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Teacher Trainees' Perspectives on Utilizing Artificial Intelligence for Plant Identification at a University in the Eastern Cape Province, South Africa

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ABSTRACT
This study explored teacher trainees' perceptions of using artificial intelligence (AI) for plant identification. Utilizing a constructivist research paradigm and a case study approach, data was collected from Botany teacher trainees through purposeful sampling. The research employed a quantitative method, where participants were asked to install the Plantnet Application on their smartphones to identify various plants for their herbarium project. Out of 100 randomly selected students who received questionnaires with a 5-point Likert scale, 67 completed and returned them. Data analysis was conducted using SPSS software, focusing on descriptive statistics. The results show that satisfaction with AI usage has positively influenced students' attitudes towards scientific plant name knowledge. AI demonstrates the potential to enhance learning methods and develop e-learning platforms tailored to users' needs. The researchers recommend this identification method for its time efficiency and high reliability. Additionally, the Plantnet AI improves the accuracy of scientific names for different species. Ongoing professional development is crucial for in-service science teachers to stay updated with evolving AI technologies and instructional methods. Integrating AI into practical Life Sciences work, including Botany and Zoology, can provide students with comprehensive knowledge of plants and animals while significantly reducing the time needed for traditional species identification. This interdisciplinary approach promotes the development and application of AI technologies in plant identification. Curriculum designers should promote customized online and onsite training focusing on AI integration within science education for in-service teachers. This proactive approach ensures that pre-service teachers enter an environment where AI is already integrated when they become in-service.

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INTRODUCTION
Campbell, Peacock, and Bacon describe PlantNet as an app designed for sharing and retrieving images to identify plants, available on iPhone and iPad.[1] Unlike earlier content-based identification apps, PlantNet can identify plants using various parts such as flowers, leaves, fruits, and bark, and it incorporates user insights. This extensive data collection makes it one of the largest mobile applications for plant identification. Additionally, PlantNet is an accessible and affordable app that

[1] B. G. Tabachnick and L. S. Fidell, *Using Multivariate Statistics*, 5th ed. (Boston: Allyn and Bacon, 2007).

provides both professional ecologists and enthusiasts with a quick and easy way to identify species, eliminating the need for traditional field guides and identification keys.[2] In South Africa's CAPS Grade 10 Life Sciences curriculum, plants and animals are identified on a small scale using manual methods. The researcher identified a gap to explore teacher trainees' attitudes towards using AI for plant identification, which could save time and prepare future teachers to integrate AI into their teaching of diverse plant species.

AI replicates human cognitive functions and behaviors, such as learning and problem-solving.[3] As a branch of computer science, AI employs machine and deep learning algorithms to learn from data and simulate human intelligence. These algorithms are used to create new content from existing text, audio, or images.[4] By dynamically linking input and output variables, AI networks predict outcomes and help solve both simple and complex problems. Technology enhances scientific processes through data collection, calculation, and analysis, necessitating image collection techniques, feature extraction, and data classification algorithms for databases. With various image capture devices available, it is crucial to compare them based on quality, resolution, and adaptability. Algorithms assist scientists in determining the best performance for classification processes, analyzing results, and evaluating the most effective problem-solving methods.

This study seeks to find out what are the various perspectives on artificial intelligence in plant identification among Life Sciences undergraduates?

LITERATURE REVIEW

Artificial Intelligence In Education

Hart *et al*. report that the PlantNet App is the most accurate for plant identification, with a 97% accuracy rate, followed by LeafSnap at 95%, iNaturalist Seek at 93%, GoogleLens at 72%, and PlantSnap at 17%. Identifying plant species in most field sites often requires a comprehensive key.[5] In education, Artificial Intelligence aims to create adaptable and personalized learning environments, offering unique educational opportunities for each student. Ideally, AI would help teachers understand how students learn best by making computational conclusions based on past knowledge, teaching methods, and learning environments.[6] They also mention that AI systems perform complex pattern matching and acquire knowledge. There are two types of AI: rule-based and machine learning-based. The latter provides recommendations or solutions based on decision-making guidelines and is essential in intelligent tutoring systems, offering detailed and individualized feedback. Machine learning-based AI is more effective as it improves over time, especially with large, complex datasets. Bates *et al*. argue that AI can facilitate or even manage the teaching and learning process.[7]

AI assistants like chatbots and techniques for personalizing learning to individual or group needs, as well as any educational software incorporating AI, directly aid the learning process. Chaka notes that AI involves programmed machines simulating human intelligence or software capable of using language, forming concepts, solving problems, and performing cognitive tasks typically reserved for humans, embedded in machine learning and deep learning.[8] This field focuses on developing and evaluating AI systems to improve teaching and learning, underpinning intelligent tutoring systems and virtual environments. Sanusi *et al*. emphasize that AI content is crucial for student achievement, as the

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[2] Patrick Mäder et al., "The Flora Incognita App – Interactive Plant Species Identification," *Methods in Ecology and Evolution* 12, no. 7 (July 14, 2021): 1335–42, https://doi.org/10.1111/2041-210X.13611.

[3] E. Rakovac Bekeš and V. Galzina, "Exploring the Pedagogical Use of AI-Powered Chatbots Educational Perceptions and Practices," in *2023 46th MIPRO ICT and Electronics Convention (MIPRO)* (IEEE, 2023), 636–41, https://doi.org/10.23919/MIPRO57284.2023.10159734.

[4] Ibrahim Khalil et al., "Exploring Primary School Mathematics Teachers' Strategies for Enhancing Students' Mathematical Writing Skills," *J. Educ. Soc. Res* 13 (2023): 196.

[5] Adam G. Hart et al., "Assessing the Accuracy of Free Automated Plant Identification Applications," *People and Nature* 5, no. 3 (June 27, 2023): 929–37, https://doi.org/10.1002/pan3.10460.

[6] Bekeš and Galzina, "Exploring the Pedagogical Use of AI-Powered Chatbots Educational Perceptions and Practices."

[7] Tony Bates et al., "Can Artificial Intelligence Transform Higher Education?," *International Journal of Educational Technology in Higher Education* 17, no. 1 (December 15, 2020): 42, https://doi.org/10.1186/s41239-020-00218-x.

[8] Mpho Chaka and Eyitayo Francis Adanlawo, "The Impact of Ethnicity on South Africa's National Unity," *African Renaissance* 20, no. 2 (2023): 315.

ability to process information, comprehend, and retain knowledge depends significantly on the learning material.[9] To foster interest in AI concepts, content must be carefully designed to motivate and arouse curiosity about how AI operates behind the scenes.

Artificial Intelligence in Plant Identification

Mäder *et al*. indicate that Flora Incognita can identify key biological indicators of local environmental changes by providing spatially and temporally referenced species occurrence data.[10] Computer-based image analysis helps extract morphological features for botanical identification, potentially addressing taxonomic issues that require highly trained specialists who primarily rely on visual identification. Plant morphology remains essential for identifying and classifying plants.[11] Huixian emphasizes that plant leaves are the most crucial recognition organs.[12] With advancements in artificial intelligence and machine vision technology, plant leaf recognition based on image analysis enhances plant classification and protection knowledge. Flogie and Aberšek argue that machine learning algorithms are vital in all AI areas.[13] These systems can learn and improve in perception, language understanding, reasoning, theorem proving, heuristic problem solving, and game playing through learning techniques. Logic programming is closely related to inductive logic programming, which aims to develop logic programs from examples of the target relation.

THEORETICAL FRAMEWORK

The research is underpinned by the Artificial Intelligence Theory. The term "Artificial Intelligence Theory" was introduced by McCarthy in 1956, as noted by Crompton & Burke.[14] This theory envisions machines capable of intelligent reasoning and thinking (Fig.1). AI is currently defined as "computing systems capable of engaging in human-like processes such as learning, adapting, synthesizing, self-correction, and complex data processing tasks." AI theory significantly impacts plant identification, offering numerous benefits and advancements. Utilizing machine learning and deep learning, AI can quickly and accurately analyze vast amounts of data, enabling precise identification of plant species based on images, leaf patterns, and other characteristics.[15] AI-powered plant identification apps and tools simplify the identification process for both experts and amateurs.[16] AI aids in monitoring plant biodiversity, detecting invasive species, and accurately cataloguing plants, supporting conservationists in protecting endangered species and maintaining ecological balance. Additionally, AI streamlines botanical research by automating identification processes, allowing researchers to focus on analysis and discovery. A convergence of the literature with Artificial Intelligence Theory highlights that AI, particularly through machine learning and image recognition, allows for rapid and precise identification of plant species. This is crucial for both ecological research and biodiversity conservation.[17] Vinayak argues that AI-powered tools like the Plantnet App provide an effective

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[9] Ismaila Temitayo Sanusi et al., "Investigating Learners' Competencies for Artificial Intelligence Education in an African K-12 Setting," *Computers and Education Open* 3 (December 2022): 100083, https://doi.org/10.1016/j.caeo.2022.100083.
[10] Mäder et al., "The Flora Incognita App – Interactive Plant Species Identification."
[11] Deborah Bambil et al., "Plant Species Identification Using Color Learning Resources, Shape, Texture, through Machine Learning and Artificial Neural Networks," *Environment Systems and Decisions* 40, no. 4 (December 9, 2020): 480–84, https://doi.org/10.1007/s10669-020-09769-w.
[12] Jiang Huixian, "The Analysis of Plants Image Recognition Based on Deep Learning and Artificial Neural Network," *IEEE Access* 8 (2020): 68828–41, https://doi.org/10.1109/ACCESS.2020.2986946.
[13] Andrej Flogie and Boris Aberšek, "Artificial Intelligence in Education," in *Active Learning - Theory and Practice* (IntechOpen, 2022), https://doi.org/10.5772/intechopen.96498.
[14] Helen Crompton and Diane Burke, "Artificial Intelligence in Higher Education: The State of the Field," *International Journal of Educational Technology in Higher Education* 20, no. 1 (April 24, 2023): 22, https://doi.org/10.1186/s41239-023-00392-8.
[15] Jianbin Xiong et al., "A Review of Plant Phenotypic Image Recognition Technology Based on Deep Learning," *Electronics* 10, no. 1 (January 4, 2021): 81, https://doi.org/10.3390/electronics10010081.
[16] Lizoon Nahar and Nada Tayem, "Empowering Digital Competencies in Environmental Education through AI-Powered Citizen Science Tool: A Case Study of the INaturalist Training Program," in *Society for Information Technology & Teacher Education International Conference* (Association for the Advancement of Computing in Education (AACE), 2024), 2212–19.
[17] Kadukothanahally Nagaraju Shivaprakash et al., "Potential for Artificial Intelligence (AI) and Machine Learning (ML) Applications in Biodiversity Conservation, Managing Forests, and Related Services in India," *Sustainability* 14, no. 12 (June 10, 2022): 7154, https://doi.org/10.3390/su14127154.

teaching aid, helping students and teachers quickly identify plants, thereby enhancing botanical knowledge without consuming much time.[18] In a similar study investigated by Obasi *et al*., they advocate that AI aids in early disease diagnosis, crop yield prediction, and precision agriculture, contributing to sustainable farming practices and food security.[19] Furthermore, AI accelerates plant breeding by analyzing vast datasets to identify superior genetic traits, leading to the development of resilient and high-yielding crops.[20]

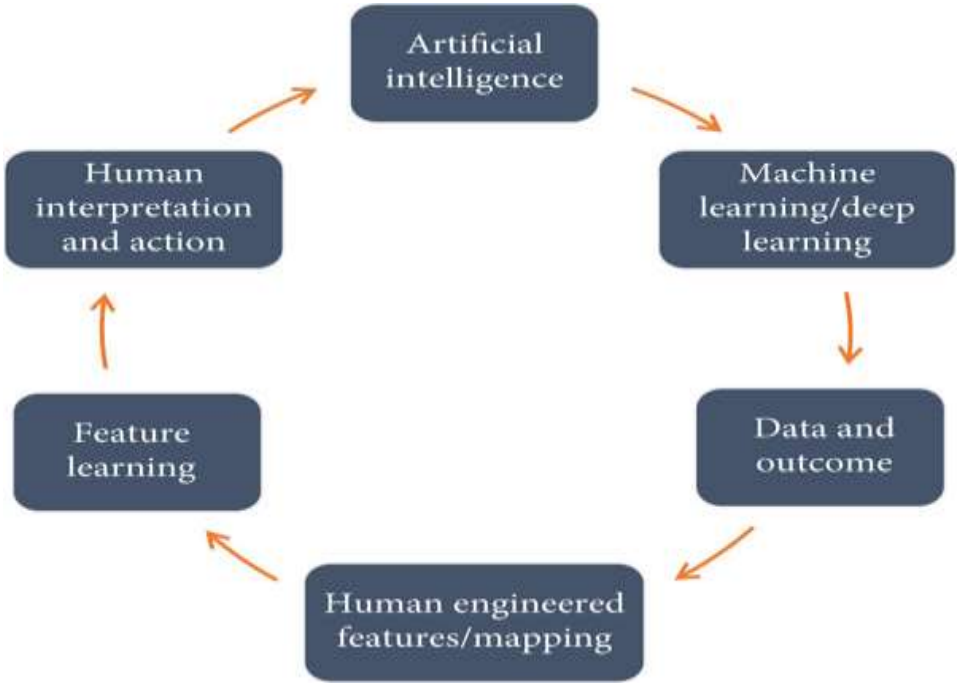

Figure 1: Artificial Intelligence Theory

METHODOLOGY

The study employed a quantitative research approach, deemed most effective for gathering data from students. It also adopted a constructivist approach to explore students' experiences with artificial intelligence in plant identification at the university, using a case study methodology. Out of 120 registered students, 67 consented to participate. The questionnaire, which included items measured on a five-point Likert scale, instructed students to download the free PlantNet App on their smartphones, collect various specimens, and identify them using the app by selecting the plant specimen with the highest accuracy percentage. The questionnaire contained 10 questions about the PlantNet App to assess teacher trainees' attitudes towards artificial intelligence in plant identification. Data was analyzed using the Statistical Package for Social Sciences (SPSS) for descriptive statistics. Respondents remained anonymous, not disclosing their names on the questionnaire. The participating students were surveyed during the school year 2024 after their Botany projects were submitted. The institution's Research Committee approved the ethical clearance certificate for conducting the study, under the reference FEDSRECC014-03-23.

[18] Tamboli Pallavi Vinayak, "Evolution Of Knowledge In Botany: From Ancient Observations To Modern Innovations," *Knowledge Evolution Across Disciplines-Contemporary Trends And Forward Thinking Innovations*, 2024, 171.
[19] S N Obasi et al., "Harnessing Artificial Intelligence For Sustainable Agriculture: A Comprehensive Review Of African Applications In Spatial Analysis And Precision Agriculture."," *Big Data in Agriculture* 6, no. 1 (2024).
[20] Wanchao Zhu et al., "Big Data and Artificial Intelligence-aided Crop Breeding: Progress and Prospects," *Journal of Integrative Plant Biology* 67, no. 3 (March 28, 2025): 722–39, https://doi.org/10.1111/jipb.13791.

PRESENTATION OF FINDINGS

Table1: Descriptive Statistics Table Interpretation

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Gender	67	1,00	2,00	86,00	1,2836	,45414	,982	,293	-1,068	,578
Agerange	67	1,00	2,00	91,00	1,3582	,48309	,605	,293	-1,685	,578
Race	67	1,00	2,00	68,00	1,0149	,12217	8,185	,293	67,000	,578
PlantId gives accurate details regarding the plant	67	1,00	5,00	292,00	4,3582	,77267	-2,350	,293	8,965	,578
PlantId provides trustworthy information of the plant	67	1,00	5,00	289,00	4,3134	,63267	-1,844	,293	9,937	,578
PlantId enhances my academic knowledge about plants in general	67	1,00	5,00	279,00	4,1642	,56668	-2,037	,293	14,095	,578
PlantId motivates me to like Botany	67	2,00	5,00	287,00	4,2836	,54512	-,503	,293	3,063	,578
.PlantId helps to save time compared to looking for plant information in library books.	67	4,00	5,00	285,00	4,2537	,43843	1,158	,293	-,680	,578
I was familiar with Artificial Intelligence before I started university	67	2,00	5,00	274,00	4,0896	,51438	-1,232	,293	7,526	,578
.Artificial Intelligence is a new concept to me.	67	1,00	5,00	142,00	2,1194	,76915	1,438	,293	3,337	,578
.Artificial Intelligence reduces my thinking ability.	67	1,00	5,00	181,00	2,7015	1,04468	,552	,293	-1,093	,578
.Artificial Intelligence is ideal for my career	67	2,00	5,00	269,00	4,0149	,47649	-1,685	,293	9,630	,578
My smartphone helps me in my learning activities.	67	3,0	5,0	293,0	4,373	,5174	,196	,293	-1,210	,578
Valid N (listwise)	67									

Category
5 point Likert Scale of the questionnaire

1 Strongly disagree
2 Disagree
3 Neutral
4 Agree
5 Strongly agree

Range
1 Strongly disagree 1.00-1.80 low negative attitude
2 Disagree 1.90-2.60 negative attitude
3 Neutral 2.70-3.40 moderate attitude
4 Agree 3.50-4.20 positive attitude
5 Strongly agree 4.30- 5.00 high positive attitude

Table 2: Results

Question	Mean	Attitude
1 Plantnet gives accurate details regarding the plant	4.3582	High positive attitude
2 Plantnet provides trustworthy information of the plant.	4.3134	High positive attitude
3 Plantnet enhances my academic knowledge about plants in general	4.1642	Positive attitude
4 Plantnet motivates me to like Botany	4.2836	Positive attitude
5 Plantnet helps to save time compared to looking for plant information in library books.	4.2537	Positive attitude
6 I was familiar with Artificial Intelligence before I started university.	4.0896	Positive attitude
***7** Artificial Intelligence is a new concept to me.*	2.1194	Negative attitude
8 Artificial Intelligence reduces my thinking ability.	2.7015	Moderate attitude
9 Artificial Intelligence is ideal for my career.	4.0149	Positive attitude
10 My smartphone helps me in my learning activities. My smartphone helps me in my learning activities.	4.3731	High positive attitude

Question 1: Plantnet provides precise information about the plant
The average is 4.3582. The value is within the range of 4.30 to 5.00. As a result, Plantnet is praised for providing precise information about plants, resulting in a strong positive attitude.[21]

Question 2: Plantnet offers reliable plant information
The average value is 4.3134. This number lies within the range of 4.30 to 5.00. Consequently, Plantnet receives a strong positive reception for offering reliable plant information.[22]

[21] Zeyun Li, "Factors Influencing Students' Continuous Willingness to Use E-Learning Platforms in Higher Education," *International Journal of Information and Communication Technology Education* 18, no. 3 (October 28, 2022): 1–11, https://doi.org/10.4018/IJICTE.313424.
[22] Hart et al., "Assessing the Accuracy of Free Automated Plant Identification Applications."

Question 3: Plantnet improves my overall understanding of plants in academia
The average is 4.1642. This value is within the range of 3.50 to 4.20, in a positive direction. So, Plantnet is highly regarded for improving their academic understanding of plants.

Question 4: Plantnet inspires me to develop an interest in Botany
The average is 4.2836. This value is within the range of 4.30-5.00 indicating a strong positive attitude towards Plantnet App which drives their interest in Botany.

Question 5: ***Plantnet helps to save time compared to looking for plant information in library books***
The average value is 4.2537. This figure lies within the 4.30-5.00 range. Hence, there is a strong favourable perception of Plantnet, which aids in saving time in comparison to searching for plant details in library books.

Question 6: I was already acquainted with Artificial Intelligence prior to beginning my university studies
The average value equals 4.0896. This number is within the 3.50-4.20 positive range. Consequently, there is a strong positive attitude towards Artificial Intelligence among those who were already familiar with it prior to starting university.

Question 7: I am familiar with the concept of Artificial Intelligence
The average value is 2.1194. This value lies within the negative attitude range of 1.90-2.60. Thus, there is a strong favorable perception of Artificial Intelligence as a novel idea to them.

Question 8: Artificial Intelligence diminishes my cognitive capacity
The average value is 2.7015. The value falls between 2.70 and 3.40 with a moderate perspective Artificial Intelligence diminishes my cognitive capacity.

Question 9: AI is perfect for my profession
The average is 4.0149. This number lies within the range of 3.50-4.20 on the positive side. Consequently, individuals have a strong positive inclination towards Artificial Intelligence in relation to their professional paths.

Question 10: My smartphone assists me with my educational tasks
The average is 4.3731. This number is within the range of 4.30 to 5.00. So, students have a strong favourable opinion about utilizing smartphones for their educational tasks.[23]

[23] Rainer Winkler, Matthias Söllner, and Jan Marco Leimeister, "Enhancing Problem-Solving Skills with Smart Personal Assistant Technology," *Computers & Education* 165 (May 2021): 104148, https://doi.org/10.1016/j.compedu.2021.104148.

Screenshots of some plants identified by teacher trainees using PlantNet App

Figure 1: The PlantApp identified the specimen as Gomphocarpus physocarpus E. Mey

The student selected the specimen with the highest accuracy percentage. *Gomphocarpus physocarpus* E. Mey., commonly known as the balloon plant or swan plant, belongs to the Apocynaceae family. This shrub, which can grow up to 2 meters tall, is notable for its distinctive, balloon-like inflated seed pods. Native to Southern Africa, including regions like Mozambique and South Africa, it thrives in seasonally dry tropical biomes. The plant has various uses, including medicinal applications and as a poison, and is sometimes used for environmental and social purposes. The species epithet "physocarpus" refers to its characteristic inflated seed pods. *Gomphocarpus physocarpus* was first described by the German botanist Ernst Heinrich Friedrich Meyer, abbreviated as E. Mey., who was known for his extensive work on Southern African flora.

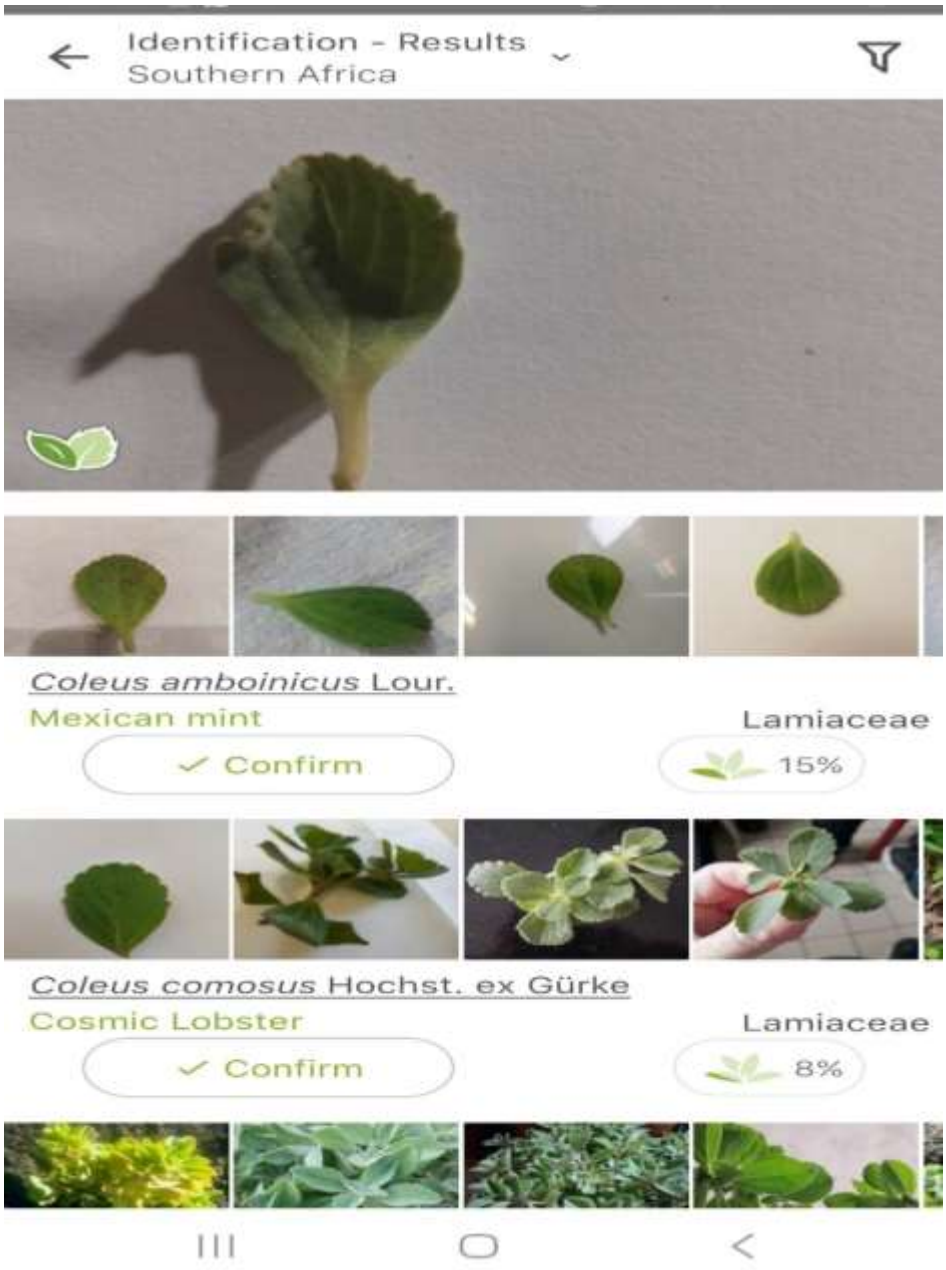

Figure 2: The PlantApp identified the specimen as Coleus amboinicus Lour

The student selecting the specimen with the highest accuracy percentage. *Coleus amboinicus* Lour., also known as *Plectranthus amboinicus* and commonly referred to as Indian borage, Cuban oregano, or Mexican mint, is a perennial herb in the mint family, Lamiaceae. The species epithet "amboinicus" refers to Ambon Island in Indonesia, where it was first described by botanist João de

Loureiro. This semi-succulent plant has fleshy, aromatic leaves with a strong oregano-like flavor and odor. Native to parts of Africa, the Arabian Peninsula, and India, it is widely cultivated in tropical regions. The plant is used both as a culinary herb and in traditional medicine, with its leaves often used in cooking for their strong flavor and various medicinal applications.

DISCUSSION

PlantNet is highly regarded for its accurate plant information, earning a strong reputation. This high average rating indicates that users strongly agree that PlantNet provides precise details about plants, reflecting the app's commitment to reliability. Students view PlantNet as a trustworthy resource for plant information, appreciating its role in enhancing their botanical knowledge and sparking interest in the field. Consequently, there is a strong preference for PlantNet, as it saves time compared to researching plant information in books. Those with prior knowledge of artificial intelligence before university tend to support it significantly and view AI as a groundbreaking concept. While some students feel that AI affects their clarity of thought, opinions vary on its impact on cognitive abilities. Overall, the findings suggest a generally favorable perception of PlantNet and AI, though some areas need improvement in understanding AI concepts, which influences career preferences towards AI. According to Wäldchen and Mäder, AI models can analyze vast amounts of data, including images of plant leaves, flowers, and other parts, to make precise identifications.[24] The study clarifies the role played by Artificial Intelligence in education, precisely in the identification in real-time thus indicating that learning can occur outside the laboratory. Students have displayed positive attitudes towards PlantNet in their plant identification and has capacitated them in botanical knowledge.

RECOMMENDATIONS

Incorporating AI into practical Life Sciences, such as Botany and Zoology, can offer students a thorough understanding of plants and animals while greatly reducing the time required for traditional species identification. This interdisciplinary strategy encourages the development and use of AI technologies in plant identification. Curriculum designers should advocate for tailored online and onsite training that focuses on integrating AI within science education for in-service teachers. This proactive approach ensures that pre-service teachers enter a teaching environment where AI is already integrated when they become in-service.

CONCLUSION

The study concludes that artificial intelligence can be an effective teaching tool for enhancing teacher trainees' understanding and botanical knowledge of plants. The Plantnet App, which utilizes machine learning and image recognition, enables quick and accurate real-time identification of plant species. This research will contribute to Life Sciences education by emphasizing the value of plant identification applications as teaching tools. This is especially advantageous for students and teachers as it saves time.

ACKNOWLEDGEMENTS

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LIMITATIONS

The opinions shared by the students in the study do not accurately reflect those of the broader student body enrolled at the institution.

[24] Jana Wäldchen and Patrick Mäder, "Machine Learning for Image Based Species Identification," *Methods in Ecology and Evolution* 9, no. 11 (November 6, 2018): 2216–25, https://doi.org/10.1111/2041-210X.13075.

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