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Unveiling the roots of botanical literacy: A systematic literature review on its concepts and domains

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Abstract

Botanical literacy is a solution to overcome plant blindness and increase plant awareness. It plays a role in improving the ability to understand plants from cognitive, attitudinal, and skill aspects. In the context of botany learning in higher education, botanical literacy focuses on cognitive aspects and involves attitudes and skills to build a holistic understanding. The preferred reporting items for systematic reviews and meta-analyses diagram was used in this systematic literature review to illustrate the inclusion and exclusion process of studies considered for inclusion in the systematic review with a total of 27 articles that provided a comprehensive explanation of the concept of botanical literacy and identified the dimensions of botanical literacy. In the cognitive domain, botanical literacy includes plant biological knowledge, plant diversity and classification, and plant ecology and its relations with the environment. In the attitude domain, the dimensions include appreciation for plants and nature, environmental concern, and plant conservation, and motivation to engage in sustainable practices. Meanwhile, the skills domain includes plant identification skills and gardening and cultivation skills. This study emphasizes the importance of botanical literacy in holistically supporting botanical learning in higher education. The implications of this study indicate the need for a deeper and more comprehensive understanding of botanical literacy, particularly in the context of education and ecological awareness in society.

Keywords: botanical literacy, dimensions of literacy, botany learning

INTRODUCTION

Botanical literacy is an individual's ability to understand, appreciate, and utilize plant knowledge daily. This literacy includes understanding plant diversity, ecological roles, cultural values, and economic benefits of plants and the ability to actively engage in environmental conservation and sustainability (Parsley et al., 2022). According to Uno and Bybee (1994), botanical literacy is part of biological literacy that includes asking questions about natural phenomena, thinking critically, evaluating scientific information, and making ethical decisions related to biological issues. Furthermore, Uno (2009) developed the concept of botanical literacy as part of scientific literacy that emphasizes understanding cognitive dimensions related to botanical concepts.

Botanical literacy supports human life and global ecosystems, providing oxygen, food, and raw materials. Botanical literacy developed in students is essential to prepare them to address future environmental challenges. It involves teaching students to think critically about plant-related issues and appreciate plants' importance in maintaining ecological balance (Uno, 2009). Improved botanical literacy can empower students by increasing their awareness of the importance of plants in their environment, ultimately contributing to their overall scientific literacy (Sari et al., 2023). It is important to provide prospective teachers with experience in managing the learning process according to students' needs to achieve optimal learning outcomes (Sari et al., 2021). Botanical education emphasizes practical learning, especially for vocational training students and teachers. This approach involves direct observation and interaction with natural spaces, such as

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Contribution to the literature

- This article reviews and analyzes various literature on the concepts and dimensions of botanical literacy. The development of botanical literacy is based on reviewing scientific publications which include botanical literacy, plant blindness, plant awareness, and botanical education. This study shows that botanical literacy involves multidimensional understanding, encompassing cognitive, affective, and psychomotor aspects.
- This systematic literature review (SLR) is constrained to original papers, restricting the research scope to the specific research subject or theme.
- The purpose of developing the concept and dimensions of botanical literacy is to enhance multidimensional understanding encompassing cognitive, affective, and psychomotor aspects, enabling students to holistically understand and appreciate plant diversity. This concept also aims to address plant blindness by raising awareness of the critical role of plants in ecosystems and human life while fostering ecological responsibility through literacy-based botanical education. Furthermore, the development of botanical literacy is expected to improve the quality of botanical education, develop practical skills such as plant identification and field observation, and support research and innovation in evidence-based botanical learning.

nature parks, to develop competencies in flora management, plant communities, and habitat interpretation (Ortiz et al., 2022).

Botanical literacy remains a significant challenge, and based on research results (Stagg & Dillon, 2022) concluded that reduced experience with nature, especially in urban environments, contributes to the cyclical process of inattention to plants. It suggests that increasing plant awareness can be achieved through direct experience with edible and beneficial plants in the local environment, thus fostering a greater connection with plant life. The study by Abrori (2020) showed a lack of early understanding of botany, emphasizing the need for balanced educational content focusing on plants and animals to improve botanical knowledge. This study is in line with reports showing Indonesian students' low scientific literacy skills. It suggests a more comprehensive approach to botanical literacy to improve students' cognitive, affective, and psychomotor dimensions. Related studies on botanical literacy research on botanical literacy is limited, especially in the Indonesian context. Most studies focus on cognitive dimensions, such as basic botanical concepts and plant identification (Bruce & Wright, 2018). The goal of analyzing scientific concepts is to offer empirical data on real-world occurrences, thereby supporting the validation of scientific hypotheses (Hardianto et al., 2024). However, affective aspects, such as attitudes and appreciation towards plants, as well as psychomotor aspects, such as practical skills in gardening or conservation, are rarely the focus. Botanical literacy that only focuses on the cognitive dimension will find it challenging to create holistic behavior change and environmental awareness. Botanical literacy needs to be divided into three aspects, as it aligns with the study by (Phan, 2019), which states that among the three learning domains–cognitive, affective, and psychomotor–the cognitive domain has received the most attention from educators, leaving significant research gaps in the affective and psychomotor domains. This division ensures a more comprehensive understanding of plants, where cognitive knowledge is complemented by emotional engagement (affective) and hands-on experience (psychomotor), ultimately fostering deeper awareness and action in plant conservation and education.

A comprehensive concept of botanical literacy must be developed to cover cognitive, affective, and psychomotor dimensions. The cognitive dimension involves knowledge of plant diversity, functions, and benefits. It is critical to address the plant awareness gap, a phenomenon where people fail to notice or appreciate plants in their environment (Paisley et al., 2022). The affective dimension includes attitudes and appreciation towards plants, which can be enhanced through educational interventions that result in positive affect and memorable encounters with plants (Stagg et al., 2024). Perceived learning through cognitive, affective, and psychomotor aspects in higher education courses can help understand the effectiveness of theories, learning models, and various techniques applied in higher education environments (Gómez Chova et al., 2012). These dimensions collectively foster a comprehensive understanding and appreciation of plants. According to Sönmez (2017), learning outcomes in education should not be limited to a single domain; instead, they should integrate cognitive, affective, and psychomotor domains. It highlights that when individuals learn cognitive behaviors, they acquire related psychomotor and affective behavior simultaneously. Therefore, a development that incorporates these three domains is required to formulate a more holistic botanical literacy. However, this definition does not fully cover the affective and psychomotor aspects important in botanical learning. Recent studies suggest that botanical literacy should

encompass three main dimensions: cognitive, affective, and psychomotor, to provide a holistic understanding of the relationship between humans and plants (Beasley et al., 2021).

Botanical literacy is an essential aspect of biology education, including knowledge, attitudes, and plant-related skills. However, existing studies tend to focus only on the cognitive dimension, such as understanding and basic knowledge of plants. These studies have not fully explored other equally essential dimensions, namely attitudes towards plants, such as appreciation, awareness, and care, and practical skills in observing, caring for, and utilizing plants in everyday life. This lack of attention to holistically developing the concepts and dimensions of botanical literacy suggests a significant research gap. Therefore, a more comprehensive study, such as an SLR, is needed, mainly since no one has studied the concepts and domains of botanical literacy, to explore and develop a theoretical framework that covers all dimensions of botanical literacy. This approach will enrich literature and make a strategic contribution to creating a more inclusive and applicable botanical education.

MATERIAL AND METHODS

The type of SLR used in this study is qualitative SLR, employing the preferred reporting items for systematic reviews and meta-analyses (PRISMA) framework to systematically screen and select articles that align with the proposed research question (RQ).

The Research Question

In preparing this SLR, I focused on two main RQs:

1. What is the concept of botanical literacy?
2. What are the dimensions that make up botanical literacy?

The first question explores the definition and in-depth understanding of botanical literacy. In contrast, the second question will identify the key components or aspects that support botanical literacy in various research contexts.

Database Searched

In compiling this SLR, I used sources from the Scopus database to ensure the quality and relevance of the articles analyzed. Scopus was chosen as the central database due to its wide coverage and credibility in providing verified scientific literature.

Search Terms and Selection Criteria

Article searches are conducted using search queries: TITLE-ABS-KEY ("botanical literacy" OR "botany literacy" OR "plant literacy" OR "education botany course" OR "botanical knowledge" OR "botany inquiry" OR "local botanical knowledge" OR "botanical education" OR "plant science" OR "plant perception" OR "plant awareness") AND PUBYEAR > 2014 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (DOCTYPE, "ar")). The selection criteria used are, as follows:

(1) articles published between 2015 to 2024,

(2) the type of document is limited to articles,

(3) the source of the article comes from the journal,

(4) the article is written in English,

(5) the article is open access, and

(6) the topic of the article is in the field of social science.

These criteria ensure that the selected articles are relevant to botanical literacy and have sufficient scientific quality.

The authors selected articles from the last 10 years to ensure the information reviewed is relevant and aligned with the latest scientific developments. This range reflects the latest research advances on botanical literacy or learning, cutting-edge trends, and emerging innovations, thus providing a comprehensive perspective. Selecting the type of articles and journals is essential to ensure the quality, relevance, and validity of the data used in the research. Scientific articles, especially those peer-reviewed, provide reliable data, clear methodology, and evidence-based findings. English is the international language of academia, so articles in this language have a wider audience reach and reflect globally recognized research.

Open-access articles are easily accessible without cost barriers, allowing researchers to obtain wholly and freely. Choosing an article topic in the field of social science is relevant to education because education is one of the essential aspects of social science, which studies the interaction of people, culture, and society.

The search used search queries that matched the inclusion criteria and resulted in 60 articles. After screening through the abstract checklist, 27 articles were selected to be analyzed and reviewed further according to the predetermined research questions. These 27 articles revealed the main themes, namely knowledge about plants, learning methods related to plants, approaches to overcoming blindness to plants, and efforts to raise awareness of the importance of plants.

The complete results can be seen in **Figure 1**, a flowchart for identifying and selecting articles related to botanical literacy.

Data Analysis

The data analysis process was conducted by thoroughly reading each paper that met the inclusion criteria. Thematic analysis is employed to examine information by identifying patterns and key categories

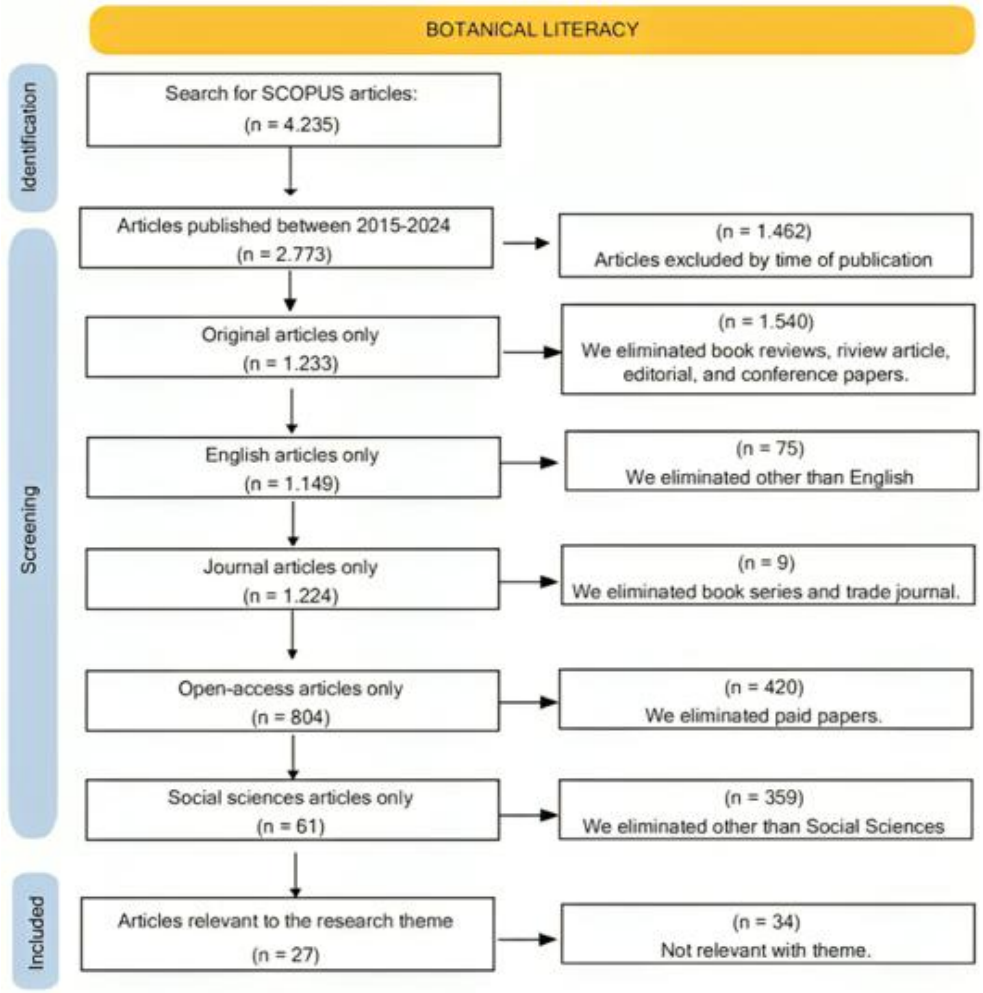

Figure 1. PRISMA flowchart (Source: Authors' own elaboration)

within research, enabling systematic organization of data based on relevant themes.

In the context of botanical literacy, this analysis structures information into several key themes, including the definition and concept of botanical literacy, which involves exploring how it is defined in various studies and identifying essential keywords that shape the concept. Furthermore, the theme of botanical literacy domain classification is analyzed by investigating how botanical literacy is categorized into cognitive, affective, and psychomotor domains, as well as reviewing references and theories that support this classification.

RESULTS

The Concept of Botanical Literacy

Based on the synthesis of the articles analyzed, the concept of botanical literacy has generated several key terms, namely awareness of plants and ecosystems, local botanical knowledge, plant environment interactions, the use of technology and accessibility in botanical literacy, traditional knowledge and community-based conservation, botanical literacy and scientific knowledge, and linearly developing botanical literacy. The detailed synthesis of these articles can be found in **Table 1**.

Table 1. Mapping of botanical literacy concepts

Reference	The concept of botanical literacy
Beasley et al. (2021, 2023) & Parsley et al. (2022)	Botanical literacy includes the ability to describe plant phenomena scientifically, design and evaluate research, interpret plant data scientifically, and engage curiosity and critical thinking about plants and their environment.
Pongsophon and Jituafua (2021)	Botanical literacy develops linearly, from simple understandings, such as plant diversity, to more complex dimensions, such as morphology, to plant ecophysiology.
Achurra (2022), Dünser et al. (2024), Kletečki et al. (2023), Pany et al. (2022), & Sanders et al. (2024)	The concept of plant awareness includes the ability to recognize, identify, and understand the role of plants in ecosystems, as of appreciating the importance of plants in ecological, visual, and conservation contexts.

Table 1 (Continued). Mapping of botanical literacy concepts

Reference	The concept of botanical literacy
da Silva Ribeiro Gomes et al. (2024), Monnais and Tousignant (2016), Müller et al. (2015), Nunes et al. (2018), & Syamsuardi et al. (2024)	Local botanical knowledge includes an understanding of plant uses (e.g., food and medicine), which is influenced by factors such as gender, age, and location.
Murren et al. (2019), Pressler et al. (2019), Stagg and Verde (2019), & Wells et al. (2021)	Understand the interaction of plants with other elements such as soil, pollinators, and the environment, as well as the ecological and conservation value of plants in the sustainability of ecosystems.
Andjić et al. (2019) & Pernat et al. (2023)	Use tools such as dichotomy keys and citizen science applications to improve understanding of plant diversity, accessibility, and identification skills.
Flores-Silva et al. (2024), Fontefrancesco and Pieroni (2020), & Syamsuardi et al. (2024)	People's traditional understanding of the utilization of wild plants (as food or medicine) and the impact of environmental change on these practices, including foraging, which supports community-based conservation.

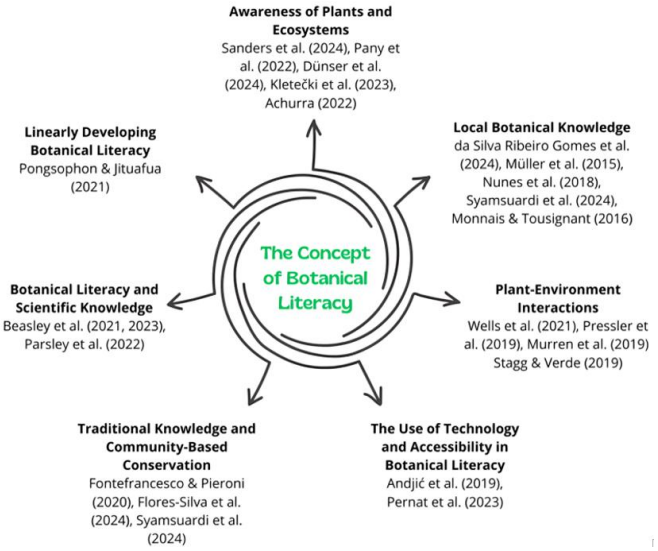

Figure 2. The concept of botanical literacy (Source: Authors' own elaboration)

The conceptual framework is illustrated in **Figure 2**.

Based on the concept mapping of botanical literacy in **Table 1**, the concept of botanical literacy:

> "Botanical literacy now encompasses more than just basic plant knowledge; it has evolved into a multidimensional understanding that integrates technology, ecology, and sociocultural awareness. By expanding its scope, botanical literacy now plays a role in building a comprehensive understanding of ecosystems and sustainability. It encourages the formation of a society that understands but is also committed to sustainably preserving the global environment".

Domains of Botanical Literacy

The synthesis of the articles not only found the concept of botanical literacy but also found the dimensions of botanical literacy (**Table 2**), which can be seen based on the following:

Uno (2009) introduced a biological literacy model that can be applied to botanical literacy with four levels: nominal, functional, structural, and multidimensional. At the nominal level, students can recognize basic botanical terms, such as "xylem" or "photosynthesis," but may misunderstand the concept. At the functional level, students can use biological terms correctly but tend to memorize them without deep understanding. The structural level shows students' understanding of more fundamental biology concepts and the ability to explain concepts in their own words. At the multidimensional level, students not only understand biological concepts but also the relationship of biology with other disciplines, history, and its relevance in society.

Botanical education should be developed to know about plants and understand and appreciate the interconnections between plants and humans in a world that Indigenous Peoples have understood for tens of thousands of years (Uno, 2009). However, this model still focuses on cognitive aspects and does not accommodate the practical and affective dimensions important in shaping comprehensive botanical literacy. Meanwhile, Pongsophon and Jituafua (2021) introduced the conceptual and procedural dimensions of botanical literacy, which include an understanding of plant diversity, morphology, and ecophysiology, as well as basic skills in observation and identification. However, this definition still lacks affective aspects, such as positive attitudes and appreciation of the vital role of plants in the ecosystem. Supported by research by Børresen et al. (2023) educational programs significantly improved secondary school students' knowledge, attitudes, and views regarding ecosystem services and biodiversity, suggesting that educational interventions can effectively improve local understanding of these concepts.

DISCUSSION

The Concept of Botanical Literacy

Botanical literacy can be defined as the understanding, skills, and appreciation of the plant world, which includes its scientific aspects and

Table 2. Domains of botanical literacy

Domains	Aspect	Synthesis Results	References
Cognitive outcomes	Plant biological knowledge	Includes understanding the structure, function, and fundamental processes in plants (photosynthesis, respiration, reproduction, and growth)	Andjić et al. (2019), Flores-Silva et al. (2024), Fontefrancesco and Kaggwa et al. (2021), Jhuang et al. (2024), Müller et al. (2015), Parsley et al. (2022), Pieroni (2020), Pongsophon and Jituafua (2021), & Stagg and Verde (2019)
	Diversity and classification of plants	Able to identify and understand various plant species and the basic principles of taxonomy.	Beasley et al. (2021), da Silva Ribeiro Gomes et al. (2024), Danzer et al. (2024), Linderwell et al. (2024), Pany et al. (2022), & Pernat et al. (2023)
	Plant ecology and its relations with the environment	Understand the critical role of plants in ecosystems, including symbiotic relationships, food chains, and soil stabilization.	Beasley et al. (2021, 2023), da Silva Ribeiro Gomes et al. (2024), Dünser et al. (2024), Kaggwa et al. (2021), Kletečki et al. (2023), Pressler et al. (2019), Sanders et al. (2024), & Wells et al. (2021)
Affective outcomes	Appreciation of plants and nature	Develop a sense of amazement and appreciation for the importance of plants in human life and ecosystems.	da Silva Ribeiro Gomes et al. (2024), Dünser et al. (2024), Fontefrancesco and Pieroni (2020), Kletečki et al. (2023), Pany et al. (2022), Parsley et al. (2022), Stagg and Verde (2019), & Syamsuardi et al. (2024)
	Environmental care and plant conservation	Develop awareness of the need to preserve and protect plants and biodiversity.	Syamsuardi et al. (2024), Parsley et al. (2022), Wells et al. (2021)
	Motivation to engage in sustainable practice	Develop a commitment and motivation to implement sustainable practices in daily life, such as gardening and participation in conservation.	Beasley et al. (2021, 2023), Dünser et al. (2024), Fontefrancesco and Pieroni (2020), Kletečki et al. (2023), & Marcos-Walias et al. (2023)
Psychomotoric outcomes	Plant identification skills	Ability to recognize and categorize different plant species using field guides or identification applications.	Beasley et al. (2023) & Pernat et al. (2023)
	Skills in gardening and aquaculture	Practical skills to plant, care for, and propagate plants and practice sustainable cultivation techniques.	Beasley et al. (2021), Dünser et al. (2024), & Wells et al. (2021)

ecological relevance in everyday life. Uno (2019) defines botanical literacy as an individual's ability to recognize, understand, and apply basic plant concepts in the context of ecosystems, focusing on ecological awareness and environmental resilience.

Meanwhile, Pongsophon and Jituafua (2021) emphasizes botanical literacy as conceptual and procedural skills in recognizing plant diversity, morphology, and ecophysiology. Botanical literacy has become essential since its scope goes beyond simply plant recognition and encompasses a more complex and multidimensional dimension. With technological advancements, botanical literacy now requires technological skills to support botanical identification and understanding in a modern context. In addition, botanical literacy cannot be separated from sustainability, as plants play a vital role in ecosystems and environmental sustainability. It is also essential to integrate social and cultural perspectives in botanical literacy, primarily through ethnobotany and local knowledge that describes people's unique relationships with plants, including demographic factors such as age and gender. This new botanical literacy should incorporate multidimensional skills that include scientific knowledge, technical skills, and appreciation for plants and the environment, promoting conservation awareness and environmental responsibility in the era of climate change. Thus, this expanded concept of botanical literacy will be more relevant and helpful in dealing with today's environmental and social challenges and building a generation aware of the importance of maintaining a balanced ecosystem.

Comprehensive and contextualized botanical literacy is essential for fostering a scientifically literate society that addresses environmental challenges. In line with research (Stroud et al., 2022), there is an urgent need to integrate plant-focused education and species literacy into the curriculum to foster a deeper understanding and appreciation of plants, as this knowledge is critical to the sustainability of industries and professions that rely on plant science and to inspire future generations to engage with ecological issues. Research by Harrison (2014) suggests this shift is essential to prepare students for a rapidly changing scientific and technological society, with ethnobiology education emerging as a promising

avenue to engage young minds in understanding the importance of plants in health and well-being.

Domains of Botanical Literacy

Cognitive outcomes

The synthesis of the articles supports three main aspects of botanical literacy in cognitive outcomes: knowledge of plant biology, plant diversity and classification, and plant ecology and its relationship with the environment. These aspects serve as fundamental components in understanding the role of plants in ecosystems and human life. Each of these aspects will be compared with other relevant literature to strengthen the findings of the synthesis. Furthermore, identifying gaps in existing studies will help provide a more comprehensive perspective on botanical literacy. By integrating these aspects, this study aims to contribute to the development of a well-rounded framework for enhancing botanical education and awareness.

Augmented reality (AR) in botany learning helps strengthen students' understanding of the morphology and function of plant parts (Jhuang et al., 2024). AR technology allows deeper visualization of plant structures so students can see plant components such as leaves, stems, and roots. Wu et al. (2013) showed that AR technology helps improve student understanding in visual-based subjects, including botany, because students can directly see 3D models of plant organs. According to Eden et al. (2024), technology integration in education is essential to improve learning outcomes and promote equity, as it enables personalized learning experiences that cater to diverse learning styles and fosters student engagement through interactive and immersive environments.

Students need to be able to observe and understand the importance of plants to the biosphere, which is obtained through contextualized education that integrates local knowledge of the cultural value of plants (Flores-Silva et al., 2024; Parsley et al., 2022). This is supported by research results by Musa et al. (2018) integrating local knowledge with scientific descriptions in teaching biodiversity significantly improved students' understanding and interest in classifying biological organisms, as evidenced by a significant increase in performance test scores.

Understanding of key concepts of botany, including plant diversity and ecophysiology: Students' understanding of plant diversity, morphology, and ecophysiology is an essential part of botanical literacy, which includes understanding plant species and their use in everyday life (Fontefrancesco & Pieroni, 2020; Pongsophon & Jituafua, 2021). Applying participatory approaches that respect socioeconomic and cultural trends is necessary to enhance the natural features of these areas and ensure that local populations, which are essential for biodiversity conservation, are actively involved in planning and management processes (Carvalho & Frazão-Moreira, 2011).

Performing theater as a learning medium improves students' understanding of floral anatomy and plant reproductive processes (Stagg & Verde, 2019). Observing mutant phenotypes reinforces the concepts of genotype and phenotype in students (Kaggwa et al., 2021). Interactive learning methods, such as Interactive Labs and multimedia resources, have increased student engagement and motivation. These tools provide personalized learning experiences that cater to diverse learning styles and paces, making science education more accessible and enjoyable for students (Hendra & Kurniati, 2024; Verawati et al., 2024).

Plant knowledge in botanical literacy is also influenced by social roles, where women are more familiar with food crops, and men are more familiar with fodder crops, indicating cultural influences in plant understanding (Müller et al., 2015). Understanding the gender dimensions of plant knowledge can better conservation and resource management strategies, ensuring that traditional knowledge is conserved and effectively utilized (Tng et al., 2021).

Affective outcomes

Esteem for plants often develops through an understanding of their aesthetic, functional, and ecological values. Social and cultural factors, such as gender, play a role in medicinal plant knowledge and daily plant use (da Silva Ribeiro Gomes et al., 2024; Dünser et al., 2024; Kletečki et al., 2023; Syamsuardi et al., 2024). Gender influences the relationship between critical thinking skills, creative thinking skills, and learning achievement, with significant differences between the two sexes (Nasution et al., 2023). In line with the research by Zubaidah et al. (2017), it was found that gender affects creative thinking skills, with male students demonstrating higher creative thinking skills than female students, which is believed to be due to differences in brain anatomy that influence their learning patterns and activities. Students and teachers showed positive attitudes towards the role of plants in ecosystems, including plants' visual and emotional benefits. According to Chen and Yang (2024) A sense of connectedness with nature mediates the relationship between sensory experiences and emotional outcomes. This connection increases positive and reduces negative emotions, fostering a deeper emotional bond with the natural world.

Plant conservation awareness develops through students' understanding of endangered species, the ecological benefits of plants, and the importance of plants in the food chain. This concept is reinforced by field activities that introduce students to local species such as *durio graveolens* and native pollinator plants,

which support increased student concern for conserving biodiversity (Parsley et al., 2022; Syamsuardi et al., 2024; Wells et al., 2021). Findings Ríos-Rodríguez et al., (2024) suggest that the relationship between contact with nature and emotional regulation is significant, providing insight into how natural environments can improve emotional well-being and overall mental and physical health in populations.

Gardening activities and interactions with plants encourage students to understand the importance of sustainable practices. Students are motivated to engage in hands-on practices such as gardening and conservation, which enhance their understanding of plant life cycles, the importance of soil, and ecological relationships within ecosystems (Beasley et al., 2021, 2023; Dünser et al., 2024; Kletečki et al., 2023; Marcos-Walias et al., 2023). Experiential learning, such as gardening, enhances students' cognitive understanding of sustainability by allowing them to observe and interact with natural processes directly. This hands-on approach helps students retain information more effectively than in traditional classroom settings (Dulce & Díaz, 2023).

Psychomotoric outcomes

Students develop practical skills in accurately recognizing and identifying plant species using tools such as the digital application Pl@ntNet and scientific identification keys during field surveys (Pernat et al., 2023). Teachers and students also develop practical skills in observing, recording, and drawing plants as part of place-based learning. The mosaic approach method helps document students' botanical knowledge by creating maps, drawings, and photographs (Beasley et al., 2023). Bruce and Wright (2018) state that digital identification applications such as Pl@ntNet support identification skills by providing information on local species quickly and accurately.

Gardening activities promote students' active engagement and enhance their understanding of botany while strengthening the social interactions in gardening (Dünser et al., 2024). These activities also include the ability to plant, care for, and manage plants in daily practice to utilize botanical knowledge directly (Beasley et al., 2021). Gardening activities also promote affective learning by fostering a connection with nature, increasing environmental awareness and motivation to engage in sustainable practices (Apanovich et al., 2023; Vella Ciangura & Mifsud, 2023).

The students demonstrated positive attitudes towards the environment with increased awareness and concern for preserving native plants and pollinator species, as seen in post-test results after participating in hands-on botanical activities (Wells et al., 2021). Garden-based learning empowers students by allowing them to take control of their education, transforming school gardens into multifunctional spaces such as outdoor classrooms and science observatories, which enhances their learning experience and engagement (Hershey & Parks, 2022). The learning experience gained by students prepares them to become competent problem solvers (Mahanal et al., 2022).

Recent studies, such as Anand et al. (2024) effective learning, involve customized teaching approaches for each domain, such as lectures for cognitive skills, group work for emotional growth, and physical exercises for psychomotor skills. Thus, botanical literacy that includes cognitive, affective, and psychomotor outcomes will provide a more comprehensive understanding. This comprehensive botanical literacy enriches students' understanding of plant concepts and encourages positive attitudes and practical skills, thus supporting environmental conservation and sustainability in education and daily life.

Limitations

The results of this study are limited by several criteria, including the range of publication years that only include articles from 2015 to 2024, document types that are limited to scientific journal articles only, language that only includes English publications, access limitations only on open access articles, and focus on the field of social sciences. These limitations make the study's results possibly less representative in comprehensively describing the concept of botanical literacy, especially when considering historical aspects, interdisciplinary approaches, and findings from non-open access or non-English publications. For future research, it is recommended to include more variation in the range of publication years, expand the types of documents used, and integrate perspectives from different disciplines to more fully define the concept and domain of botanical literacy. This more inclusive approach will help gain a more comprehensive understanding of botanical literacy, thus supporting the identification of essential domains in botanical education and research.

CONCLUSION

Based on the synthesized articles, this research successfully answered two main questions about botanical literacy. First, botanical literacy is a comprehensive understanding that includes scientific, ecological, social, and cultural aspects of plants. This definition involves basic knowledge of botany and an appreciation of the importance of plants in ecosystems and human life at large. Secondly, this study identified that botanical literacy consists of three main domains: cognitive, affective, and psychomotor. The cognitive domain includes scientific and ecological understanding of plants, and the affective domain involves appreciation and awareness of the importance of plant conservation.

In contrast, the psychomotor domain includes practical plant identification and care skills. These results confirm that developing a well-rounded botanical literacy requires a multidimensional approach involving various aspects of learning and hands-on experience.

The implications of this study indicate the need for a deeper and more comprehensive understanding of botanical literacy, particularly in the context of education and ecological awareness in society. This study shows that botanical literacy involves multidimensional understanding, encompassing cognitive, affective, and psychomotor aspects. However, limitations in literature coverage and disciplinary perspectives suggest a need for more research integrating interdisciplinary approaches. Recommendations for future research include expanding the literature sources to include publications from different disciplines, languages, and formats and spanning a wider range of years for a more comprehensive picture. In addition, further research should explore the influence of demographic factors, local culture, and technology in shaping botanical literacy so that the research results are more relevant and applicable to improving education and public awareness of plant and environmental conservation.

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