Asian Journal of Biology Education, 2024
https://doi.org/10.57443/ajbe.16.0_15

Practical Note

Plant Identification Mobile Apps: Users' Difficulties and Impressions

Paulina A. BAWINGAN [1, 2)]*, Emmanuel M. MONTEVIRGEN Jr. [1, 3)], Peter Paul L. CANUTO [1, 4)], Lorna E. LUCAS [1)], Julius C. PUMARAS [1, 5)]

[1)] Saint Louis University, [2)] University of Santo Tomas,
[3)] Lipay National High School, [4)] Ifugao State University,
[5)] Mariano Marcos State University, Philippines

(Received: 8 August 2022, Accepted for publication: 7 March 2024)

In this study, four plant identification mobile apps, namely *LeafSnap*, *PictureThis*, *Pl@ntNet*, and *PlantSnap*, were tried by volunteer participants who are students, teachers, and plant enthusiasts. The participants were asked to take images of at least four plants and upload them to these apps for their identification. The participants were then asked about their impressions of and difficulties with the use of these mobile apps by a questionnaire. Their responses reveal that they found the use of mobile apps interesting, enjoyable, and very useful. It could add to their knowledge of plants, help them connect with nature and the world, and provide data for research purposes. There were, however, difficulties that they encountered with the use of the mobile apps, such as the slow Internet connection, some inconsistencies in identification, and the need to purchase the apps after the trial period. Despite these difficulties, the satisfaction of the users supports the need to explore the idea of using mobile apps in teaching taxonomy or systematic biology among students or even as citizen's science tools.

Keywords: LeafSnap*, mobile apps,* PictureThis, Pl@ntNet, PlantSnap, *plant taxonomy*

***Author for correspondence:** Email address: pbawingan@gmail.com

INTRODUCTION

Plants play significant roles in the ecosystems and human lives. Unfortunately, some individuals show a lack of interest and appreciation of plants regardless of their ecological and economic relevance (Weigelt *et al*., 2021). Wandersee and Schussler (1999) considered this "plant blindness," referring to the lack of recognition among people of the plant's presence in the environment, its significance to the biosphere, and its aesthetic and biological features. Also, Balas and Momsen (2014) showed that most students prefer studying animal species compared to plants. Many people find plant identification much more complex than animal identification (Wang, 2017). Identifying plants through conventional methodologies is demanding, laborious, time-consuming, and requires botanical expertise, making it frustrating for beginners (Goëau *et al*., 2012; Yanikoglu *et al*., 2014; Wäldchen *et al*., 2018; Perera and Arudchelvam, 2021).

The utilization of automated plant identification systems, image recognition technology, apps, and curation of digital plant images have become functionally significant (Yanikoglu *et*

al., 2014; Zhu *et al*., 2016; Boho *et al*., 2020; Jones, 2020). In Serbia, Iskrenovic-Momcilovic (2020) compared the use of mobile identification apps with multimedia teaching using digital herbarium in botanical fieldwork. The results showed that the contribution to the quality and durability of students' learning at cognitive levels of analysis, evaluation, and synthesis is higher in using the mobile application than in multimedia teaching. In China, Wang (2017) also found that plant identification mobile apps in outdoor learning can significantly make the dimension of natural science learning interest and attitude higher than that of non-use of the apps. Several factors, however, affect the efficiency of automated plant identification systems. One is the basis for plant identification by the plant leaf, the most often used plant part and considered the most reliable (Sachar and Kumar, 2021). The leaf is the easiest part of the plant to collect during field studies, and it can provide plenty of data (Perera and Arudchelvam, 2021). The identification of the plant by its leaf depends on shape, color, texture, and venation (Sachar and Kumar, 2021). However, using the leaf as the basis for identification is not always functional due to its diversity and differences in features (Zhang *et al*., 2018). Flowers and fruits may also be used but they have a short span of production (Perera and Arudchelvam, 2021); hence, one has to wait during the flowering season. Whatever plant organ to use, problems in plant identification by mobile apps may be caused by the lack of data presentation and depiction of the organs of the plant (Boho *et al*., 2020), and the quality of the images to be uploaded, and the rareness of some species (Jones, 2020).

Filtered searches in Google Scholar revealed that in the Philippines articles on mobile plant identification apps are mostly related to app development and less focused on its implication for science education. No study has been done on the use of existing plant identification mobile apps in the classroom. Consequently, this study was conducted to test the use of four plant identification mobile apps: *LeafSnap*, *PictureThis*, *Pl@ntNet*, and *PlantSnap*. These mobile apps are readily available online and free to use (at least within a trial period for some of the apps). This study intended to explore the possibility of their use to facilitate classroom learning, particularly on plant taxonomy, by identifying difficulties encountered by the participants with their use of the plant identification mobile apps, their impressions of the use of the apps, their most preferred app, and the reason for their choice. In addition, to determine the potential of plant identification mobile apps as basic taxonomy teaching tools for citizen, plant enthusiasts who are not professional botanists were invited to participate in the study.

MATERIALS AND METHODS

Research Respondents

The participants in this study were 235 senior high school students and undergraduate college students 18 years old and above, and 50 biology teachers and plant enthusiasts. They signified their voluntary participation through an informed consent form after being explained the nature and objectives of the survey.

Research Procedures and the Questionnaire

The participants were instructed to download and install four mobile apps, *LeafSnap 2.21*, *PictureThis 3.9, Pl@ntNet 3.8.1*, and *PlantSnap 5.00.6*, on their smartphones or tablet computers. Next, they were asked to choose at least four plants they would like to know their scientific names and take their clear photos, giving special attention to the details of their leaves and flow-

ers if present. Then, they uploaded the plant photos individually to each plant identification mobile app and waited for the identification result provided by the app. They were requested to take screenshots of the results of plant identification for recording purposes. After using the apps, they were asked to answer a questionnaire on Google Forms.

The following data were gathered from the participants through the questionnaire: (1) their profile which included gender and category (whether they are students, teachers, or plant enthusiasts), (2) the difficulties they encountered when using the mobile apps, (3) their impressions of the use of the mobile apps, and (4) the mobile app they preferred the most and why. Six choices were given for the difficulties (Table 1) and eight items for the impressions. Choices were open-ended to allow the participants to add other difficulties encountered and impressions. For the difficulties, the participants were asked to choose all those that they encountered. For the impressions, the participants evaluated each item using a 5-point Likert scale: 1 = strongly disagree; 2 = disagree; 3= neutral; 4 = agree; and 5 = strongly agree.

The responses of the first fifty participants were subjected to Cronbach's alpha to determine the internal validity and reliability of the questionnaire. The result ($\alpha = 0.93$) showed excellent internal consistency of the questionnaire

Data Analysis

Frequency counts (f) and percentages were computed for the responses on the difficulties encountered and preferred mobile apps, and the median was used to determine the central tendency of participants' impressions.

Ethics Statement

All participants declared their voluntary participation in the study through a prior informed consent form. Participants, especially the students, were given sufficient time (two weeks) to do the activity at their most convenient time.

RESULTS AND DISCUSSION

Problems Encountered

As shown in Table 1, the students, teachers, and plant enthusiasts encountered similar problems or difficulties when they used the plant identification apps. The foremost encountered problem was the slow network connection, the second was the limited number of shots to be

Table 1: Difficulties encountered by the respondents in the use of the mobile apps

Difficulties encountered	Teachers and Plant Enthusiasts (n=50)	Students (n=235)		Total (n=285)	
	f*	**f***	**%**	**f***	**%**
1. Slow network connection affects the use of mobile apps.	34	150	63.8	184	64.6
2. The mobile apps have a limited number of shots per day.	19	105	44.7	124	43.5
3. We need to purchase the apps after a period of trial.	16	51	21.7	67	23.5
4. Plant identification varies among the mobile apps.	15	46	19.6	61	21.4
5. The mobile apps require a more sophisticated mobile operating system.	6	33	14.0	39	13.7
6. The mobile apps are too complicated to use.	5	15	6.4	20	7.0

*f: frequency counts

taken per day, the third was the need to purchase the apps, and the fourth was the inconsistency in the names of the plants provided by the apps. A small number of participants considered the mobile phone operating system as a problem or complicated to use.

The slow network connection that primarily affected the use of the plant identification apps among all the users (Table 1, item No. 1) reflected the poor Internet connection in the country (Natividad, 2021 Feb. 22). The poor and declining performance of Internet services is an unfortunate reality due to the country's weak telecommunications infrastructure, a lack of good information and communications technology (ICT) tools, low engagement of the citizens, insufficient capacity and training, the country's archipelagic and geographic environment (Salac and Kim, 2016), and the high cost of Internet services and subscriptions (Albert *et al*., 2016; Natividad, 2021 Feb 22). The limited number of shots per day (No. 2) and the need to purchase mobile apps (No. 3) are dependent on each of the app's features. Varied plant identification among the apps (No.4) could be due to the clarity of the photos taken, the rareness of the plant species, and whether the plant is included in the app's database. A few participants may have used phone models that lack the more sophisticated operating system required by the plant identification apps (No. 5) indicating that the app may not work efficiently on some phone models, especially the older models. However, similar to app operation complexity (No. 6), system sophistication requirements could be due to a lack of understanding of the instructions for the use of the apps.

Impressions on the Use of the Plant Identification Mobile Apps

Despite these difficulties, the participants gave favorable impressions of their use of the plant identification mobile apps (Table 2). Eight items were presented to the participants (No. 1 - 8), but two items (No. 9 - 10) were added by the participants. The median response for almost all items was 5 (strongly agree). The only response that was not given a median score of 5 by both the teachers and plant enthusiasts, and students was item No. 6, and those by teachers and plant enthusiasts were item No. 1 and No. 5.

Table 2: Impressions of the Participants on their Use of the Mobile Apps

Respondents' reactions	Median of Reactions*	
	Teachers and Plant Enthusiasts	Students
1. I find the mobile apps interesting and enjoyable.	4.5	5
2. It is user-friendly.	5	5
3. The mobile apps are content-rich, and I learned a lot about the plants.	5	5
4. I find the mobile apps useful in plant identification.	5	5
5. The mobile apps are easily accessible.	4.5	5
6. The plant identification is consistent in all four mobile apps.	4.5	4
7. The mobile apps are collaborative citizen science tools.	5	5
8. The mobile apps help me connect with nature and the world.	5	5
9. The mobile apps can be good sources of research data.	5	5
10. I will recommend its use to friends/colleagues/classmates.	5	5

*5-point Likert scale: 1 = lowest score (strongly disagree) and 5 = highest score (strongly agree).

Not only did the students find the mobile apps interesting and enjoyable but they also learned a lot about the plants. They may even have gained information not usually presented in their textbooks. The students' and teachers' impressions regarding the use of the plant identification mobile apps indicate that the teachers can adopt the use of these plant mobile apps in their teaching. The plant enthusiasts also found enjoyment in the activity while acquiring knowledge about the plants.

With the evolution of technology and the Internet, mobile learning has become a new field in educational applications (Fu and Li, 2010 as cited by Wang, 2017). The results of this study showed the great potential of the use of the four mobile apps *LeafSnap*, *PictureThis*, *Pl@ntNet*, and *PlantSnap* as a classroom teaching tool in plant taxonomy and even as a citizen's science teaching material. The use of plant recognition and learning mobile apps based on an expert system can allow students to flexibly and fully understand different plant genera and species and enable them to learn about these plants more actively and excitingly outdoors. Automated plant identification systems provide potential users with powerful tools to record, collect, and share images of plant species (Boho *et al.*, 2020). The use of these mobile apps is e-learning that not only allows the students to widen their knowledge, skills, and experiences but also provides opportunities for interactive learning and collaboration. Most of all, learning can be enjoyable. All these advantages that mobile apps provide may contribute to diminishing the so-called "plant blindness" that many manifest; instead, a greater appreciation for plants would develop.

Preferred Plant Identification Mobile Apps

Based on their learning and user satisfaction, the participants preferred one or two plant identification mobile apps. For the students, the most preferred app was *LeafSnap* (37.4%), next was PictureThis (31.3%), *Pl@ntNet* came next (19.8%), and last was *PlantSnap* (11.5%). The teachers and plant enthusiasts had the same order of preference: *LeafSnap* (36%), *PictureThis* (28%), *Pl@ntNet* (20%), and *PlantSnap* (16%).

According to the respondents *LeafSnap* was the most user-friendly because it has no limit on the photos to upload per day, provides the fastest identification and most accurate plant identification, and describes other interesting features about the plant. The most stated reason for the choice of *PictureThis* was the richness of information about the plant. It includes the plant's name story, its exciting facts, and its symbolism. In addition, it also gives users tips and simple instructions on how to take care of the plant. Most importantly, compared to the other apps, *PictureThis* blocks unnecessary ads. Some respondents liked *PlantSnap* because it is user-friendly and very informative. Others chose *Pl@ntNet* because of its high accurate identification rate and the inclusion of the author's information in the species name. A few participants chose all apps because they believe all are important in plant identification and are easy to use.

The fact that many participants prefer apps that provide more information about the plants suggests that existing apps should consider this when they upgrade or develop other versions. In addition, enrichment of the database of these apps, especially adding the profiles and IDs of wild and rare plants is essential. Contributions among the users are, therefore, necessary for the structured observations of species, which enhance the future improvement of these automatic plant identification systems (Rzanny *et al.*, 2019).

Despite some limitations, exploring plant identification mobile apps to enhance the learning of plants and plant taxonomy is advisable, timely, and relevant. Almost every student has a smartphone or a tablet and can be connected to the Internet at any time. Since the apps used in the present study were shown to be interesting and enjoyable to use besides being informative, their use can supplement traditional methods in teaching plant taxonomy.

ACKNOWLEDGMENT

Our heartfelt gratitude goes to all the participants who made this research possible.

REFERENCES

Balas, B. and 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

Boho, D., Rzanny, M., Wäldchen, J., Nitsche, F., Deggelmann, A., Wittich, H. C., Seeland, M. and Mäder, P. (2020) Flora Capture: a citizen science application for collecting structured plant observations *BMC Bioinformatics* 21: 576. https://doi.org/10.1186/s12859-020-03920-9 https://doi.org/10.15173/ijsap.v3i2.3671

Goëau, H., Bonnet. P., Barbe, J., Bakic, V., Joly, A. and Molino, J-F. (2012) Multi-organ plant identification. *MAED '12: Proceedings of the 1st ACM International Workshop on Multimedia Analysis for Ecological Data - November 2012*. pp. 41-44. http://doi.org/10.1145/2390832.2390843

Iskrenovic-Momcilovic, O. (2020) Contribution of using mobile application on botanical fieldwork in primary school. *Interactive Learning Environments*: 1-13. https://doi.org/10.1080/10494820.2020.1826531

Jones, H. G. (2020) What plant is that? Tests of automated image recognition apps for plant identification on plants from the British flora. *AoB PLANTS* **12**(6): plaa052. https://doi.org/10.1093/aobpla/plaa052

Pärtel, J., Pärtel, M. and Wäldchen, J. (2021) Plant image identification application demonstrates high accuracy in Northern Europe. *AoB PLANTS* **13**(4): plab050. https://doi.org/10.1093/aobpla/plab050

Perera, P. S. T. and Arudchelvam, T. (2021) Leaf-based plant identification system for Sri Lankan medicinal plant. *In*: Arai, K. (ed.) *Advances in Information and Communication. Proceedings of the 2021 Future of Information and Communication Conference (FICC), Volume 2.* pp. 831–836. Springer Cham. https://doi.org/10.1007/978-3-030-73103-8_59

Rzanny, M., Mäder, P., Deggelmann, A., Chen, M. and Wäldchen, J. (2019) Flowers, leaves or both? How to obtain suitable images for automated plant identification. *Plant Methods* **15**: 77. https://doi.org/10.1186/s13007-019-0462-4

Sachar, S. and Kumar, A. (2021) Automatic plant identification using transfer learning. *IOP Conference Series: Materials Science and Engineering* **1022**: 012086. https://doi.org/10.1088/1757-899X/1022/1/012086

Salac, R. A. and Kim, Y. S. (2016) A study on the Internet connectivity in the Philippines. *Asia-Pacific Journal of Business Review* **1**(1): 67-88. http://dx.doi.org/10.20522/APJBR.2016.1.1.67

Wandersee, J. H. and Schussler, E. E. (1999) Preventing plant blindness. *The American Biology Teacher* 61(2): 82-86. http://online.ucpress.edu/abt/article-pdf/61/2/82/48775/4450624.pdf

Wang, C. (2017) The research on the application of plant identification and mobile learning APP based on expert system. *In*: Escudeiro, P., Costagliola, G., Zvacek, S., Uhomoibhi, J. and McLaren, B. M. (eds.) *Proceedings of the 9th International Conference on Computer Supported Education (CSEDU) - Volume 2*, pp. 332-339. SCITEPRESS. https://doi.org/10.5220/0006313103320339

Wäldchen, J., Rzanny, M., Seeland, M. and Mäder, P. (2018) Automated plant species identification-Trends and future directions. *PLoS Computational Biology* **14**(4): e1005993. https://doi.org/10.1371/journal.pcbi.1005993

Weigelt, P., Denelle, P., Brambach, F. and Kreft, H. (2021) BotanizeR: A flexible R package with Shiny app to practice plant identification for online teaching and beyond. *Plants, People, Planet* **4**(2): 122-127. https://doi.org/10.1002/ppp3.10226

Yanikoglu, B., Aptoula, E. and Tirkaz, C. (2014) Automatic plant identification from photographs. *Machine Vision and Applications* **25**: 1369-1383. http://doi.org/10.1007/s00138-014-0612-7

Zhang, S., Huang, W. and Wang, Z. (2018) Plant species identification based on modified local discriminant projection. *Neural Computing and Applications* **32**: 16329–16336. https://doi.org/10.1007/s00521-018-3746-0

Zhu, H., Huang, X., Zhang, S. and Yuen, P. C. (2016) Plant identification via multipath sparse coding. *Multimedia Tools and Applications* **76**: 4599–4615. https://doi.org/10.1007/s11042-016-3538-4

WEBSITES

Albert, J. R. G., Serafica, R. B. and Lumbera, B. T. (2016) Examining trends in ICT statistics: How does the Philippines fare in ICT? *PIDS Discussion Paper* Series No. 2016-16. Philippine Institute for Development Studies (PIDS), Quezon City. *ECONSTOR.* Retrieved: August 10, 2022, from https://www.econstor.eu/handle/10419/173537?locale=en

Natividad, N. (2021, February 22). Why Internet speeds in the Philippines are so slow. *Vice World News.* Retrieved: August 15, 2021, from https://www.vice.com/en/article/n7vy3m/why-internet-speeds-philippines-slow-laws

MOBILE APPS

LeafSnap: http://leafsnap.app/

PictureThis: http://www.picturethisai.com/

Pl@ntNet: https://pl@ntnet.or/en/

PlantSnap: https://www.plantsnap.com/