings suggest that the psychomotor aspects of botanical literacy are more developed compared to the cognitive and affective components (Figure 1).

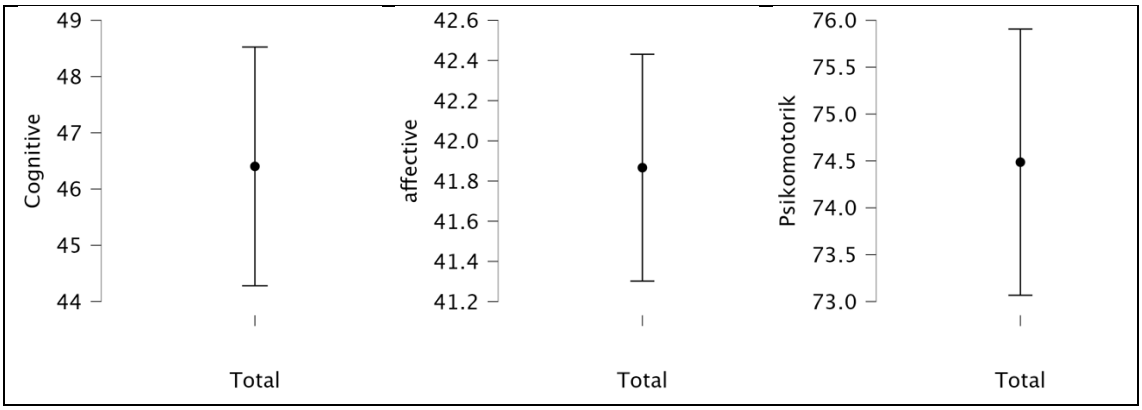


Figure 1. Intervals Plot

Gender

Based on the results of the descriptive analysis by gender, it was found that male students had a lower average cognitive score of 40.018 compared to female students, who scored an average of 47.523. In the affective domain, male students had an average score of 41.982, while female students scored 41.846, indicating relatively similar results. In contrast, in the psychomotor domain, male students achieved a higher average score of 78.772 compared to 73.735 for female students. These findings suggest that male students tend to have higher psychomotor abilities than their female counterparts (Figure 2).

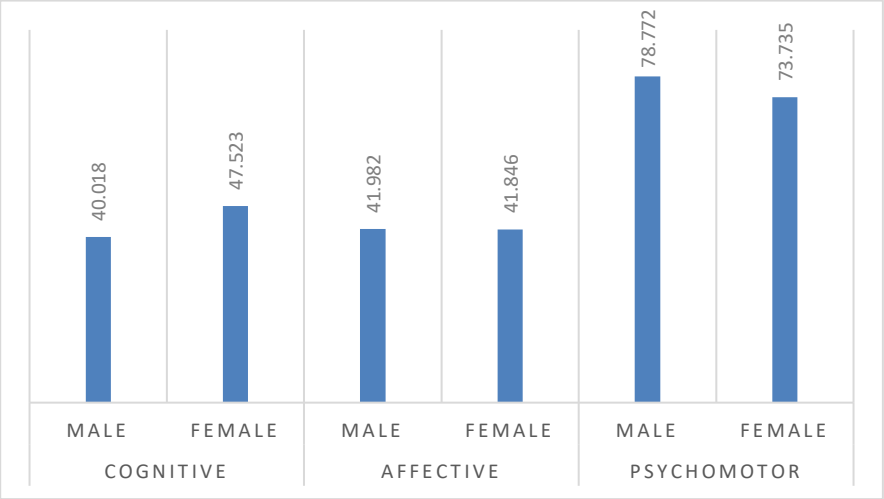


Figure 2. Botanical Literacy by Gender

Based on the results of the descriptive analysis, there are differences in students' botanical literacy abilities by gender across the three domains: cognitive, affective, and psychomotor.

In the cognitive domain, the average score of male students was 40.018, which was lower than that of female students, who achieved an average score of 47.523. This result indicates that female students tend to have a better cognitive understanding of botanical literacy compared to their male counterparts. This difference aligns with the findings of da Silva Ribeiro Gomes et al. (2024), who reported that women exhibit greater engagement with plant-related knowledge, particularly in the areas of collecting and utilizing local plant species. Additionally, factors such as interest and learning motivation may also influence cognitive knowledge acquisition, with female students generally showing a stronger inclination toward ecological and environmental conservation issues (Nunes et al., 2018).

In the affective domain, the results showed nearly identical average scores between male and female students, at 41.982 and 41.846 respectively. This indicates that both male and female students exhibit a similar level of emotional engagement, concern, and interest in botanical literacy. Such similarity may be attributed to the influence of educational programs delivered uniformly to all students, shaping relatively consistent perspectives and attitudes toward the importance of plants in life. This finding is consistent with the perspective of Beasley et al. (2021), who stated that uniform educational experiences can foster a shared sense of curiosity and concern for local flora among learners.

In the psychomotor domain, the average score of male students was 78.772, which was higher than that of female students, who scored an average of 73.735. This difference indicates that male students tend to possess better practical skills in direct interaction with plants. This may be influenced by gender roles in daily activities, where males are more frequently involved in practical or physical tasks, including those related to the commercialization of plants (Nunes et al., 2018). Furthermore, differences in preferences for outdoor activities may also influence psychomotor skills. Another perspective is offered by Lestari et al. (2025), who argue that perceptions of the ability to access, evaluate, and use information are also shaped by social constructs and differing learning experiences between genders. Therefore, learning strategies that take gender aspects into account are

essential to create an equitable learning environment and support the enhancement of information literacy and reflective thinking skills for all students..

The findings of this study emphasize the importance of educational approaches that consider gender differences in the development of botanical literacy. Adaptive and responsive education tailored to gender characteristics can help enhance botanical literacy comprehensively. Lampert et al. (2019) highlight the need for optimal plant biology teaching to address the phenomenon of "plant blindness" and the low interest of students in botany. Moreover, efforts to increase direct experiences for all students, both male and female, can serve as an effective strategy to reduce gaps in psychomotor skills while simultaneously raising awareness and concern about the vital role of plants in ecosystems (Wells et al., 2021).

Consistent with the findings of Grier (1919), who tested 183 students, gender differences were observed, with female students demonstrating a slight advantage in mastering information related to natural studies compared to male students. This finding indicates a potential difference in perception or learning approaches between males and females in understanding botanical material. Therefore, it is important to consider gender aspects in curriculum planning and development, particularly by strengthening the foundational botanical content within natural studies to ensure a more inclusive and effective learning approach for all students.

Before and After the Botany Course Program

Based on the results of the descriptive analysis conducted before and after the implementation of the Botany course program, the average botanical literacy scores in the cognitive domain were 45.440 before the program and 47.386 after the program, both falling within the moderate category. In the affective domain, the average scores were 41.806 before and 41.929 after the program, also classified as moderate and showing nearly identical results. Meanwhile, in the psychomotor domain, the average scores were 74.130 before and 74.852 after the program, both within the high category and indicating relatively stable outcomes. Overall, these results suggest that botanical literacy abilities across the cognitive, affective, and psychomotor domains remained relatively stable before and after the program (Figure 3).

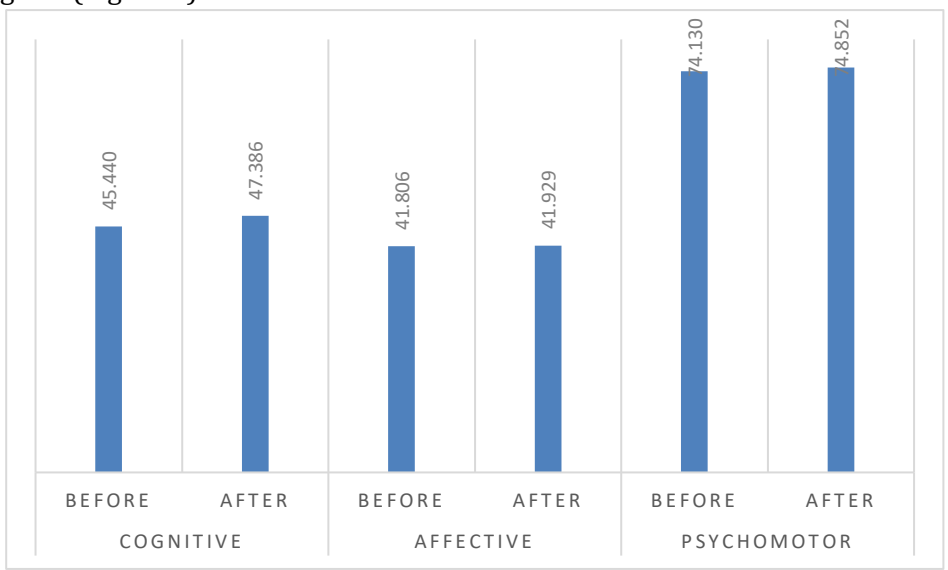


Figure 3. Botanical Literacy Before and After the Program

Based on the results of the descriptive analysis of botanical literacy abilities before and after the implementation of the Botany course program, findings revealed variations across the three literacy domains: cognitive, affective, and psychomotor.

In the cognitive domain, the average student score was 45.440 before the program and 47.386 after the program, although both scores still fall within the moderate category. These results illustrate the profile of students' cognitive abilities in understanding botanical concepts before and after participating in the course program. This aligns with Stocum (2015) research, which states that well-designed educational programs can facilitate students' cognitive comprehension of scientific concepts, including in the field of botany. Additionally, Uno (2009) emphasizes that exposure to relevant and contextualized material in learning can lead to better understanding.

In the affective domain, the average score before the program was 41.806 and after the program was 41.929, showing nearly identical results that remain within the moderate category. These findings indicate that students' attitudes or concern toward plants tend to be stable before and after the program. Beasley et al., (2021) emphasize that direct experience and intensive interaction with local flora are crucial for fostering curiosity and care for plants. Therefore, the lack of direct experience during the program may be one of the factors contributing to the stability of affective outcomes. According to Dünser et al., 2024), attitudes toward plants tend to be positive, even though interest remains relatively low. This is attributed to students' appreciation of the cultural ecosystem services and arrangements provided by plants. Thus, strengthening these attitudes can be pursued through integrating these two components into botany teaching to raise awareness of plants, broaden knowledge about their role in ecosystems and the global climate, and encourage acceptance of conservation efforts.

Meanwhile, in the psychomotor domain, the average scores were 74.130 before the program and 74.852 after the program, both falling within the high category. Although there is a slight difference in scores, these results reflect a relatively stable profile of students' psychomotor skills in practical interactions with plants before and after the program. Wells et al., (2021) state that continuous direct experience is crucial for strengthening psychomotor skills, and thus, programs designed with more intensive practical approaches have the potential to enhance these abilities. Consistent with Ward et al., 2014), through direct involvement in practical labs and authentic research, students are trained to conduct field observations, laboratory experiments, as well as systematic data collection and analysis. These activities require manual dexterity, procedural accuracy, and proficiency in using laboratory instruments, all of which are essential components of the psychomotor domain.

Overall, the results of this study revealed that students' botanical literacy improved following participation in the Botany course, although the magnitude of improvement varied across the cognitive, affective, and psychomotor domains. The findings also indicated differences in botanical literacy profiles between male and female students, suggesting that learning experiences may not contribute equally to botanical literacy development across gender groups. Furthermore, the results highlighted the persistence of several indicators associated with Plant Awareness Disparity (PAD), demonstrating that increased botanical knowledge does not automatically translate into greater awareness and appreciation of plants in everyday life.

These findings support previous studies emphasizing that botanical literacy extends beyond conceptual understanding and encompasses attitudes, awareness, and practical engagement with plants (Parsley et al., 2022; Uno, 2009). The observed improvements in students' botanical literacy following the Botany course are consistent with research demonstrating that direct experiences with plants, field-based activities, and authentic learning environments can strengthen students' understanding of plant diversity and ecological significance (Auffret et al., 2022; Marcos-Walias et al., 2023). However, the persistence of PAD-related tendencies suggests that traditional botany instruction may still be insufficient to fully address students' awareness of plants and their ecological roles.

Therefore, there is a need to develop learning approaches that not only improve botanical knowledge but also foster meaningful interactions with plants through more diverse practical, inquiry-based, and contextual learning experiences. The present findings indicate that strengthening field observations, plant identification activities, local biodiversity exploration, and community-based learning may contribute to the enhancement of all dimensions of botanical literacy. Integrating local plant resources and real-world environmental issues into botany instruction may further help students recognize the relevance of plants to ecological sustainability and human well-being (Marcos-Walias et al., 2023).

In addition, advances in digital learning technologies provide opportunities to enrich botanical learning experiences through virtual field trips, digital herbarium collections, plant identification applications, and interactive learning platforms. Such innovations can complement direct field experiences and increase students' engagement with plant-related content, thereby improving the quality and relevance of botany education in contemporary higher education settings (Li et al., 2024).

Thus, this study contributes to the growing body of knowledge on botanical literacy by providing empirical evidence of botanical literacy development following participation in a university Botany course. The findings offer important implications for curriculum design and instructional practices aimed at enhancing students' cognitive, affective, and psychomotor botanical literacy while simultaneously addressing challenges related to Plant Awareness Disparity in higher education.

CONCLUSION

The results indicate that Indonesian university students exhibited varying levels of botanical literacy across the cognitive, affective, and psychomotor domains. Overall, cognitive and affective literacy were categorized as moderate, while psychomotor literacy was high. Gender-based analysis showed that female students achieved higher cognitive literacy scores, whereas male students demonstrated stronger psychomotor literacy. Comparisons before and after participation in the Botany course revealed slight improvements across all domains, although these differences were not statistically significant. These findings suggest that botanical literacy development is influenced by both gender-related characteristics and learning experiences, highlighting the need for instructional approaches that balance conceptual understanding, positive attitudes toward plants, and practical engagement with plant-related activities.

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