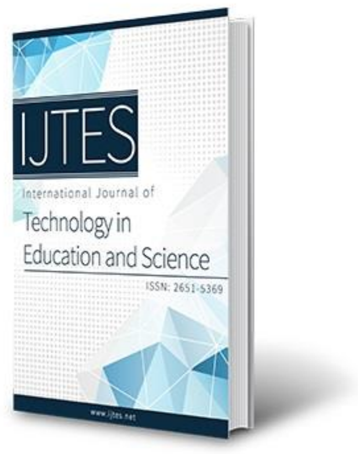

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Development of an Artificial Intelligence-Based Mobile Application Platform: Evaluation of Prospective Science Teachers' Project on Creating Virtual Plant Collections in terms of Plant Blindness and Knowledge

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Development of an Artificial Intelligence-Based Mobile Application Platform: Evaluation of Prospective Science Teachers' Project on Creating Virtual Plant Collections in terms of Plant Blindness and Knowledge

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Abstract

This research aims to investigate the use of an artificial intelligence-based mobile application with plants and plant identification techniques (AImPLANT) with prospective science teachers in outdoor activities. The goals of the study are: i) to develop an AI-based mobile application from scratch based customized for education ii) to enhance knowledge about common plants iii) to increase awareness of plants, animals, and the natural environment, offering solutions to reduce plant blindness iv) to support outdoor activities to observe, identify and taxonomically determine specific characteristics of plants (endemic, economic, health, aesthetic etc.) v) guide students creating an individual virtual herbarium. The research will achieve the expected goals by coding an original "AI-Based Mobile Application" using ChatGPT and PlantNet APIs through technologies like Flutter, Firebase, Firestore, involving approximately 3200 lines of code. The mobile application includes components such as an "Plant collection (herbarium) project module", "AI-based chatbot", "AI-based plant identification module", "AI-based student assessment module", and a "Student assistance section". The application provides guidance in creating virtual plant collections (herbariums). Additionally, aids by the "help module" and "chatbot". Furthermore, an AI-based "self-assessment module" evaluates like a teacher based on the answers. The research question and sub problems were based on prospective science teachers' knowledge about plant identification and taxonomy, plant blindness, and opinions on studying with artificial intelligence outdoors with common plant species. The research, once again showed that artificial intelligence facilitates teaching biology, increases academic success, has positive contributions to eliminating plant blindness, and reduces teacher candidates' concerns about artificial intelligence and affects their opinions positively.

Introduction

Artificial intelligence (AI) is a commonly used general term to describe computers and other intelligent machines simulating cognitive functions attributed to the human mind, like learning and problem-solving (Russell & Norvig, 1995). AI can be conceptualized as bestowing human capabilities such as thinking, interpreting, analyzing, and decision-making on systems like computers, robots, or programs (Asan et al., 2020). AI includes a great diversity of the cognitive domain, like learning, reasoning, planning, problem-solving, perception, natural language processing, deep learning, expert systems, image processing, sentiment analysis, and speech recognition (Asan et al., 2020). AI learns through large data processing with the help of its data analysis and machine-learning techniques and gains more intelligence with the integration of new information (Gür & Ayden, 2019; Holmes, 2020; M. I. Jordan & Mitchell, 2015; LeCun et al., 2015). Over the last decades, the role of AI in the education, usually referred to as Artificial Intelligence in Education (AIED), has been quite significant (Chen et al., 2020).

According to Chen, Chen, and Lin, in the last years, the online and simple web materials that the students used to research and to get high grades with adaptable, web-based intelligent tools. Chassignol et al. (2018) states that AIE is used to improve the learning process of students, afford teachers more potent teaching strategies, and morph schools into more potent learning institutions. With the students having options that are suited to their individual learning style and interest, AIE makes it possible to be pointed towards processes in which one can learn at their own speed, thus making the learning process more effective for them, and affording them the ability to manage their own learning (Brown et al., 2020).

AIE isn't only used for learning content personalization, but it also serves the purpose of tracking and evaluating the students' academic and pedagogical development. For instance, supporting teachers in identifying students' areas of weakness and giving personalized feedback to them increases the performance of the students (Brown et al., 2020). Furthermore, with the monitoring of performance, the recognition of the student's learning problem is done with the help of AI (Siemens & Baker, 2012). It can also be used to monitor the intellectual and social development of the students by identifying the weak and stronger points and offering personalized feedback to them (Koedinger & Corbett, 2005). AI would even be helpful in the development of virtual teachers who would automatically answer questions from the students (Brown et al., 2020; Holmes et al., 2023). These virtual teachers can engage with students interpersonally and interactively, helping them understand the learning materials and making learning more enjoyable (Brown et al., 2020).

Furthermore, AI will be able to give teachers options for better methods of teaching. It can ready teaching materials, plans for learning, and assignments based on the educational level and learning needs of the students. This allows teachers to be more responsive to the needs of students and control learning processes to be more productive (Koedinger & Corbett, 2005). AIE is changing the learning and teaching environment by providing personalization and productivity other than those of traditional education. The introduction of AI in learning environments enhances the increase of educational systems because it unlocks the change of education with growing smart technologies (Coşkun & Gülleroğlu, 2021). AI is able to simulate human intelligence tasks, for example, thinking and learning; it has made the work of educators better in schools and classrooms. Through AIED students are provided with the chance to learn at their own pace; in fact, there are alternatives presented for any student depending on his personal style of learning and his interests, a fact that makes the learning process more effective and the students able to be responsible for their learning processes, as mentioned by the study of Brown et al. (2020).

iNaturalist

One of the commonly used AI platforms in science education research is "iNaturalist," which is a mobile application and website for exploring and documenting nature by nature enthusiasts. Through a community for species identification of animals, plants, fungi, and other organisms from photos, video, and sound recordings, users share their observations of flora and fauna that they encounter in nature. iNaturalist will enable students to be more knowledgeable about wildlife, document their findings, and participate in the research needed for conservation through the availed data that provides information on biodiversity.

The use of iNaturalist in education has been documented to enhance students' engagement in environmental citizenship activities and increase natural environmental knowledge and enhanced levels of environmental literacy (Caruso et al., 2016; Forrester et al., 2017; R. C. Jordan et al., 2012). It increases interest in nature, self-efficacy for carrying out environmental actions, and scientific self-efficacy among students (Smith et al., 2021). Furthermore, such tools, including by iNaturalist, in an activity like BioBlitz, have positive results for students in enhancing their knowledge and awareness of biodiversity and ecosystems and fostering the participation of students in biodiversity conservation activities (Gass et al., 2021). AI-based plant recognition projects, too, constitute an important integral part of making the experience quick and effective for both the students and researchers involved because they can identify accurately and rapidly (Barbosa et al., 2022).

Ickert-Bond & Kaden (2022) evaluated an adaptation of a traditional 'flora class' curriculum at the University of Alaska Fairbanks (UAF) remotely in collaboration with iNaturalist, as a targeting tool, for students in rural locations. Keeping in mind the assumed access limitations, especially for such students, the class was conducted through inexpensive, wide-angle macro lenses to allow students to document the plants in detail and upload their pictures into iNaturalist as a means to participate in this social network of plant enthusiasts from around the world. The other researchers shared the courses they have developed and what problems they have found with the implementation; these were STEM methodologies integrated with AI platforms at a faculty of education. This model enabled students to study local flora in greater detail, improve their plant-identification abilities, add to plant-diversity data, and share this with other, geographically isolated students in other parts of Alaska. For students, based on the AI-driven evaluation and feedback they got about online course delivery, this model appeared to be a success. This is a big step toward enabling quality education for students from rural and geographically isolated areas and also boosting the quality of delivery of such courses.

Smith et al. (2021) assigned a research project to students at universities for their "Environment and Ecology" activities during the spring semester. The students signed up at SciStarter.org and iNaturalist, and made at least one observation of indoor arthropods using iNaturalist for the "Never Home Alone" project. In the fall semester, students collected structured outdoor explorations with the Seek app; identified invasive plants with iNaturalist; used wasp observations to relate biodiversity to studies of invasive species; and learned about pollinators and ecosystem services at the local, regional, and global scales. Lastly, students measured positive and negative perceptions of indoor arthropod diversity, self-perceptions, and societal perceptions of indoor insects. The pre-test mean score of students for interest in nature, self-efficacy for environmental action, interest in science, science learning, and scientific self-efficacy were found to be greater than the post-test mean score.

Gass et al. (2021) tested the enhancement of biodiversity education using BioBlitz events. BioBlitz is an event that aims to identify and conduct the inventory of every living species in an area at a given time, continuously done through iNaturalist and other similar platforms. Students made and posted their observations using the iNaturalist mobile application. The aims of the activities were to sensitize students in relation to biodiversity and ecosystems and engage them in the development of biodiversity conservation. Based on these findings, the study concludes that ecology-based outdoor activities, such as a BioBlitz, can truly be effective instruments in driving the knowledge and awareness of students concerning biodiversity and ecosystemic topics.

ChatGPT

The incorporation of the use of ChatGPT in science education offers a great way to optimize learning experiences. Indeed, some studies have already shown the potential benefits of using chatbots in educational contexts, more specifically within STEM: Science, Technology, Engineering, and Mathematics (Clark, 2023). Chatbots help in giving real-time responses, increasing students' engagement, and further exploring learning through interaction; thus, it becomes a great classroom instrument for teachers (Clark, 2023). It has also been shown that ChatGPT may be used to support the designing of science units, quizzes, and rubrics for this reason, it has much flexibility of meeting a wide range of pedagogical needs (Cooper, 2023). But the use of ChatGPT in education has many positives, hence the many positives' educators need to look at the pros and cons in the use of this technology (Sun & Hoelscher, 2023). Faculty members should design some assignments for developing a critical view of problems to encourage problem-solving and active learning in the learning situation through ChatGPT (Sun & Hoelscher, 2023). In addition, ChatGPT users should have a good command of the subject area to design good questions and analyze the generated response (Araújo, 2024).

More recently, ChatGPT is applied to science education to provide promising results in the provision of both academic answers and support for undergraduate medical education. Besides, ChatGPT is well placed to provide a personalized learning experience, tailored feedback, and realistic simulations of different phenomena to enhance student learning outcomes. However, there will be ethical concerns with the use of ChatGPT and thus require formal design in policy and in training programs in its adoption into education responsibly (Tsang, 2023). After all, integrating ChatGPT into science education will totally transform teaching practices, increase the engagement of the students, and the learning experiences will be personalized. Educators and students both derive much benefit from the properties which interactive, responsive chatbots such as ChatGPT bring to the table to produce a more effective and capable learning space.

Plant Identification and Plant Blindness

Plant identification and plant blindness are crucial topics in science education. Plant blindness, defined as the tendency to overlook plants, has significant implications for conservation efforts (Balding & Williams, 2016). Despite the vital role plants play in sustaining life on Earth, many individuals fail to notice them to the same extent as animals, leading to a lack of awareness about the significance of plants (Nyberg et al., 2019). This phenomenon has been observed across various studies in plant biology, psychology, and education (Balding & Williams, 2016). Education plays a pivotal role in addressing plant blindness and promoting plant awareness. Overcoming plant blindness necessitates valuing and respecting the essence of plants, which is essential for creating a sustainable future (Thomas et al., 2021). Efforts to combat plant blindness involve enhancing plant science education to raise awareness about the importance of plants in the ecosystem (Jose et al., 2019). Teachers need to possess knowledge of plant species and identification skills to effectively teach about biodiversity and sustainability (Palmberg et al., 2019). Research indicates that differences in visual processing between plants and animals may contribute to plant blindness (Nyberg et al., 2019). To tackle this issue, educators should focus on designing instructional strategies that help students compensate for their perceptual limitations and overcome plant blindness (Balas & Momsen, 2014). Initiatives such as outdoor education programs and experiential learning can significantly contribute to increasing plant awareness among students (Lima, 2020; Wu, 2023). The lack of attention towards plants, as evident in plant blindness, poses a significant challenge in biology education (Ahi et al., 2018). To address this, there is a need to integrate plant-focused curriculum content and botanical education initiatives to spark interest in plants among students (Daniel et al., 2023). By enhancing plant awareness and knowledge, individuals can develop a deeper understanding of the ecological functions of plants and contribute to conservation efforts (Sanders et al., 2021).

Recent scholarly investigations in botanical education underline a critical pedagogical shift toward an experiential and technology-integrated learning approach. Borsos et al. (2023) have shown by the study with preservice teachers that the contact with natural conditions when identifying the plant species diversified can help in making a big contribution to the ability of identifying nontraditional groups of plants, such as medicinal and spice plants, which can potentially enrich botanical education in the future. This is reinforced by the findings of Pedrera et al. (2023), declaring the problem of plant blindness and calling for reduction in the curriculum regarding broader biological concepts. In the light of this, botanical education approaches taken a step further with the integration of technology, as seen in the example of Barbosa et al. (2022) where they implement artificial intelligence for plant species recognition, thus opening a promising way of using advanced tools for biological understandings in an entirely new and enhanced way.

All these studies taken together point to multifaceted approaches in botanical education, combining hands-on natural experiences with cutting-edge technological application to increase the effectiveness and engagement of botanical sciences. Pedrera et al. (2023) found out that science teaching should aim at enhancing the student knowledge concerning biodiversity and plant biology and at the same time give the students the ability to be aware and find value in plants. They also pointed out that science education should be able to empower students to make decisions informed by biodiversity and plant biology since both will be of high significance when meeting challenges in life. CONȚIU et al. (2021) discussed that the virtual projects are more effective than the traditional physical herbarium project in all dimensions. Research indicates that experiences in natural settings enable prospective science teachers to identify a wider diversity of plant species more capably, thereby providing an indispensable opportunity in the effective teaching of botanical knowledge to their future students (Ickert-Bond & Kaden, 2022; Smith et al., 2021)

Method

Application Development Process

AImPLANT is developed mobile-based by using Flutter framework, Dart programming language, Firebase development platform, and Firestore database, enhanced by Artificial Intelligence technologies using APIs. The application name is obtained from a combination of two words: "AI" and "I'm Plant," representing a combination of technology and botanical science. The prime functions carried out by the application are facilitated with the help of APIs, thus making it easy for users to find botanical information.

Application Functions and User Interface

The main interface of the application consists of welcome screens, user login, and registration, in addition to the home page. The homepage directs the user to take pictures, create plant collections, interact with a smart chatbot, take quizzes, and ask questions.

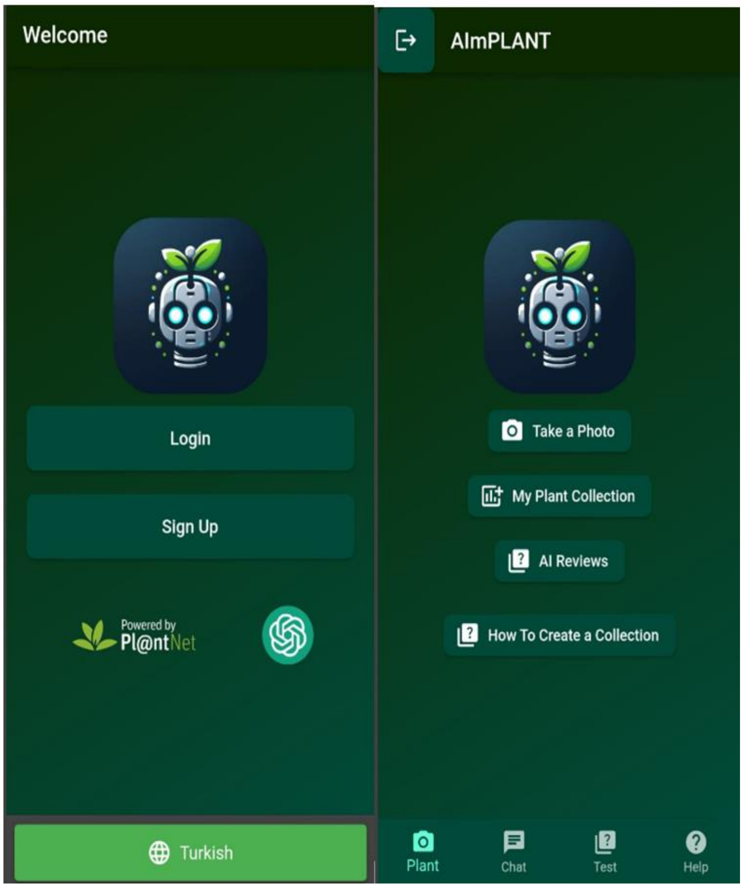

Figure 1. AImPLANT Welcome and Home Screen

Photo Capture and Identification

Users can take photographs of the plants directly from the application, which can be then used to identify with the use of PlantNet and ChatGPT APIs. Identified photos are added to the user's collection.

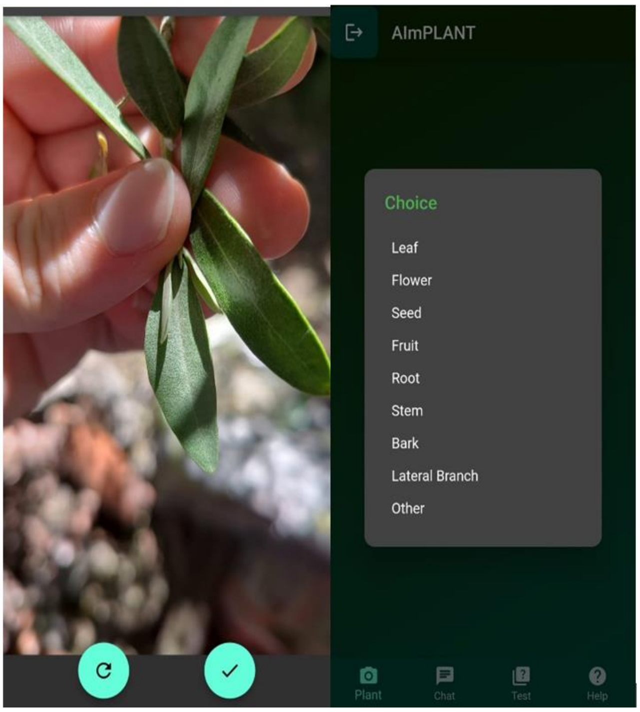

Figure 2. AImPLANT "How to Take Photo?"

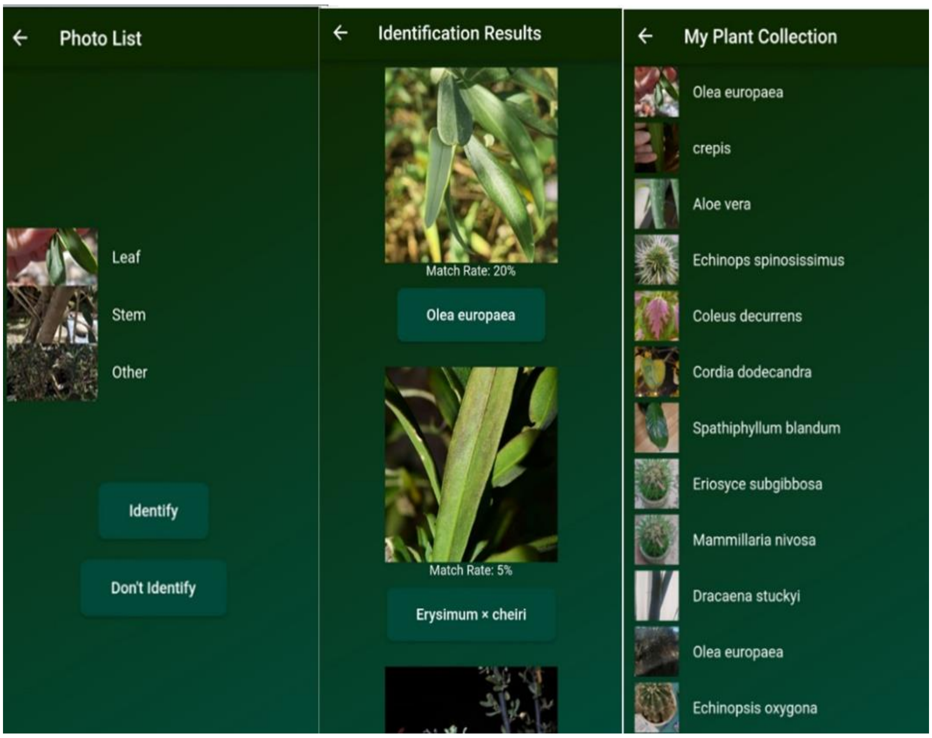

Figure 3. AImPLANT "Photo List", "Identification Results" & "Plant Collection" Screens

Multilingual Support

AImPLANT has interfaces in English and Turkish. This paper elaborates on the Turkish language support, user experience, and the interface effectiveness as tested in this language.

Map Creation Feature

One of the research activities completed with the application was the visualization of geographic locations for plants collected by users, done on a digital map. This mapping functionality facilitates a user's analysis of diversity and distribution of botanical materials collected during field studies.

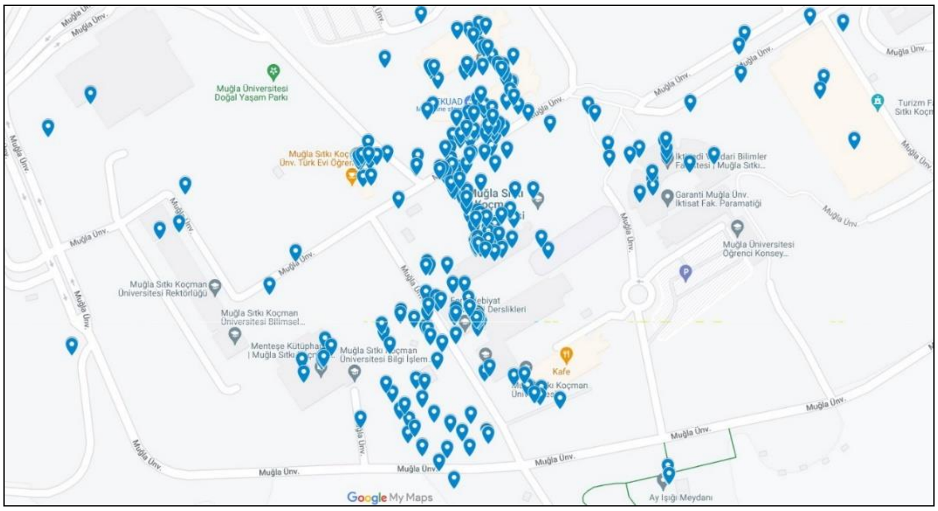

Figure 4. Pre-service Science Teachers Plant Locations in University Campus

The map link used in this research:
https://www.google.com/maps/d/viewer?mid=1HUFSTVVJhWBTjOXxOmn3yQPL92oukY8

Enhanced Test Module Integration

The testing module will be an important development in the redefined methodology for the AImPLANT mobile application. Educators should be able to provide a testing module through an administrative panel pertaining to educational content in the form of tests. This will allow for the testing of the botanical knowledge of participants, which should be conducted within the application itself. This module will automatically score student responses and provide instant feedback with educational insights, run by AI evaluation.

Integration of ChatGPT-Powered Botanical Chatbot

This is supplemented with enhancement to the AImPLANT mobile application's performance—an inbuilt, specially designed chatbot powered by ChatGPT acting as an interactive assistant for botanical information. This way, users are more engaged in conversational, real-time access to a lot of plant knowledge.

Integration of the "Help" Section in AImPLANT

The "Help" section in the AImPLANT application serves as a collaborative, supportive platform for users to reach out for help either anonymously from teachers or from other classmates. This provision is meant to allow an environment of community-driven help with learning and problem-solving in the subject of Botany.

Purposes of the Research

The primary objectives of this research are to investigate the impact of a designed artificial intelligence (AI)-based mobile application, called AImPLANT, on the plant blindness, knowledge levels, and the opinions of the participants toward the use of AI in outdoor activities. AI-Based Mobile Application Development: The project aims to develop an AI-based mobile application that is adapted for extracurricular teaching activities for pre-service teachers.Plant Blindness Identification and Mitigation: Research directed toward the identification and suggestion of ways to mitigate plant blindness through preservice teachers' increased awareness of plants, animals, and the natural environment, especially in urban settings.

Knowledge Acquisition about Plants: This study aimed to enrich and raise levels of knowledge of the participants concerning plants through instructional materials and activities given by the mobile application. This app allows the pre-service teachers to observe plants outside of school, identify and catalogue plants with the developed mobile application, and make a virtual plant collection where practical applications in carrying out scientific research about the plants (tree, bush, herb) are made.Perception of the Preservice Teacher Toward the Mobile Application: Their opinion about the specially developed AI-based mobile application shall play a critical role in drawing the possible impact that this application could bring for educational technologies. This process will be framed with a view to examining the frequency of use, ease of accessibility to this technology, problems faced, and the level of satisfaction with the application. This present research is, therefore, an attempt to understand the potential of AI-based mobile technology in science education, and it is part of those important social objectives: enhancing the environmental awareness of pre-service teachers and reducing the degree of plant blindness.

Research Design

In this research a quasi-experimental design was employed on a single group based on pre-test post-test model. The research group consisted of 2nd, 3rd, and 4th prospective science teachers from the Mathematics & Science Department in Education Faculty of Education at Muğla Sıtkı Koçman University, totaling 24 participants. In research design, the effects of the experimental study were assessed within a single group through activities conducted and evaluated by pre and posttests. The pre-service teachers worked individually in a group of two to four and created a virtual collection of their plants in Muğla Sıtkı Koçman University campus with the AImPLANT application. A significant difference between the pre-test scores and post-test score averages would indicate the effectiveness of the study method.

Table 1. Research Design

Group	Pre-test	Intervention and Activities	Post-test
G_1 (*n*=24)	T_1, T_2	AI-based mobile application in outdoor activities “AImPLANT”	T_1, T_2, T_3

G1: Experimental group; T1: Academic Achievement Test; T2: Plant Awareness Survey; T3: Mobile Application Feedback Form

In this research, AImPLANT was implemented over the Spring Semester of 2023-2024 academic year in the Department of Mathematics and Science Education, with a voluntary sample of 24 prospective science teachers from 2nd, 3rd, and 4th grades.The empirical study involved five weeks of outdoor activities using the mobile application, in which participants developed "Virtual Plant Collections". The evaluation of levels of plant blindness, academic performance, and attitude towards using AImPLANT was observed in this study. The outcome of this process is aimed to display the effectiveness of AImPLANT in enhancing science education.

Data Collection

Academic Achievement Test

The total number of questions posed in the academic performance test was 35, arranged under six categories: "Plant Ecology and Diversity," "Plant Morphology and Anatomy," "Monocotyledonous and Dicotyledonous Plants," "Herbarium Techniques," "Plant Taxonomy," and "Ecosystem Knowledge." The questions designed under each category were constructed to test recall and comprehension of participants or their analytical skills. It is a great test for comprehensive evaluation of participants' knowledge about the basic concepts in botany and for applying the knowledge. As to the validity and reliability of the academic achievement test, this test was administered to 74 participants, and through the Kuder-Richardson formula, the analyses indicated that the test is highly reliable (KR_{20}=0.817, KR_{21}=0.758). Evaluations in Cronbach's Alpha show that the test is very strong in internal consistency (α=0.814). We used Google Forms, which helped us in collecting data in an efficient and effective manner and processing it for easier review of the responses of participants.

Plant Awareness Test

Plant awareness test extracted from İri & Çil (2020) research. The inquiry posed to prospective science teachers aimed to elucidate their awareness of plant varieties prior to and following an educational intervention. The plant awareness survey consists of two parts. For this assessment, participants were requested to spontaneously list ten living organisms that came to mind. This exercise served as both a pre-test and a post-test, enabling an analysis of shifts in their cognitive frameworks concerning plant life, potentially influenced by the intervening educational content. Following this, they were shown a slideshow consisting of 28 images, each displayed for 3 seconds, depicting various living organisms. Upon completion of the slideshow, participants were instructed to list the names of the living organisms they could recall. Subsequently, a post-test was administered to gauge any shifts in plant awareness compared to the pre-test results. This research design aims to elucidate the impact of visual stimuli on the recognition and retention of plant life within the context of science education. These data were collected in a classroom environment face to face with paper and pencil.

Mobile Application Feedback Form

In the scope of this study, several aspects of the user experience associated with the AImPLANT application were investigated. The participants were asked to express their opinions related to the menu and interface design of the application. Their answers were subject to categorizing and analyzing. Then, their opinions and perceptions related to the speed and functioning of the application were sought, and corresponding data underwent similar procedures of categorizing and analyzing. Lastly, the participants were asked to identify the core issues and problems they had encountered while using the application. The issues were similarly categorized and analyzed within corresponding categories. This three-stage approach was viewed as a reasonable way to provide a multidimensional overview of the user experience elements of the application. The data collected in this process was analyzed in detail to assess the extent to which AImPLANT is user-friendly and to identify some potential improvements. To facilitate the process of data collection and analysis, we used Google Forms, which facilitated the process of data collection and streamlines the process of evaluating participant responses.

AImPLANT Outdoor Activity Process

The participants are first given an initial assessment regarding their knowledge level in the first week of the activity. Then, orientation with the mobile application and experimental procedure is thoroughly presented to the teacher candidates. In this discussion, the presentation on how herbaria should be prepared and applied is also presented. Also explained are the advantages and disadvantages of the virtual plant herbaria. Then, instructional focus is given on the functional aspect of the mobile application where step-by-step procedures on how to create an account, how to identify plants using the features of the mobile application, chatbot integration, access to the plant library, and making a virtual herbarium are thoroughly elaborated.

Week two is about the flora of the campus environment. Characteristics, species, and locations of campus plants are identified and described. Basic principles of plant taxonomy are introduced, and their use within the mobile app modules are explored. Participants also learn to effectively utilize the search and filtering features within the mobile application, enhancing their interactive experience with the tool.

The third and the fourth weeks include campus field studies where plants are discovered personally by the participants and samples are collected. These have been analyzed by use of the mobile application to enable a thorough examination of its root, stem, leaf, flower, fruit, and seed characteristics together with the habitat and locational attributes of the plants. In this week the prospective science teachers were asked to record certain features of the added plants to their collection. Documented quite clearly should be the exact place of collection of the plant, like Muğla-Kötekli or in the garden of the Faculty of Science of Muğla Sıtkı Koçman University or campus. Also include the square number from the Flora of Turkey where the plant is registered and other taxonomic classification details like species, subspecies, genus, and family. The plant form should be identified as a tree, shrub, herb, fungus, moss, fern, or algae. It will also be necessary to establish whether the plant is a monocotyledonous (single-seed leaf) or a dicotyledonous (two-seed leaves) one and also whether the plant is gymnosperm (open-seeded) or angiosperm (enclosed seed).

The life cycle of the plant needs to be examined to determine whether the plant is an annual, biennial, or a perennial woody plant. Detailed study of habitat characteristics and the ecotone from which the plant was collected is therefore necessary. That is, in relation to sunlight and shade, attention should be paid to the plant's preference, the physical and chemical nature of soil, moisture in the soil, the topographical and climatic features of the region and other ecological factors. The level of environmental pollution needs to be ascertained, and it should also be stated whether the pollution is natural or manmade. An assessment should also be made for the elements of water, soil and air. In addition, the specific traits of the plant should be included, whether it is an endemic, ornamental, forest plant, or maquis, and whether the plant is vascular (veined). During the study, the presence of organisms, such as fungi, lichens, mosses, parasites, insects, caterpillars, spider webs, and bird nests, living on the plant, must be noted. This approach should be a rich source of information for botanical knowledge for prospective science teachers and, therefore, for their herbarium projects.

The fifth and final week closes with the formal evaluation tests for the participants, which examine the knowledge and skill imparted over the course of the program. Such evaluations often serve as critical indicators of how far the participants have gone and, indeed, how effective the training program was.

Results

Academic Achievement Results

In a research study that sought to determine the influence of an educational application called AImPLANT on academic achievement as far as the plant is concerned, pre-tests and post-tests were given to the upcoming teachers. Since the sample is small and does not meet the threshold limit of 30 suggested for the use of large-sample techniques, we underwent normality checking to justify the use of the statistical treatment. The commonly used normality check that has the potential of achieving very good results is the Shapiro-Wilk test. The results showed that pre-test and post-test has normality distribution (W_{pre}=0.93, P_{pre}=0.12, W_{post}=0.92, P_{post}=0.05).

Table 2. Academic Achievement Test Pre-test and Post-test Statistics

Tests	N	$\bar{x}$	SD	df	t	p
Pre-Test	24	16.71	5.64	23	-6.63	<0.0001
Post-Test	24	21.54	4.87			

Since the pre-test and post-test groups were paired, a "paired sample t-test" was carried out. The calculated t-statistic = -6.63; p-value = <0.0001 was determined and is very significant to reject the null hypothesis. This means that the probability for observed difference between groups to occur randomly is very low, signifying that the difference is statistically significant. These results very much support the fact that the AImPLANT outdoor activities have been efficient in a way such that it has shown an enhancement in participant performance in the post-test.

Plant Awareness Test Results

Plant Awareness Test First Question

For this assessment, participants were requested to spontaneously list ten living organisms that came to mind. This exercise served as both a pre-test and a post-test, enabling an analysis of shifts in their cognitive frameworks concerning plant life, potentially influenced by the intervening educational content.

Table 3. Plant Awareness Test First Question Frequency Results

Category	Pre-test		Post-test		McNemar
	f	%	f	%	P
Plant	68	28.33	136	56.66	<0.001
Animal	163	67.92	99	41.25	<0.001
Others	9	3.75	5	2.08	0.20
Total	240	100	240	100	

Table 4 shows the results of McNemar's test on shifts in the categorization of living organisms from the pre-test to post-test. In essence, the percentage of those identifying as 'Plant' significantly increased from 28.33% in the pre-test to 56.66% in the post-test ($p < 0.001$). On the other hand, the percentage of 'Animal' answers significantly decreased from 67.92% to 41.25% ($p < 0.001$). The percentage of answers in the category 'Others' presented a percentage which does not present significant modification ($p = 0.20$). This means that important changes in the awareness took place in relation to plant life because of the AImPLANT treatment, concerning greater importance given to plants in the hierarchy of living beings.

The Shapiro-Wilk test, a widely used test for assessing the normality of data distribution, was utilized. The results showed that pre-test and post-test has normality distribution (W_{pre}=0.93, P_{pre}=0.12, W_{post}=0.92, P_{post}=0.05).

Table 4. Plant Awareness Test First Question Pre-test and Post-test Statistics

Test	N	x̄	SD	df	t-value	p-value	Difference
Pre-Test	24	2.83	1.86	23	-4.84	<0.0001	Significant
Post-Test	24	5.58	2.17	23			Difference

As shown in Table 5, the computed t-value of -4.84 indicates that the pre-test and post-test scores are significantly different from each other, thereby suggesting that, in the post-test, the respondents provided more answers related to plants than they did in the pre-test. The t-value is negative, representing a great increase in terms of specific responses after the intervention. The p-value is <0.0001, which indicates the difference observed is not a product of random variation; hence, confident findings on the evidence presented are highly assured. All these results firmly confirm the increased effectiveness of the outdoor AImPLANT activities and the improved performance of participants on the post-test to a significant level.

Plant Awareness Test Second Question

A slideshow consisting of 28 images, each displayed for 3 seconds, depicting various living organisms. Upon completion of the slideshow, participants were instructed to list the names of the living organisms they could recall. Table 6 demonstrates that the result of the McNemar test revealed statistically significant changes in the categorization of living organisms between the pre-test and post-test. There is a notable increase in the proportion of responses identifying 'Plant', rising from 36.13% in the pre-test to 45.93% in the post-test. Conversely, the proportion of 'Animal' responses decreased significantly from 63.87% to 54.07%. These findings indicate a significant shift in awareness towards plant life following the AImPLANT intervention, suggesting enhanced recognition and prioritization of plants within the broader context of living organisms.

Table 5. Plant Awareness Test Second Question Frequency Results

Category	Pre-test		Post-test		McNemar
	f	%	f	%	P
Plant	112	36.13	152	45.93	0.0063
Animal	198	63.87	179	54.07	
Total	310	100	331	100	

The Shapiro-Wilk test, a widely used test for assessing the normality of data distribution, was utilized. The results showed that pre-test and post-test has normality distribution (W_{pre}=0.93, P_{pre}=0.11, W_{post}=0.95, P_{post}=0.24).

Table 6. Plant Awareness Test Second Question Pre-test and Post-test Statistics

Test	N	$\bar{x}$	SD	df	t-value	p-value	Difference
Pre-Test	24	4.71	1.83	23	-3.22	0.0038	Significant
Post-Test	24	6.21	2.04	23			Difference

As shown in Table 7, the computed t-value is -3.22, suggesting that respondents' answers to the pre-test and post-test significantly differed; therefore, it can be inferred that the respondents answered more items on plants in the post-test than in the pre-test. A negative t-value, such as this, suggests that the specific answers significantly rose after the intervention. The computed p-value of 0.0038, on the other hand, showed that the difference is not brought about by random sampling; this is, in fact, at a very high level of statistical significance. The results very well confirmed the improvement in post-test performances of the respondents in outdoor activities using the AImPLANT.

Opinions About the AImPLANT Application

This research analyzed various user experience aspects regarding the AImPLANT app. Initially, participants were asked to share their thoughts on the design of the menu and the interface, with their responses being categorized and analyzed. They were also requested to provide their opinions on the speed and functioning of the app, and this data was similarly categorized and analyzed. Finally, participants described the major challenges they faced while using the app, and these issues were also categorized and reviewed. This three-stage system was designed to give a comprehensive analysis of the user experience with the app. The data collected were meticulously analyzed to determine if AImPLANT is user-friendly and to identify potential areas for improvement.

Menu and Interface Design of the AImPLANT Application

Participants were asked, "How did you find the menu and interface design of the AImPLANT application?" The responses have been categorized.

Table 7. Categorized Answers for Menu and Interface Design

Categories	Frequency	Percentage (%)
Positive Answers	18	75.00
Improvement Suggestions	3	12.50
Other	3	12.50
Total	24	100

According to Table 8 results, in the first category, "Positive Responses" are featured. Prospective science teachers generally expressed satisfaction with the application's interface, using phrases such as "It was very beautiful," "Quite attractive and beautiful," and "It had a handy and modern interface." Such comments really prove the application to be user-friendly and presentable, thereby functionally satisfying. The feedback further demonstrates that users have a positive perception of the design of the application, affirming that it facilitates ease of use.In the second category, "Improvement Suggestions" are present. Here, prospective science teachers have indicated that some aspects of the application need enhancement. For example, one user emphasized the need for smoother navigation by stating, "It can be cumbersome to be taken back to the home tab each time I press the back button." Another user highlighted the need for further development with remarks like "It needs better development" and "It's nice but needs improvement in some areas," pointing out that certain features of the application could be further improved.

Speed and Performance of the AImPLANT Application

Participants were asked about their opinions on the speed and performance of the AImPLANT application. Responses were categorized to assess the functionality and user experience of the application. This information has been utilized to analyze the overall performance of the application and identify potential areas for improvement.

Table 8. Categorized Answers for Speed and Performance

Categories	Frequency	Percentage (%)
Positive Answers	16	66.67
Improvement Suggestions	6	25.00
Other	2	8.33
Total	24	100

Participants generally expressed satisfaction with the speed and performance of the application. Responses included statements like "There was no problem with speed," and "It was fast, and responses were quick," indicating that the application operates smoothly and efficiently. Users highlighted that they did not encounter any difficulties in accessing information or performing functions within the application, noting that it served them promptly and generally provided accurate results.However, participants did mention some issues with the speed of certain features of the application, particularly with uploading photos and the slow loading of some images. These feedbacks point to the need for performance improvements in specific functionalities of the application.

Additionally, it was noted that speed reductions could occur when the application was used outdoors, suggesting that work on connection stability and application optimization is required.Some participants also commented on external elements unrelated to the application, though these remarks were in the minority in the overall analysis.

Issues of the AImPLANT Application

Participants were asked the question, "What are the main issues you encounter while using the AImPLANT application?" Responses have been categorized and analyzed accordingly.

Table 9. Categorized Answers for Issues

Categories	Frequency	Percentage (%)
Technical Issues	8	33.33
Learning Phase Challenges	2	8.33
Internet Connection Issues	2	8.33
User Interface Issues	5	20.83
No Problems Encountered	7	29.17
Total	24	100

Participants experienced more issues in the categories of "Technical Problems" and "User Interface Issues," as expected for a prototype application being tested for the first time. Specifically, participants encountered various technical difficulties, particularly with the Android operating system, such as the app not functioning, challenges during photo uploads, response errors, and occasional recognition errors. Additionally, issues like the application freezing and causing the phone to become unresponsive were also reported. Such problems indicate the need for further work on operating system compatibility and stability, which are common issues in the initial release of software.Some participants mentioned difficulties during the learning phase of the application but noted that they became accustomed to using the app over time. This suggests that while the user experience may initially appear complex, participants gradually find the interface more comfortable to navigate.Challenges such as difficult in-app information access, forgetting or misplacing information, highlight the need for a more intuitive and user-friendly interface. Participants also expressed dissatisfaction with the lengthy processes involved in filling out forms and the inability to sort images in collections as desired.

Discussion

The results of the study revealed that utilizing the AImPLANT application significantly enhanced the academic achievement of prospective science teachers in plant knowledge. The substantial improvement from pre-test to post-test scores in the Academic Achievement Test emphasizes the efficiency of integrating AI-based mobile learning tools in educational settings. This confirms existing literature that highlights how AI can tailor learning experiences to individual needs and improve outcomes across various knowledge domains (Chen et al., 2020; Holmes, 2020).Moreover, the increase in plant awareness, as evidenced by the Plant Awareness Test results, underscores a shift toward greater recognition of plant species. This shift is crucial for addressing plant blindness, a significant challenge in biological education as documented by Pedrera et al. (2023) and Brownlee et al. (2023). By offering direct, interactive learning experiences through a mobile platform, AImPLANT may help bridge the educational gap, making plant identification more accessible and engaging.

Technological Integration and User Experience

The use of technologies like Flutter, Dart, and Firebase within AImPLANT underscores the trend toward employing robust, scalable technologies in educational applications. While feedback on the application's interface and functionality is generally positive, there are areas noted for improvement. Addressing these points could further enhance user engagement and learning effectiveness.Challenges, particularly in outdoor settings, indicate the need for further technical enhancements, such as improving the stability and speed of the application under various network conditions. These improvements are vital for the usability of mobile learning tools during outdoor educational activities (Smith et al., 2021).

Implications for Teaching and Learning

The study's findings suggest that AImPLANT and similar AI-enhanced tools could be beneficial in other areas of science education, potentially addressing engagement issues in complex subjects like botany or ecology. Additionally, the application's support for creating virtual herbariums presents a novel learning approach that merges traditional botanical education with modern technology. This hybrid model could serve as a blueprint for integrating hands-on and digital learning across various disciplines, optimizing the benefits of both in-person and digital educational methods.

Conclusion

This research conducted with the prospective science teachers from Muğla Sıtkı Koçman University through the application AImPLANT shows solid proof of means and ways in terms of its effectiveness in integrating artificial intelligence in the settings and how they will result in improved learning outcomes, more so in the context of plant identification and environmental awareness. This study proves the potential of AI tools in decreasing plant blindness and improving botanical knowledge which an educated society with an environmental conscience need.The participants gained knowledge and awareness of plant life from the application of the AImPLANT application, as indicated by the statistical improvements from the pre-test to post-test of the Academic Achievement Test and the Plant Awareness Test. In these terms, AI-enhanced experiential learning in natural contexts might bear a great impact on understanding and retention of environmental knowledge by students.

Participants were generally satisfied with the functionalities and design of the AImPLANT interface, as it is easy to use and contains enjoyable features, such as the AI-driven chatbot and plant identification tools. In opposition, areas of development needs have been identified in terms of performance stability and issues with navigation, thus pointing strongly to the need for continuous development and refining.This further supports the research that AImPLANT is a tool for educational and technology-positive attitude objectives in outdoor scientific investigations. This enables students to be in actual experience with their environments, with immediate feedback on AI closing the gap between the theoretical knowledge gained and the practical use of it.

It is thus final that the AImPLANT project epitomizes how AI would revolutionize practices in education through the dynamic and interactive learning environment personalized to the individual needs of the students. Therefore, in that sense, the research adds to the general discussion about the potential role of AI in education, which is promised to be important because learning in sciences is all about understanding and interacting with the natural world. Future research should continue to pursue these possible uses, expand the capabilities of the application, and find more possibilities for its use in other educational settings and in other disciplines.

References

Ahi, B., Atasoy, V., & Balci, S. (2018). An Analysis of Plant Blindness in Turkish Textbooks Used at the Basic Education Level. *Journal of Baltic Science Education*, *17*(2), 277–287. https://doi.org/10.33225/jbse/18.17.277

Araújo, J. L. (2024). Can ChatGPT Enhance Chemistry Laboratory Teaching? Using Prompt Engineering to Enable AI in Generating Laboratory Activities. *Journal of Chemical Education*. https://doi.org/10.1021/acs.jchemed.3c00745

Asan, O., Bayrak, A. E., & Choudhury, A. (2020). Artificial Intelligence and Human Trust in Healthcare: Focus on Clinicians. *Journal of Medical Internet Research*, *22*(6), e15154. https://doi.org/10.2196/15154

Balas, B., & Momsen, J. L. (2014). Attention "Blinks" Differently for Plants and Animals. *Cbe—Life Sciences Education*, *13*(3), 437–443. https://doi.org/10.1187/cbe.14-05-0080

Balding, M., & Williams, K. (2016). Plant Blindness and the Implications for Plant Conservation. *Conservation Biology*, *30*(6), 1192–1199. https://doi.org/10.1111/cobi.12738

Barbosa, M. R. de V., Vieira, A. O. S., Peixoto, A. L., Canhos, D. A. L., Stehmann, J. R., Menezes, M., & Maia, L. C. (2022). Building Networks to Promote Knowledge of Brazil's Biodiversity: The Experience of the INCT - Virtual Herbarium. *Biodiversity Information Science and Standards*, *6*. https://doi.org/10.3897/biss.6.91462

Borsos, É., Fekete, A. B., & Boric, E. (2023). Have teachers' opinions about outdoor education changed after the pandemic? *Journal of Biological Education*, 1–15. https://doi.org/10.1080/00219266.2023.2192730

Brown, T. B., Mann, B. F., Ryder, N. C., Subbiah, M., Kaplan, J., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A., Ziegler, D. M., Wu, J. C., Winter, C., … Amodei, D. (2020). *Language Models Are Few-Shot Learners*. https://doi.org/10.48550/arxiv.2005.14165

Brownlee, K., Parsley, K. M., & Sabel, J. L. (2023). An analysis of plant awareness disparity within introductory biology textbook images. *Journal of Biological Education, 57*(2), 422-431. https://doi.org/10.1080/00219266.2021.1920301 "

Caruso, J. P., Israel, N., Rowland, K., Lovelace, M. J., & Saunders, M. J. (2016). Citizen Science: The Small World Initiative Improved Lecture Grades and California Critical Thinking Skills Test Scores of Nonscience Major Students at Florida Atlantic University. *Journal of Microbiology & Biology*

Education, *17*(1), 156–162. https://doi.org/10.1128/jmbe.v17i1.1011

Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial Intelligence trends in education: a narrative overview. *Procedia Computer Science*, *136*, 16–24. https://doi.org/10.1016/j.procs.2018.08.233

Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *Ieee Access*, *8*, 75264–75278. https://doi.org/10.1109/access.2020.2988510

Clark, T. M. (2023). Investigating the Use of an Artificial Intelligence Chatbot With General Chemistry Exam Questions. *Journal of Chemical Education*, *100*(5), 1905–1916. https://doi.org/10.1021/acs.jchemed.3c00027

CONȚIU, A., CONȚIU, H.-V., & Toderaș, A. (2021). Students' "Virtual Herbarium" – A Research Project on Plants and Specific Living Environments. *Romanian Review of Geographical Education*, *10*(2), 23–43. https://doi.org/10.23741/rrge220212

Cooper, G. (2023). Examining Science Education in ChatGPT: An Exploratory Study of Generative Artificial Intelligence. *Journal of Science Education and Technology*, *32*(3), 444–452. https://doi.org/10.1007/s10956-023-10039-y

Coşkun, F., & Gülleroğlu, H. D. (2021). Geçmişten Günümüze Yapay Zekanın Gelişimi Ve Eğitim Alanında Kullanılması. *Ankara Universitesi Egitim Bilimleri Fakultesi Dergisi*. https://doi.org/10.30964/auebfd.916220

Daniel, J., Russo, A., & Burford, B. (2023). How Might We Utilise the Concept of Botanic Gardens' in Urban Contexts to Challenge Plant Blindness? *Biodiversity and Conservation*, *32*(7), 2345–2364. https://doi.org/10.1007/s10531-023-02607-w

Forrester, T. D., Baker, M., Costello, R., Kays, R., Parsons, A. W., & McShea, W. J. (2017). Creating advocates for mammal conservation through citizen science. *Biological Conservation*, *208*, 98–105. https://doi.org/10.1016/j.biocon.2016.06.025

Gass, S., Mui, A., Manning, P., Cray, H., & Gibson, L. (2021). Exploring the value of a BioBlitz as a biodiversity education tool in a post-secondary environment. *Environmental Education Research*, *27*(10), 1538–1556. https://doi.org/10.1080/13504622.2021.1960953

Gür, Y. E., & Ayden, C. (2019). *Yapay Zekâ Alanındaki Gelişmelerin İnsan Kaynakları Yönetimine Etkisi*.

Holmes, W. (2020). Artificial Intelligence in Education. In *Encyclopedia of Education and Information Technologies* (pp. 88–103). Springer International Publishing. https://doi.org/10.1007/978-3-030-10576-1_107

Holmes, W., Bialik, M., & Fadel, C. (2023). *Artificial intelligence in education*. Globethics Publications. https://doi.org/10.58863/20.500.12424/4276068

Ickert-Bond, S. M., & Kaden, U. (2022). North to the future: A new asynchronous delivery of the classic "flora class" at the University of Alaska Fairbanks. *Journal of the Botanical Research Institute of Texas*, *16*(1), 343–356. https://doi.org/10.17348/jbrit.v16.i1.1237

İri, F. G., & Çil, E. (2020). Attitudes toward Plants: Comparing the Impact of Instruction through Writing & through a Botanical Garden Trip. *The American Biology Teacher*, *82*(4), 218–226. https://doi.org/10.1525/abt.2020.82.4.218

Jordan, M. I., & Mitchell, T. M. (2015). Machine learning: Trends, perspectives, and prospects. *Science*, *349*(6245), 255–260. https://doi.org/10.1126/science.aaa8415

Jordan, R. C., Ballard, H. L., & Phillips, T. B. (2012). Key issues and new approaches for evaluating citizen-science learning outcomes. *Frontiers in Ecology and the Environment*, *10*(6), 307–309. https://doi.org/10.1890/110280

Jose, S., Wu, C., & Kamoun, S. (2019). Overcoming Plant Blindness in Science, Education, and Society. *Plants People Planet*, *1*(3), 169–172. https://doi.org/10.1002/ppp3.51

Koedinger, K. R., & Corbett, A. (2005). Cognitive Tutors. In *The Cambridge Handbook of the Learning Sciences* (pp. 61–78). Cambridge University Press. https://doi.org/10.1017/CBO9780511816833.006

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature*, *521*(7553), 436–444. https://doi.org/10.1038/nature14539

Lima, M. (2020). Let Them Shine: Insights From an Outdoor Education Initiative for Primary School Students About an Olive Tree Collection. *Preschool and Primary Education*, *8*(2), 130. https://doi.org/10.12681/ppej.21988

Nyberg, E., Brković, I., & Sanders, D. (2019). Beauty, Memories and Symbolic Meaning: Swedish Student Teachers´ Views of Their Favourite Plant and Animal. *Journal of Biological Education*, *55*(1), 31–44. https://doi.org/10.1080/00219266.2019.1643761

Palmberg, I., Kärkkäinen, S., Jeronen, E., Yli-Panula, E., & Persson, C. (2019). Nordic Student Teachers' Views on the Most Efficient Teaching and Learning Methods for Species and Species Identification. *Sustainability*, *11*(19), 5231. https://doi.org/10.3390/su11195231

Pedrera, O., Ortega-Lasuen, U., Ruiz-González, A., Díez, J. R., & Barrutia, O. (2023). Branches of plant blindness and their relationship with biodiversity conceptualisation among secondary students. *Journal of Biological Education*, *57*(3), 566–591. https://doi.org/10.1080/00219266.2021.1933133

Russell, S., & Norvig, P. (1995). A modern, agent-oriented approach to introductory artificial intelligence. *ACM SIGART Bulletin*, *6*(2), 24–26. https://doi.org/10.1145/201977.201989

Sanders, D., Eriksen, B., Gunnarsson, C. M., & Emanuelsson, J. (2021). Seeing the Green Cucumber: Reflections on Variation Theory and Teaching Plant Identification. *Plants People Planet*, *4*(3), 258–268. https://doi.org/10.1002/ppp3.10248

Siemens, G., & Baker, R. S. J. d. (2012). Learning analytics and educational data mining. *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, 252–254. https://doi.org/10.1145/2330601.2330661

Smith, H., Allf, B., Larson, L., Futch, S., Lundgren, L., Pacifici, L., & Cooper, C. (2021). Leveraging Citizen Science in a College Classroom to Build Interest and Efficacy for Science and the Environment. *Citizen Science: Theory and Practice*, *6*(1), 29. https://doi.org/10.5334/cstp.434

Sun, G., & Hoelscher, S. H. (2023). The ChatGPT Storm and What Faculty Can Do. *Nurse Educator*, *48*(3), 119–124. https://doi.org/10.1097/nne.0000000000001390

Thomas, H., Ougham, H. J., & Sanders, D. (2021). Plant Blindness and Sustainability. *International Journal of Sustainability in Higher Education*, *23*(1), 41–57. https://doi.org/10.1108/ijshe-09-2020-0335

Tsang, R. (2023). Practical Applications of ChatGPT in Undergraduate Medical Education. *Journal of Medical Education and Curricular Development*, *10*, 238212052311784. https://doi.org/10.1177/23821205231178449

Wu, M. (2023). Not Just Having Fun: Experiential-learning–based School Field Trips Improved Local Children's Mental Models of the Mangrove Nature Reserve in Shenzhen, China. *People and Nature*, *5*(5), 1697–1716. https://doi.org/10.1002/pan3.10540

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