Plant Awareness, Plant Awareness Disparity (PAD), and Plant Literacy in Secondary Education: A Systematic Review as a Basis for a Contextualized-DepEd Intervention

Jill Carmel E. Moleno[1], Monera A. Salic-Hairulla[2]

[1,2]Department of Science and Mathematics Education, Mindanao State University – Iligan Institute of Technology, Bonifacio Ave. Tibanga, Iligan City, 9200, Philippines

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ABSTRACT

The issue of Plant Awareness Disparity (PAD) has remained a significant problem in the field of secondary science education due to the natural complexity of plant processes, textbook-heavy instruction, and prevailing zoocentrism. This systematic review aims to identify factors influencing students' awareness, interest, and understanding of plants; explore effective educational interventions; and analyze common themes in biodiversity and botany education. This is to contribute towards the formulation of a contextualized intervention for the Department of Education (DepEd) while attempting to increase plant awareness and resolve plant blindness. Using PRISMA framework a comprehensive database search was conducted in ERIC, PubMed, Scopus, ProQuest, Semantic Scholar, and Google Scholar. Out of 619 records retrieved from databases and snowballing, 592 were excluded based on predefined criteria. Moreover, 27 studies were found to be eligible to synthesize common themes. The findings reveal that overcoming PAD requires active learning, thereby supporting the implementation of a hybrid, local, and experience-based approach aligned with the competencies of the DepEd. The review highlights that for successful implementation, botany education for teachers and a multidisciplinary diagnostic method are necessary to develop 21st-century skills and environmental stewardship.

Keywords: Plant Awareness, Plant Blindness, Plant Awareness Disparity, Plant Literacy, Contextualized, Localization, Zoocentrism

INTRODUCTION

Teaching and learning about plants are integral components of science education. In the context of science education, understanding plant life is essential for developing ecological awareness among learners. However, plants are often overlooked due to their complex nature and mechanism. A cross-sectional assessment in Spain on species literacy among primary, secondary, and university students revealed 100% identification values for animals and only 73% for plants, showing a decline in plant knowledge [23]. This issue highlights a critical gap in science education, as such neglect leads to a lack of awareness and a growing phenomenon of plant blindness among students. Mirroring this global deficit within the local landscape, a recent study by Reference [17] on ethnobotanical awareness conducted at CMU, Bukidnon, revealed that despite living in a region rich in biodiversity, high school students' knowledge of local plants still demonstrated limited visual attention and understanding of ethnobotanical flora.

Beyond educational factors, urbanization has heavily contributed to increasing plant blindness. Environmental changes such as urbanization further aggravate this issue [28]. Urbanization limits green spaces and turning places to fit modernization and digital lifestyles, thereby reducing students' exposure to the natural environment and hindering their ability to learn, identify, and become aware of plant characteristics, names, and importance. Compounding the effects of these physical barriers, prolonged exposure to media and entertainment industry that heavily feature animal species may have contributed to the plant blindness of the students [23].

This phenomenon is documented in literature from 1998 to 2020 in the study by Reference [33], which points out that regular contact with plants that have direct relevance to people's lives increases their interest in and knowledge of plants in urban settings. For example, a study by Reference [9] also pointed out that students' plant knowledge directly comes from traditional family knowledge of a medicinal plant. Thus, integrating student cultural knowledge into the classroom makes plant education meaningfully efficient.

Despite the clear need for culturally grounded plant education, this indicates a significant gap in the literature, as there is a limited number of studies from 1999 to 2024 on plant blindness within the field of science education [1]. Particularly in the secondary education contexts, these studies are concentrated in the United States of America, about eight (8) studies, and focus primarily on university students' level of awareness and understanding of plants, about 8 out of 22 studies. Most of the respondents were university students because designing research tools and interventions is much more convenient for this demographic [7] [27]. This reliance on university samples limits the generalizability of findings to younger students, as secondary students are at a different developmental stage, possess different baseline knowledge, and are influenced by distinct pedagogical environments that require specialized, age-appropriate interventions.

Bridging this geographical and demographic gap, the Philippine context underscores the need for localized and contextualized interventions. As the country is known for its richness in natural resources and biodiversity, which is also conserved by most of the Philippines' indigenous tribes, it would be helpful if indigenous and local knowledge were integrated into science education. As also claimed by Reference [30] in their study involving the Higaonon tribe, integrating ethnobotanical practices into lessons is important because it enhances cultural relevance and student engagement, fosters critical thinking, and highlights the importance of plants in biodiversity while leaning toward a more learner-centered approach. However, because students in an urbanized region cannot easily access remote tribal landscapes, school-based solutions must be established. In urbanized areas of the Philippines, a community garden, for example, could serve as a remedy for the lack of awareness regarding plant life among individuals and students. Utilizing gardens as a basis for learning programs about plants has a significant impact on increasing students' engagement, academic performance, and plant knowledge. It is highly effective for science teaching as it encourages students to combat plant blindness in a real-life setting and context, promoting a more accurate understanding of plants compared to textbooks, as presented in the study by [2].

To address these gaps, this review utilizes the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to conduct a structured systematic review of plant awareness, plant awareness disparity, and plant literacy in secondary education. Specifically, the main objective of this review is to gather the findings from the existing literature to identify recurring themes in finding relevant educational approaches for contextualized Department of Education (DepEd) interventions in secondary schools. Furthermore, this study not only provides an overview but also highlights gaps in current research by offering insights into how plant education is effectively integrated into learning environments. To guide this systematic review, the following research question is posed:

"What themes emerge from existing research on plant awareness, plant awareness disparity, and plant literacy among secondary education learners that can inform the development of a contextualized intervention for DepEd schools? "

By investigating this question and by systematically examining the existing literature, this review aims to provide an update and to contribute to the body of knowledge on plant education by exploring innovative approaches and their integration into formal and informal education systems. In order to successfully achieve the objective of the study, the review gathers and synthesizes relevant evidence, such as determining plant awareness, PAD, and plant literacy are described in studies involving secondary education; discovering factors influencing students' awareness, interest, and understanding of plants; identifying educational strategies or interventions that have been used to improve plant awareness; and examining recurring themes in the teaching and learning of plants within biodiversity and botany education. Ultimately, it seeks to improve plant awareness and literacy, as well as address the issue of plant blindness, specifically aiming to contribute to the development of a contextualized intervention for DepEd secondary schools.

METHODOLOGY

A. Research Design and Framework

This study was guided by PRISMA framework to ensure clarity and transparency in article selection on plant awareness, plant blindness, and plant literacy in secondary education in conducting a systematic review [39]. The PRISMA framework follows a structured and transparent process for identifying, screening, assessing, and selecting eligible studies to include in the review [25].

Table I. Inclusion and exclusion criteria for article selection that was included in the systematic review

Criteria	Inclusion	Exclusion
Population	Studies involving secondary school learners or equivalent levels (approximately ages 12-18)	Studies focusing exclusively on university students, primary students, professional training, or adult learners
Concept	Studies discussing plant awareness, PAD, plant literacy, botanical literacy, plant-related learning, or attitudes toward plants	Studies unrelated to plant awareness, plant learning, or student perceptions of plants
Context	Studies conducted in formal educational settings (schools or school-based programs)	Studies focusing only on agriculture production, forestry training, or laboratory plant science without an educational focus
Study Type	Empirical research (qualitative, quantitative, or mixed methods	Editorials, opinion papers, book reviews, review articles, abstracts without full papers
Publication Type	Peer-reviewed journal articles and relevant gray literature (theses, dissertations, conference proceedings) available in full text	Publications without accessible full-text, duplicate records, or sources lacking sufficient methodological information
Language	Written in English	Articles not written in English
Year Range	Published from 2020 to 2026	Publication before 2020

B. Eligibility Criteria

Table I summarizes the inclusion and exclusion criteria used to ensure that the studies included were directly relevant to the DepEd intervention for plant awareness, PAD, and plant literacy in secondary education. These inclusion and exclusion criteria were established before the screening process to ensure that only relevant and high-quality studies were included in the systematic review. This procedure follows the structured approach used in PRISMA-guided reviews.

Studies were included if: (1) the population involves secondary school learners; (2) the concept focuses on studies discussing plant awareness, plant blindness, plant literacy, botanical literacy, plant-related learning, or attitudes toward plants; (3) were conducted in formal educational settings or school-based programs; (4) were empirical research; (5) publication type was peer-reviewed journal articles and or relevant gray literature, including theses or dissertations, and conference proceedings; (6) were written in English; and (7) were published from 2020 to 2026.

Studies were excluded if: (1) the population focusing exclusively on university students, primary students, professional training of teachers or pre-service teachers, or adult learners; (2) concepts were unrelated to plant awareness, plant learning, or student perceptions of plants; (3) studies focused solely on agriculture production, forestry, training, or laboratory plant science without educational focus; (4) were non-empirical literature such as editorials, opinion papers, book reviews or chapters, review articles, and/or abstracts without full papers; (5) were publications without full text, duplicate records, and sources that lack sufficient methodological information; (6) were not written in English; and (7) were published before 2020.

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C. Information Sources and Search Strategy

Literature searches were conducted using reputable journals from ERIC, PubMed, Scopus, ProQuest, Semantic Scholar, and Google Scholar to identify peer-reviewed studies published between 2020 and 2026 that focused on plant awareness, plant blindness, and plant literacy in secondary education. The databases searched, standard search strings, and applied filters used in searching studies are summarized in Table I. A systematic literature search was conducted using six (6) databases. These electronic databases were selected because they provide broad coverage of studies related to plant literacy and education in secondary school. The search strategy across all databases ensures consistency in capturing relevant literature on plant awareness in secondary education. A core Boolean search string was developed and applied, with minor adjustments based on database-specific indexing systems and search functionalities.

The standardized search strings used in the review were as follows:

("plant awareness" OR “plant awareness disparity” OR "plant blindness" OR "plant literacy" OR "botanical literacy" OR "plant appreciation" OR "plant identification" OR "plant knowledge" OR "plant perception" OR "attitudes toward plants" OR "plant education" OR "botany education") AND ("secondary education" OR "secondary school" OR "high school" OR "middle school" OR "junior high school" OR "senior high school" OR “adolescents” OR “students”) AND (“education” OR “learning” OR “teaching” OR “curriculum” OR “instruction” OR “pedagogy” OR "science education" OR "biology education").

Table II. The list of databases searched, corresponding search strings, and applied filters used in the literature search

Database	Search String	Applied Filters
ERIC	("plant awareness" OR “plant awareness disparity” OR "plant blindness" OR "plant literacy" OR "botanical literacy" OR "plant appreciation" OR "plant identification" OR "plant knowledge" OR "plant perception" OR "attitudes toward plants" OR "plant education" OR "botany education") AND ("secondary education" OR "secondary school" OR "high school" OR "middle school" OR "junior high school" OR "senior high school" OR “adolescents” OR “students”) AND (“education” OR “learning” OR “teaching” OR “curriculum” OR “instruction” OR “pedagogy” OR "science education" OR "biology education")	Peer-reviewed only, full text available, Plant (Botany), Secondary School Students, secondary education, journal articles;
PubMed	The same full core string applied	English, full text available, Year: 2020-2026
Scopus	The same full core string applied	Article type: Journal; Year: 2020-2026
ProQuest	The same full core string applied	Peer Reviewed, Document – Full Text, English, Dissertation Paper, Conference Paper, Scholarly Journals, and Subject (science education, ethnobotany, biodiversity, student, education)
Semantic	The same full core string applied	Year: 2020-2026
Google Scholar	The same full core string applied	Search by Relevance, Year:2020-2026

The unified or full string ensured that the same conceptual scope was maintained across all databases while allowing flexibility for database-specific filters and syntax. Search filters were also applied to narrow down relevant studies for this review, including year range of publication, full-text document, only peer-reviewed paper, English language, article type, participants: secondary school students, subject: botany, plants, science

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education, etc., and searchable fields such as title, abstract, and keywords.

The selection of articles uses the Publish or Perish application using databases from Scopus and Semantic Scholar. The remaining databases, like ERIC, ProQuest, PubMed, and Google Scholar, were manually searched. In addition to Publish or Perish, this study also utilizes Zotero and TERA to organize the articles more efficiently. The manual search studies across different databases mentioned were assisted by Zotero, which automatically saved each study, including its full-text PDF if found. All retrieved records were then imported into TERA for de-duplication, and a manual verification of duplicates was done in a master list of raw data using a Google Sheet. After the manual verification of duplicates, a list of 538 records was screened with the help of TERA to easily look through the titles, including the abstract of each study.

Moreover, in choosing articles, 4 steps were followed: 1) Identification of journals to be included in the systematic review; 2) Screening, or selection, of data; 3) Eligibility, determining the article to be used as material for literature assessment; and 4) Inclusion, combining and reporting results [22] [24]. The literature search was conducted on April 29, 2026. Using a PRISMA-guided approach, an initial set of 317 records was identified from databases (7 from ERIC and PubMed, 79 from Scopus, 95 from ProQuest, 122 from Semantic Scholar, and 307 from Google Scholar). In addition to database searching, backward snowballing was conducted to enhance the comprehensiveness of the review. Reference lists of selected review articles were examined to identify additional relevant empirical studies that may not have been captured in the initial database search. Reference lists of selected review articles were examined to identify additional relevant empirical studies that may not have been captured through the initial database search. From that snowballing, 2 publications were gained. So a total of 619 records were initially identified, ready for the next steps.

A diagram flow of the analysis from PRISMA based on articles relevant to the research can be seen in Figure 1. The PRISMA diagram maps the selection and screening process of relevant studies.

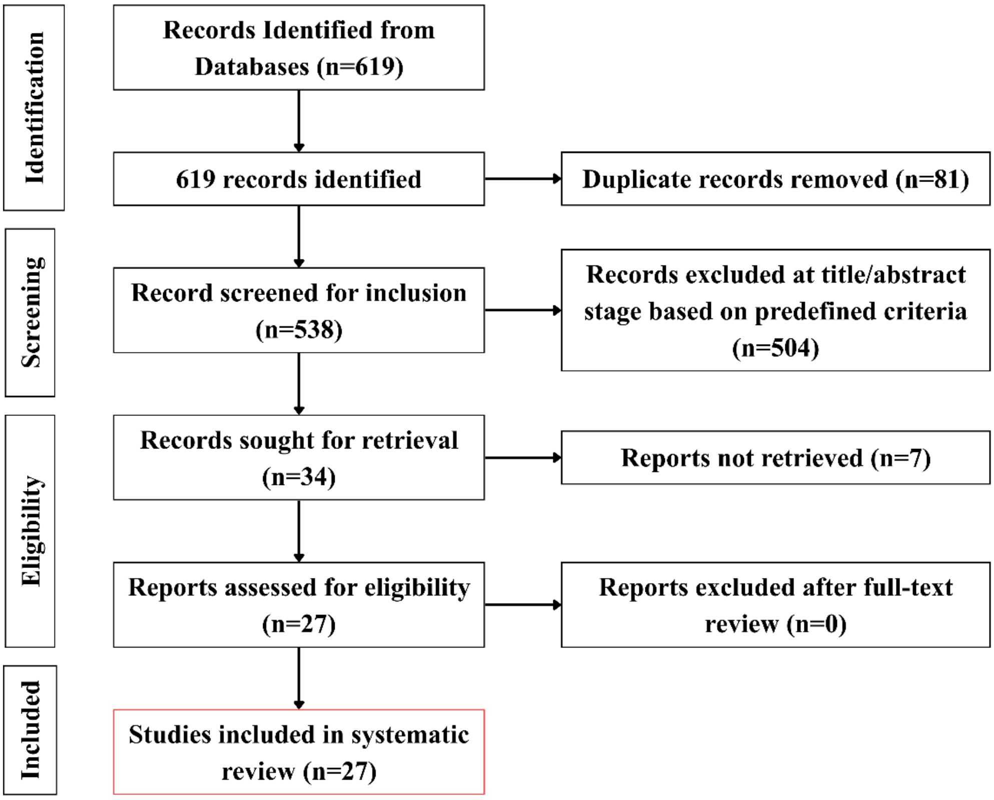

Fig 1. PRISMA flow diagram mapping the selection and screening process of relevant articles for systematic review

D. Study Selection and Screening Process

The process began with the identification stage, where the total number of publications was identified from six different electronic databases, yielding a total of 619 records. All retrieved records were imported into TERA for deduplication. After automated duplicate detection, a manual verification was done of near-duplicate entries, including studies that were not detected in TERA. 81 duplicates were removed, resulting in 538 unique records for the title and abstract screening. Articles were initially screened based on title and abstracts, followed by full-text evaluation using predefined inclusion and exclusion criteria shown in Table I. Only studies involving plant awareness, plant blindness, and plant literacy in secondary education, and with freely accessible full texts, were included. Search terms included a combination of related concepts like botanical literacy, plant appreciation, plant identification learning, attitudes toward plants, plant education, and botany education.

After duplicate removal and title and keywords screening, 34 articles remained for full-text retrieval. Applying predefined inclusion criteria focusing on plant awareness, plant blindness, and plant literacy in secondary school students, school-based research, empirical study design, articles published within the specified year range, English publication, and open-access full-text availability, 27 studies were included in the final dataset that met all the predefined criteria.

The list of included studies is shown in Table III. This rigorous approach ensures quality over relevance studies and supports transparency in article selection and ensures that the discussion is grounded in recent and accessible peer-reviewed literature, increasing the validity and reliability of findings related to plant literacy. The selected studies cover areas of botanical education and plant awareness, including the evaluation of plant blindness in secondary curricula, pedagogical strategies to improve plant identification, and the assessment of student attitudes toward plant conservation. In this way, future studies can create accurate, innovative interventions and reliable insights in efforts to improve understanding and awareness of plants or botany.

This review was conducted with just one reviewer for screening and eligibility. The use of a single reviewer for screening and eligibility created a limit for this study, since it lacked independent verification. Although the full text was assessed against the predefined inclusion and exclusion criteria before a final decision was made. There remains a possibility of selection bias or the exclusion of relevant studies. Nevertheless, the use of clearly defined inclusion and exclusion criteria, together with the screening process, kept things consistent and transparent in article section.

Table III. The list of included studies

No.	Author/Year	Title
S001	Bakar et al. (2020)	Plant and Animal Awareness in Nature Education Perspectives: Where is Blindness?
S002	Marcos-Walias et al. (2023)	Plant Awareness Disparity among Students of Different Educational Levels in Spain
S003	Brcáková et al. (2025)	The connection between Cognitive and Affective Dimensions of Plant Awareness in Relation to Understanding the Cooling Functions of Vegetation
S004	Gubo & Schiffl (2022)	The Development of Students' Interest in and Knowledge of Botany by Means of a Workshop on Pollination and Floral Ecology
S005	Bunnaen et al. (2025)	The Learning Center Development to Create Knowledge, Awareness, and Appreciation Value of Medicinal Plants in Mahasarakham University Demonstration School (Secondary)
S006	Silva et al. (2025)	Dance with plants: Taylor Swift's music videos as advance organizers for meaningful learning in botany
S007	Eugenio-Gozalbo et al. (2020)	Gardens as Science Learning Contexts Across Educational Stages: Learning Assessment Based on Students' Graphic Representations
S008	Diana et al. (2020)	Applying the phenetics approach to improve 21st-century student plant literacy
S009	Gatarira et al. (2026)	Artificial intelligence plant classification complements the dichotomous key to enhance student understanding and

		engagement in plant identification in Rwanda
S010	Wyner & Doherty (2022)	Caring to know a name: An examination of New York City student attitudes towards knowing a tree's name
S011	Torres –Porras et al. (2025)	The plant blindness and the human as non-animal bias cycles in the educational system, and the need to overcome them
S012	Dietrich et al. (2026)	Investigating plant awareness: Image composition affects student perception of floral and fauna
S013	Anggraeni et al. (2021)	Making teaching materials by utilizing the Cibodas Botanical Garden in an effort to improve plant literacy and classification skills of high school students
S014	Safitri et al. (2025)	EduPlant: A design thinking-developed educational kit for plant classification to enhance junior high school students' 21st-century skills
S015	Kriemadi et al. (2026)	Experiencing Biodiversity in Upper Secondary Education and Botanical Gardens Through a Novel Karyotype-Based Educational Approach Using the Genus Tulipa L. as a Model
S016	Sanjaya et al. (2025)	Exploration of Plant Literacy of High School Students in Mentawai: A Quantitative Approach through Inventory, Processing, and Data Reporting
S017	Viney et al. (2026)	Fossil Forests Kits: A Hands-on Approach to Paleobotany and Paleoclimate
S018	Dias et al. (2023)	High School Students' Ethnobotanical knowledge from a Public School in State of Amapá
S019	Gonzaga-Leong-on (2020)	Implementation and Evaluation of 7Es Scientific Inquiry through Plant Assay Guide Manual among Grade 9 Science, Technology, and Engineering (STE) Junior High School Students
S020	Eneng et al. (2025)	Mapping secondary school students' botanical literacy using rasch analysis to support deep learning in science
S021	Pany et al. (2022)	Measuring students' plant awareness: A prerequisite for effective botany education
S022	Fardhani et al. (2025)	Plant Awareness Profile of Junior High School Students by Grade Level and Gender
S023	Finger et al. (2022)	Plant Identification in the 21st Century—What Possibilities Do Modern Identification Keys Offer for Biology Lessons?
S024	Asad & Kramer (2024)	Influence of Practical Work Experience on Biology Academic Performance in Senior Secondary Schools of Yenagoa
S025	Jamaludin et al. (2024)	The Influence Of Medicinal Plant Literacy Through Youtube Media On Ecological Intelligence Via The PBL Model In Social Studies Subjects (Quasi-Experiment At Mts Miftahul Huda Majalengka)
S026	Wulandari et al. (2023)	The Plant Blindness Profile of Secondary School Students
S027	Lampert et al. (2020)	Students' conceptions of plant reproduction processes: This paper was presented at the ERIDOB conference 2020

E. Data Extraction

To ensure a rigorous and consistent review process, a standardized spread sheet was used to extract data from the 27 selected studies. This structured approach was designed to minimize bias, maintain uniformity across studies, and streamline the cross-study synthesis. The extracted information included the title of the study, author(s), year of publication, country conducted, population, diagnostic method used, pedagogical intervention, pedagogical approach, localization, factors or challenges reported that contribute to PAD, key findings, and relevant implications. In this way, the included studies' organized dataset served as the primary foundation for our subsequent thematic synthesis and analysis.

RESULTS AND DISCUSSION

After thorough assessment of the full-text studies from the identification, screening, and eligibility process, a total of 27 studies were included in the systematic review. The studies' eligibility to be included was based on the standard extraction form and the eligibility criteria, focusing on plant awareness, plant literacy, and plant blindness conducted in formal educational settings and focusing on the secondary school students. Overall, the extraction results indicate that the reviewed literature is primarily centered on pedagogical intervention designed to mitigate plant blindness, with a strong emphasis on hands-on and technologically integrated methodologies. The findings reveal that addressing this phenomenon requires a shift from traditional lecture-based instruction toward an inquiry-based approach, or experiential learning, and modern technological integration that significantly enhances student motivation, critical thinking, and overall academic performance. Furthermore, the review highlights the contextualization and localization in botanical education, with a student’s immediate environment and culture acting as a crucial catalyst for increasing plant awareness and literacy.

A. Distribution of the included studies according to diagnostic assessment used, pedagogical intervention, pedagogical approach, localization, and factors or challenges reported that contribute to PAD.

The distribution of the included studies diagnostic assessment used, education intervention, pedagogical approach, localization, and factors or challenges reported that contribute to PAD is summarized in Table IV.

Table IV. Distribution of the included studies according to diagnostic method, pedagogical intervention, localization, and reported challenges

Category	Subcategory	Number of Studies (n)
Diagnostic Method	Standardized Testing	13
	Rating Scales & Questionnaires	16
	Qualitative and Observation Methods	10
Pedagogical Intervention	Experiential Learning	7
	Technology-Based Learning	7
	Alternative Classroom Pedagogy	4
	No Pedagogical Intervention (Baseline Diagnostic Study)	9
	Inquiry-Based Learning	8
Localization	High Localization	17
	Moderate	1
	General/low	9
Reported Challenges	Zoocentrism	12
	Pedagogical Limitations	9
	Operational, Technological, and Resource Friction	6

Note: Some studies reported more than one category; therefore, frequencies under Diagnostic Method and Pedagogical Intervention are overlapping and do not total 27.

The data extraction matrix, shown in Table IV, lays out important trends from the 27 studies on plant blindness and plant literacy. These distributions give us some important insights into where botanical education research stands right now. In the Reported Challenge section, Zoocentrism appeared the most in 12 studies. This term describes the tendency of students to focus more on animals than plants. It was followed by Pedagogical limitations in 9 studies, highlighted that it is because of passive teaching method and overly focused textbook learning. While Operational, Technological, and Resource Friction showed up in only 6 studies which a technology-based intervention was implemented.

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The localization of the studies on the other hand, has appeared to be high with 17 studies. With 17 studies focused on High Localization, we see the importance of resolving plant blindness by making learning about plants part of students' everyday surroundings. By doing this, it directly counters Zoocentrism, by encouraging students to notice the plants around them instead of just focusing on animals. In Diagnostic Method, Rating Scales and Questionnaire have 16 studies, leaned towards measuring perceptions. Looking at Pedagogical Intervention, 9 studies were identified as a Baseline Study without interventions were applied. These studies show that the field is still heavily focused on figuring out exactly what plant blindness or PAD is, before moving on to create interventions. Furthermore, the most common teaching method are Inquiry–Based Learning with 8 studies and Experiential Learning with 7 studies. Followed by Technology-Based Learning and Alternative Classroom Pedagogy, with 6 and 4 studies respectively. Several studies used mixed-method and approaches, which explains the overlapping data in Diagnostic Methods and Pedagogical Intervention categories. The overlap between different assessment methods and teaching strategies shows us that fighting plant blindness needs a mix of approaches. Combining tests on how students think with watching how they behave can really help measure literacy improvements. In addition, these overlaps show recurring themes instead of separate groups.

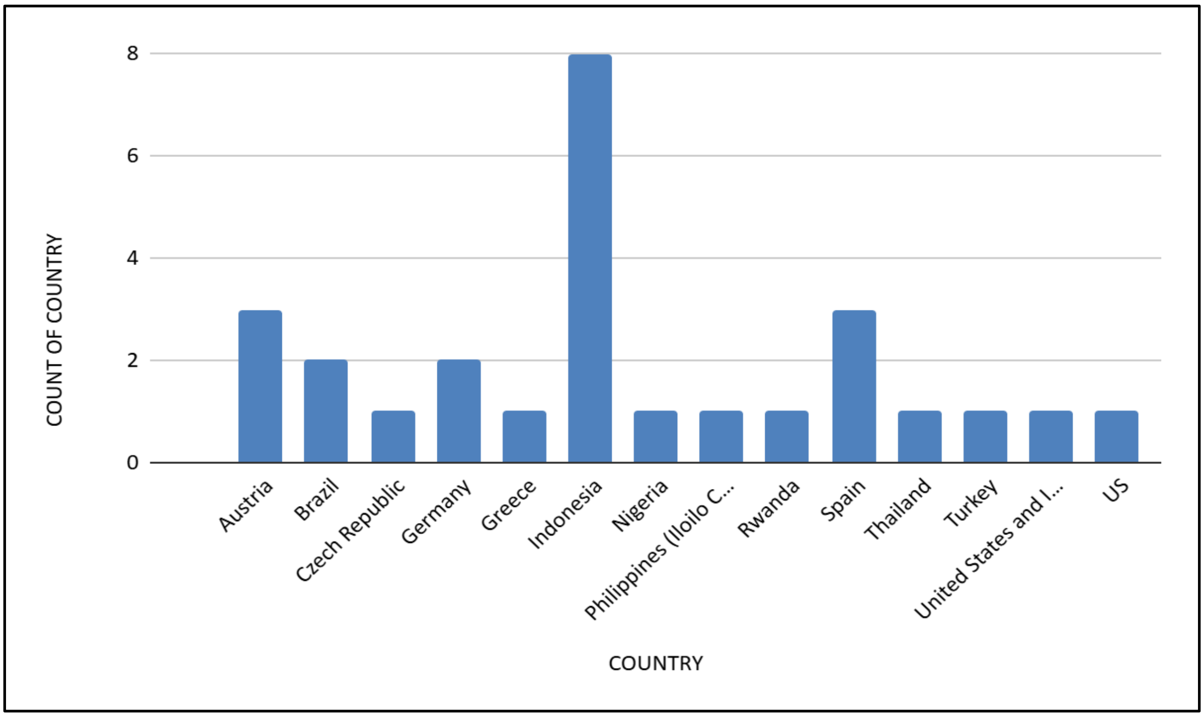

Fig. 2 Geographic distribution of the reviewed study

Moreover, the extracted data on the reviewed studies included the country or geographic location where each study was conducted. A geographic distribution of the included studies can be seen in Figure 2. The data matrix revealed that most of the research about resolving PAD in secondary school students that was conducted in formal educational settings was in the country of Indonesia, which accounts for 8 studies. The Philippines, on the other hand, has only 1 study found from the electronic databases used in this study. This underscores a significant gap and a clear lack of research and local initiative on resolving PAD in Philippine secondary schools. Nevertheless, this study was able to examine themes and patterns that emerged from the included reviewed literature. The categories provide the basis for the thematic discussion presented in the following subsection. These subsections provide valuable insights to inform the development of a contextualized intervention for DepEd schools.

B. Mapping Plant Awareness, PAD, and Plant Literacy

Out of the final set of literature selected for this review, 9 studies were identified as baseline diagnostic studies where no teaching interventions were introduced, while majority of the study incorporated Rating Scales & Questionnaires (n=16). When evaluated collectively, the results of these diagnostic assessments consistently demonstrate that secondary school students exhibit a significantly lower understanding of plant concepts

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compared to their knowledge of animal biology. Specifically, students when evaluated with complex plant mechanisms and their ecological interactions demonstrate a conceptual difficulty in these areas, viewing plant systems as stagnant rather than dynamic. Moreover, the reviewed literature tracks the historical evolution of how botanical perception is conceptualized, defined, and addressed. The phenomenon characterized by an inability to recognize plants in the immediate environment, failure to appreciate ecological importance, and a belief that animals are superior to plants was first termed “plant blindness” by Reference [35]. However, because of its prejudiced connotation, the term was improved by Reference [27] into Plant Awareness Disparity (PAD). To clarify that it is not merely a visual impairment but rather an active, neurological, and cultural filter that can be reversed with proper educational design. Consequently, the term was shifted to "plant literacy" to better align with broader science education goals. Its standard definition as merely species recognition was now highly fragmented across educational contexts. Noted by Reference [26], strictly added that a student cannot become plant-literate if they will not perceive plants as active living organisms and components in our ecosystem rather than just background scenery. That true plant awareness reflects holistic literacy on students' perceptual awareness, cognitive understanding, and affective valuation of plants.

Table V. Summary of reviewed diagnostic studies assessing student plant awareness and literacy

No.	Author/Year	Diagnostic Assessment
S002	Marcos-Walias et al. (2023)	Diagnostic Assessment Tool: Plant Awareness Disparity (PAD) is highly prevalent at all educational levels. Students recognized and identified local animals significantly better than local plants.
S011	Torres-Porras et al. (2025)	Visual Image-Based Questionnaires: The study confirmed the plant blindness hypothesis. When students were asked to identify a living being, students tended to focus on an animal across the two images.
S012	Dietrich et al. (2026)	Written Image Description Tasks: The study empirically confirmed PAD. Plants were generally identified less frequently and described in far less detail than animals.
S016	Sanjaya et al. (2025)	Modified test instruments and questionnaires: The plant literacy of high school students is relatively low, particularly in the “nominal” aspect, which requires the most improvement.
S020	Eneng et al. (2025)	Rasch Analysis (Botanical Literacy Test): The study reveals that students’ understanding of plants remains at a basic level and a severe gap in higher-order thinking skills. Most students possessed only moderate botanical literacy, focusing merely on naming isolated plant parts rather than understanding complex plant-environment interactions.
S021	Pany et al. (2022)	Developed Questionnaire: The study result indicated that students generally consider plants to be less alive than animals but more alive than bacteria.
S022	Fardhani et al. (2025)	Developed Questionnaire: The Junior High School (JHS) students demonstrated a relatively high level of general plant awareness, with one major exception: the attention to plants indicator remained persistently low.
S026	Wulandari et al. (2023)	Open-ended questionnaires: Junior High School (JHS) exhibited a significantly higher rate of plant blindness than Senior High School Students (SHS).
S027	Lampert et al. (2020)	Open-ended paper and pencil task: Secondary students fundamentally misunderstand the plant life cycle.

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To uncover secondary student conceptual boundaries, these reviewed literatures utilize different methods and instruments. Moving beyond standardized testing, 16 of these studies used rating scales and open-ended questionnaires such as the Rasch Analysis [11], Grade-Level Regression [13], and Drawing Diagnostics [21], to map student cognition, shown in Table V. The findings show that students frequently lack a basic understanding of botany, such as naming and identification, which links directly to a decline in plant awareness and a failure to understand how dynamic plant systems function and interact with the environment. Furthermore, these studies help explain why secondary school students show low baseline botanical performance and why their interest dips during early adolescence. Therefore, the reviewed literature supports the need for a more comprehensive baseline assessment framework, one that combines both a written test and creative visual diagnostics to capture a holistic map of student knowledge. Implementing this approach may improve diagnostic frameworks and teaching of plants within biodiversity and biology education. Additionally, the results of these diagnostic studies reveal that the students have more knowledge of animals compared to plants, which leads to the next thematic synthesis. Overall, the reviewed literature reveals secondary education research does not treat plant awareness, PAD, and plant literacy as isolated concepts. They form a linear, interconnected pedagogical framework governing how secondary school students perceive and interact with plants in their environment.

C. Zoocentrism as the Factor of Plant Blindness

Zoocentric factors emerged dominant among the recurring themes within the selected studies, with 12 studies explicitly examining the impact of these factors on students' plant blindness. The synthesized data indicate that most of the examples used in biology curricula to teach life sciences and ecosystems focus on animals, leaving plants less appreciated and understudied. Overall, this disproportionate emphasis establishes a psychological bias toward animals as a default model organism for understanding biology.

Table VI. Reviewed studies documenting zoocentric biases to plant literacy

No.	Author/Year	Zoocentric Factors
S001	Bakar et al. (2020)	Students and humans generally naturally exhibit higher baseline awareness of animals.
S002	Marcos-Walias et al. (2023)	Students had high animal literacy, and it did not strongly correlate with high plant literacy. Moreover, school must implement specific educational programs that actively generate interest in botany, rather than treating plants as background biology.
S006	Silva et al. (2025)	Cause of PAD is multifaceted; one factor is the preference for animals often sees plants as a "background noise.
S011	Torres-Porras et al. (2025)	There is a persistent plant blindness cycle in the educational system. Students know plants are alive but visually perceive them merely as a background for animal life. Due to the perceptual biases of the educational system on animals as an example for living things rather than plants, which actively perpetuates plant blindness.
S012	Dietrich et al. (2026)	Plant blindness is heavily driven by human visual perception and the way educational images are constructed. Results revealed that animals were more easily perceived by students than plants.
S015	Kriemadi et al. (2026)	The authors claim that through their intervention, students can overcome their perception on plants as inferior than animals and can value plants as equally important to animals.
S017	Viney et al. (2026)	Familiarity is the first step in cultivating plant awareness. Traditional education heavily focuses on animal fossils rather than the evolutionary history of plants. The study reveals that the intervention developed focusing on plant fossils has made students realize that plants can also

		become fossils.
S020	Eneng et al. (2025)	Students suffer from Plant Awareness Disparity (PAD) because traditional science curricula overemphasize animals and teach botany as a series of isolated facts to memorize.
S021	Pany et al. (2022)	The results of this study highlight that students consider plants to be less alive than animals but more alive than bacteria.
S022	Fardhani et al. (2025)	Urban students possess basic knowledge about plants; their attention to plants remained persistently low due to the human bias toward animals.
S026	Wulandari et al. (2023)	Junior high school students revealed to have higher plant blindness compared to senior high school students, and this is accordingly because students recognized a plant was frequent visual exposure and consumption. This is also due to the lack of direct interaction with plants, and the school curricula often teach about or use animals as an example in every accessible learning resource.
S027	Lampert et al. (2020)	The result in this study mentioned that students fundamentally misunderstood the plant life cycles. These very students also view biology through a heavily animal-centric lens; the complex, multi-step plant life cycle is highly unintuitive to them.

A common pattern observed across the literature listed on Table VI involves the compounding effects of evolutionary and visual filters. For example, a study of Reference [4] and [10] demonstrates that students' recognition of a living organism depends on its ability to move, sense danger, and display anthropomorphic features. Because plants lack these traits, students often consider them to be merely a "green backdrop" and view them as less alive [26].

Moreover, the school contributes to this bias as the produce textbooks and learning resources highly focuses on animal as an example to teach biology. In addition, a study by Reference [34] and [36], reports that it is not just the students that have plant imperceptions but the teachers as well. This failure to adequately train teachers fails to address this systemic bias, thereby resulting in the transmission of zoocentric prejudice down to the next generation of students. Hence, these findings confirm that PAD is not an accidental learning deficit, but rather the byproduct of psychological, evolutionary, and institutional zoocentrism.

D. Inquiry-Based and Experiential Learning Interventions as Strategies to Reduce PAD

Integrating plant literacy into the secondary educational curriculum requires innovative ways from traditional teaching methods. The extraction data shows that certain interventions and pedagogical approaches are effective in increasing plant literacy. From the 27 articles reviewed a total of 15 articles were obtained that mentioned the importance of experiential and hands-on, inquiry-based learning in teaching botany and across disciplines. Specifically, there are 8 studies that used an inquiry-based learning and 7 in experiential learning. Both pedagogical approaches, when evaluated in a constructivist lens, enhances critical thinking and motivation, leading to improved overall performance in students and reducing PAD compared to theoretical or lecture-based teaching.

The studies listed in Table VII indicate that a traditional, textbook-based lecture promotes passive learning, which has been shown to decrease student interest in plants. To counter this, most of the studies utilize scaffold scientific inquiry. For example, the implementation of 7E laboratory manuals to conduct localized bioassays on plants transformed high school students from being passive observers into active researchers [17]. Similarly, a 5E developmental cytogenetic workshop using *Tulipa* models allows students to prepare microscopic slides and view live chromosomes on plants. This investigation successful bridged the gap between macroscopic plants and microscopic genetics [20]. Another common theme among these studies is experiential modelling which leverages physical, historical, or environmental context to stimulate curiosity, such as the Fossil Forest paleobotany kit [37]. In this study, students built 3D models of plant vascular systems derived directly from 2D micrographs, helping them conceptually reconstruct ancient ecosystems and fix their fragmented understanding of plant life cycles.

These findings suggest that to overcome PAD among students, teachers must implement constructivist learning strategies that encourage active learning and allow students to physically engage with dynamic plant systems. Ultimately, the hands-on, experiential learning strategies utilized in these studies also improve both cognitive retention and motivation, establishing lifelong appreciation for botanical education, compared to traditional or theoretical instruction.

Table VII. Pedagogical Approaches and Interventions of Reviewed Literature Emphasizing Hands-On Plant Education

No.	Author/Year	Pedagogical Intervention
S001	Bakar et al. (2020)	Experiential Learning: I am discovering the nature from microcosms to macrocosms in the Ilgaz Mountain Park
S003	Brcáková et al. (2025)	Technology-Enhanced Outdoor Education combined with Project-Based Learning (PBL) Module
S004	Gubo & Schiffl (2022)	Experiential Learning: Multi-phase interactive Workshop on pollination and floral ecology
S005	Bunnaen et al. (2025)	Experiential Learning and PBL: Medicinal Plant Learning Center
S007	Eugenio-Gozalbo et al. (2020)	Inquiry-Based Science Education: Garden-Based Learning Program
S008	Diana et al. (2020)	Place-Based Education and Contextual Learning: Phenetics Approach
S009	Gatarira et al. (2026)	Technology-Based Pedagogy: Using AI as a scaffold to support and modernize traditional inquiry-based learning.
S010	Wyner & Doherty (2022)	Placed-Based Education and Technology-Based Learning: Using mobile applications to bring scientific observation to the immediate, local environment.
S013	Anggraeni et al. (2021)	Place-Based Education and Contextual Learning: Custom-developed teaching materials (modules) that integrated the local ecological potential of the Cibodas Botanical Garden (CBG)
S015	Kriemadi et al. (2026)	Constructivist 5E Instructional Model and Cooperative Inquiry-Based Experiential Learning: Karyotype-Based Educational Approach (KBEA) using the genus Tulipa L. (tulips) as a model organism
S017	Viney et al. (2026)	Hands-on, Situated Learning, and Object-Based Learning: Fossil Forests STEM Kit
S018	Dias et al. (2023)	Cultural Learning Integrated with Play-Based Learning: Active Creation of Classroom Murals and the Handling of Didactic Educational Games
S019	Gonzaga-Leong-on (2020)	Constructivist: 7Es Scientific Inquiry through Plant Assay Guide Manual (Seminar Workshop)
S023	Finger et al. (2022)	Technology-Based Experiential Learning: The study contrast traditional cognitive scaffolding against modern digital scaffolding to determine which strategy best supports students in overcoming the complexity of botany
S024	Asad & Kramer (2024)	Hands-on Experiential Learning and Practical Engagement: Extensive Practical Biology Sessions

E. Technology-Based Approaches in Botanical Education

Within the 27 included studies, the integration of technology in teaching and learning botany emerged as a prominent intervention, with 7 studies. Results of these studies that utilized technology-based learning, drive student motivation and have improve students' performance in species identification.

The reviewed studies emphasized how technology-based approaches enable cognitive offloading. This process involves using artificial intelligence (AI), mobile applications, advance organizers (AOs), thermovision, augmented reality (AR), and digital media. These tools reduce the weight of memorizing complex terminology, allowing students to identify plants more easily. Research also shows that these technologies decrease field anxiety and save time during tasks. In contrast, one study by Reference [14] challenges these findings, noting that while digital tools yield positive results, a paper-based approach actually leads to a faster success rate for plant identification. Furthermore, evidence suggests a hybrid approach because these issues highlights the drawbacks of over-relying on technology, such as reduced critical thinking and poor long-term memory formation. Consequently, this issue was acknowledged in the study of Reference [15], in which they designed a hybridized workflow. This system allows students to use AI while also using traditional keys to verify morphological traits, thereby blending a lower cognitive workload with high analytical rigor. Similarly, a combination of physical lab instruments with AR brought advanced botanical mapping into underfunded classrooms, directly bypassing the physical infrastructure limitations highlighted under resource friction. Overall, these findings support the need balanced botanical pedagogy that integrates traditional and technology-based strategies, ensuring that students benefit from technological innovations without losing analytical and learning skills.

Table VIII. Technological interventions in botany and their effects on student motivation and plant identification

No.	Author/Year	Technology-Based Approach
S003	Brcáková et al. (2025)	I am discovering the nature from microcosms to macrocosms in the Ilgaz Mountain Park using Thermovision or Thermal Imaging Cameras
S006	Silva et al. (2025)	Advance Organizers (AOs) via Audiovisual Media and Pop Culture Integration
S009	Gatarira et al. (2026)	Hybridized approach combining AI-powered PlantNet application
S010	Wyner, & Doherty (2022)	Localized “street tree” curriculum centered around using a tree identification mobile app (LeafSnap)
S014	Safitri et al. (2025)	Development and limited trial of EduPlant, a versatile educational kit that integrate Augmented Reality (AR)
S023	Finger et al. (2022)	Digital, Polytomous Mobile Application (ID-Logics) equipped with Visual Scaffolding,
S025	Jamaludin et al. (2024)	Implementation of a Problem-Based Learning (PBL) model integrated with Digial Media (YouTube)

F. High Localization: Contextualizing Botany within the Immediate Environment

Contextualization and localization's impact on PAD emerged as one of the recurring themes in the included studies, with 17 studies out of the 27 reviewed studies showing that students exhibit higher academic performance and increased plant awareness and literacy when textbooks, interventions, and integration into formal education curricula are connected to their immediate environment and cultural experiences.

Table IX. Culturally contextualized interventions and their impact on student plant literacy

No.	Author/Year	Localization
S001	Bakar et al. (2020)	The Intervention took place outdoors and focused on the specific local biodiversity of the Ilgaz Mountain Park
S002	Marcos-Walias et al. (2023)	It is a baseline study but the assessment specifically tested students on their knowledge of their local fauna and flora found in their local environment.
S003	Brcáková et al. (2025)	Intervention took students outdoors to actively measure the ecological services of the local vegetation in their immediate environment
S004	Gubo & Schiffl (2022)	The workshop heavily relied on real, physical plant objects (e.g., creeping cinquefoil, geranium, and asters) found directly in the botanical garden.

S005	Bunnaen et al. (2025)	Highly contextualized to local therapeutic flora, specifically focusing on *Solanum trilobatum* L., *Solanum indicum* L., and *Cissus quadrangularis* L.
S007	Eugenio-Gozalbo et al. (2020)	The intervention utilized a localized courtyard garden on the school premises where students interacted directly with the crops they grew.
S009	Gatarira et al. (2026)	Teachers curated a digital repository containing images of various local leaf types. Students analyzed these observable morphological features to connect theoretical classification with real-world plant biodiversity.
S010	Wyner, & Doherty (2022)	The intervention exclusively utilized the local urban street trees that students pass by daily on their way to school.
S013	Anggraeni et al. (2021)	The intervention was built entirely around utilizing the local natural resources and specific flora of the Cibodas Botanical Garden in Cianjur Regency.
S014	Safitri et al. (2025)	The kit explicitly utilizes AR to facilitate local plant identification and requires students to engage in physical herbarium practices, ensuring they interact with flora in their immediate environment.
S016	Sanjaya et al. (2025)	The study explicitly focuses on the local biodiversity context of the Mentawai Islands, arguing that utilizing local plant inventories allows students to engage in an in-depth analysis of their immediate environment.
S017	Viney et al. (2026)	The kit was originally developed for U.S audience but was successfully translated and adapted for an Indonesia version, allowing students to engage with paleobotany in a globally adaptable context.
S018	Dias et al. (2023)	The intervention focused exclusively on the local medicinal plants already utilized by the students' families and communities, especially highlighting botanical families such as Lamiaceae, Asteraceae, Fabaceae, Malvaceae, Myrtaceae, and Rutaceae.
S019	Gonzaga-Leong-on (2020)	The manual explicitly guides students through local plant identification, collection, and the extraction of plant compounds using contextual materials found within their own culture and locality.
S023	Finger et al. (2022)	Used local woody plants (e.g., trees and shrubs) found within the authentic natural surroundings of the students' school environment.
S025	Jamaludin et al. (2024)	The intervention explicitly focused on medicinal plants situated within the student's local school environment, ensuring the learning resource was physically accessible and culturally relevant.
S026	Wulandari et al. (2023)	The study focused on 30 specific local vegetables adapted to the Nate Benuah agricultural area, such as *Luffa aegyptiaca*, *Premna serratifolia*, and *Solanum lasiorcapum.*

As documented in the frequency distribution on Table IV and IX, this heavy clustering toward high localization underscores the importance of contextualization and localization in teaching and learning plant education. These studies explore various ways to connect plant biology to the students' immediate environment. For example, some studies use ethnobotanical integration, where students' baseline knowledge comes from family traditions and wisdom passed down through generations. Interventions incorporating medicinal plants, student-built cultural murals, and peer learning games successfully validate this community wisdom. This bridges the gap between household folk remedies and formal academic taxonomy. Moreover, several studies leverage local, real-world locations to build structured lessons based on local resources. For instance, using the Cibodas Botanical Garden replaces abstract textbook mandates with tangible, regional flora, which drastically improves students' motivation and makes the lesson more experiential, context-rich exercise. Furthermore, some studies show that the integration of everyday dietary flora by utilizing familiar local agricultural vegetables serves as a highly effective, low-barrier entry point to teach complex morphology and ecology. This proves that everyday familiarity is a necessary stepping stone before moving on to advanced biological inquiry. Overall, these approaches focus on utilizing contextualized and localized instructional materials or activities. Therefore, the reviewed literature shares the same findings: that plant literacy cannot be achieved through abstract and universal textbook examples. Instead, cognitive and affective botanical learning must be anchored in the student's immediate environment and cultural wisdom.

CONCLUSION

This systematic review examined the themes and patterns of resolving Plant Awareness Disparity (PAD) in secondary school students conducted in the formal educational setting, with particular attention to the interconnection of plant awareness, PAD, and plant literacy described in studies; factors influencing students' awareness, interest, or understanding of plants; as well as the educational strategies and interventions used to improve PAD or plant-related learning as a basis for contextualized DepEd intervention. Based on the 27 studies included in the review, the findings show that PAD remains a pertinent issue in secondary science education. This issue arises not only because traditional teaching methods, involving a reliance on textbooks, fail to capture the attention of students but also from zoocchauvinism in biology education in schools, which results in a predominance and bias toward animals, treating plants as green background and less alive.

The review further showed that simply adding botanical concepts to the standard education curriculum is not enough to combat plant blindness. This is because traditional, passive instruction naturally defaults to zoocentrism and fails to capture the attention of secondary school students. Hence, the suggestion to use a constructivist approaches in teaching plant education. In addition, the review highlights the importance of the localization of plant instruction materials, activities, or interventions to ensure the cultivation of this crucial competence. Also, students will be able to be hands-on in their learning, as this promotes experiential learning and a learner-centered approach. Moreover, the review also indicates that using advanced technology can also facilitate learning on plants by lowering the students' anxiety and saving time on the complexity of the subject matter. However, these methods not fully eliminate a problem, as they also reduce the cognitive effort needed to understand sophisticated scientific concepts. Thus, no single approach appears to resolve PAD.

RECOMMENDATION

Overall, the findings support a pedagogical intervention that aligns with specific DepEd science competencies across secondary education spectrum:

First, school must mandate a baseline plant awareness diagnostic test prior to instructional design; this ensures that educators can accurately map existing PAD and surface-level misconceptions before implementing targeted lessons.

Second, intervention must be anchored in place-based education. This is achieved by implementing local plant identification activities; utilizing school gardens or immersive plant walks, and deliberately integrating local or indigenous plant knowledge. Synthesizing these elements, botany becomes more than just an abstract, text-heavy topic. It transforms into a science that is deeply tied to specific locales and a culture, while also reduces zoocentrism.

Third, to ensure high cognitive and affective engagement, learning modules should adopt inquiry-based 5E or 7E lesson design. The finding also supports an approach utilizing modern technologies while emphasizing the traditional botanical verification skills. Within these constructivist cycles, technology should not be used alone, the result of the reviewed study support a hybrid use of mobile plant identification apps and traditional dichotomous keys. These hybrid approaches initially lighten cognitive load and makes student more involved and hands-on on the activity. That way, they build up long-term memory and sharpen their critical thinking.

Finally, the literature shows that both learners and educators have visual biases in botany. That is why we need teacher training programs in botany education. Providing this opportunity to teachers will allow them to improve and to effectively manage and teach botany, It is crucial for ending the on-going cycle of treating animal life as more important than plant.

In addition, it should be noted that well-informed learners on plants through education interventions promote interdisciplinary 21st-century skills required of a well-rounded individual. In this regard, the various forms of instruction listed above contribute to developing skills associated with design thinking and prototyping, mathematics and statistics, social sciences, computer proficiency, and personal character development. Hence, future research should evaluate these methods through the lens of the need for a more comprehensive diagnostic assessment framework, one that combines both a written test and creative visual diagnostics to capture a complete picture of student knowledge. Crucially, the successful execution of this multifaceted framework and intervention underscores the urgent need for comprehensive botany training for educators. By fostering a deeper connection with local plants, this intervention ultimately aspires to cultivate long-term environmental stewardship and equip the next generation with the ecological consciousness necessary for sustainable development in the Philippines.

LIMITATIONS OF THE STUDY

This systematic review gives a data-driven overview of strategies and challenges in botanical literacy and Plant Awareness Disparity (PAD). Yet, we need to consider some methodological limitations when looking at the results. First off, the search only included studies in English, excluding studies in other languages like localized interventions and diagnostics. So, there's a potential geographic bias because of the language restriction. Additionally, the literature search was limited to a six-year period from 2020 to 2026. It does get us modern tech advancements, such as AI apps and AR tools. Still, it leaves out earlier foundational work and any long-term trends that started before 2020. So, while the review covers recent innovations, it might miss valuable insights from non-English journals and from relevant studies published before 2020.

Furthermore, the strict need for full-text access and institutional subscriptions left out lots of important stuff, like locked journal articles and private conference info. Valuable secondary school plant data got excluded too, since it wasn't freely accessible. The method used showed big differences in how the 27 chosen studies were done. Things like their basic research designs, where they took place, how many students were involved, and how long their teaching methods lasted all varied. Because of this diversity, doing formal stats analysis wasn't possible. Instead, the author looked at common ideas or themes that recurring. Lastly, one person handled the study in choosing titles, abstracts, and full texts. While there were predefined criteria and structured process set in place beforehand to stay fair and objective, there was still a risk of bias because no other researcher rechecked the data. Having another person verify everything would've helped make the process more reliable.

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