Biosfer: Jurnal Pendidikan Biologi

Journal homepage: http://journal.unj.ac.id/unj/index.php/biosfer

Comparison of plant identifier application ability as a recommendation for biology learning

Asrizal Wahdan Wilsa[1*], Sunyoto Eko Nugroho[2], Agung Tri Prasetyo[2]

[1] Elementary School Teacher Education Program, STKIP Nahdlatul Ulama Indramayu, Indonesia.
[2] Natural Science Education, Postgraduate Program, Universitas Negeri Semarang, Indonesia.

*Corresponding author: asrizalwahdanwilsa@stkipnu.ac.id

ARTICLE INFO

Article history
Received: 05 December 2022
Revised: 26 March 2023
Accepted: 30 March 2023

Keywords:
Biology Learning
Plant Classification
Plant Identification
Plant Identifier Application.

ABSTRACT

This study aims to test the ability of the Plant Identifier application to identify plants as a recommendation for biology learning and practicum on plant identification and classification materials. The applications used in this research are Google Lens, Plant Net, Picture This, and Leaf Snap. Object samples include moss plants, ferns, dicot plants, and monocot plants. This study uses the VES (Visual Encounter Survey) method with an exploratory-descriptive approach. Application testing includes the speed of object detection, the accuracy of detecting objects based on shape and color, as well as the completeness of plant taxonomy information which includes division, class, order, family, genus, and species. The results of application testing show that: (1) the Google Lens and Picture This applications are superior in terms of speed in detecting objects, (2) Google Lens and Picture This are also superior in terms of accuracy in detecting objects based on shape and color, (3) the Picture This application is an application superior in completeness of taxonomic information. Based on these findings it can be concluded that the Picture This application is the most superior application and can be a recommendation for biology learning and practicum on plant identification and classification materials.

Wilsa, A., Nugroho, S. E., & Prasetyo, A. (2023). Comparison of plant identifier application ability as a recommendation for biology learning. *Biosfer: Jurnal Pendidikan Biologi, 16*(1), 55-65. https://doi.org/10.21009/biosferjpb.31488

INTRODUCTION

The level of biodiversity in Indonesia is one of the largest in the world so that Indonesia is called a Mega Biodiversity Country. This is because Indonesia is located between two continents, namely Asia and Australia. This strategic geographical location is one of the factors that causes Indonesia to become the center of biodiversity in the world (Febriansyah, 2019). Biodiversity in Indonesia has plant species of no less than 38,000 plant species (BAPPENAS, 2003). Indonesia's plant species richness is ranked 5th in the world with an endemicity level of ± 55% spread over various types of ecosystems (Mittermeier et al., 1999). However, of all that is known, currently only 8,000 plant species have been identified (Pujianto et al., 2020). This amount is estimated to be only 20% of the total flora in Indonesia (Utomo, 2011).

The process of plant identification is a process of matching a plant according to a particular taxonomy (Zahro, 2016). Generally, identification activities are carried out by matching plants with identification books and using a determination key (Santri et al., 2021). However, the use of this identification method is less efficient because it takes a long time for the identification process (Aring et al., 2018). In the current technological era, the use of technology can facilitate the process of identifying and classifying plants (Prasvita, 2012; Rifai et al., 2020). The integration of contextual learning with technology and paying attention to student learning styles makes the teaching and learning process easier and more effective (Pujianto et al., 2020).

In the teaching and learning process there are several methods that can stimulate students' creativity and interest in the lesson. One of the interests that can be involved is situational interest, which is caused by stimuli from the environment (Lee et al., 2017). Optimal learning results can be obtained by students if students interpret a lesson well if they experience it directly (Widia et al., 2016). Students are also more interested in doing something that is not related to the rules and procedures in the classroom so that students feel more freedom in learning when outside the classroom (Thomas, 2000). The learning atmosphere outside the classroom tends to be different from the learning habits in the classroom so that students feel not monotonous (Muchsin et al., 2021).

Biology learning emphasizes scientific work processes to obtain data based on facts, concepts and principles so that they can be applied in everyday life (Kemendikbud, 2016). Based on previous research, the integration of contextual learning with technology on plant identification and classification materials showed positive results. Masropah et al. (2022) concluded that learning biology on plant concepts using Google Lens really helps students in constructing their own knowledge, apart from being able to analyze digital literacy skills, it can also improve student activities and learning outcomes (Sofian et al., 2022). Google Lens is the most recommended application for the process of plant identification in biology learning (Nuraini et al., 2022; Shapovalov et al., 2019). Not only Google Lens, other similar applications are used by Sugandi et al. (2020) namely the Pl@ntNet application, Kumar et al. (2012)) with Leaf Snap application, and Hannah et al. (2020) with the Picture This application which showed that the application used in the study had a good performance in identifying plants.

There have been many studies related to the identification and classification of plants using the Plant Identifier application. However, previous studies did not compare application characteristics and were generally limited to identifying plant species (Leu et al., 2021), inventory of plants (Tamaela et al., 2020), and test the accuracy of objects (Shapovalov et al., 2019) with the results displayed by the application. The Plant Identifier application is available for free on the Play Store or APP Store, but not all applications can provide maximum performance when used by users. As a supporting tool for biology learning and practicum on plant identification and classification materials, more in-depth testing (speed, accuracy, and completeness of taxonomic information) from plant identifier applications (Google Lens, Pl@nt Net, Picture This, and Leaf Snap) very important thing to do. Because by comparing the ability of the plant identifier application in terms of speed, accuracy in detecting objects based on shape and color, as well as the completeness of the taxonomic information presented by the application, fast, accurate, and complete applications can be obtained in presenting information as recommendations for biology learning and practicum in plant identification and classification materials. Thus, this study aims to test the ability of the Plant Identifier application as a recommendation for biology learning and practicum on plant identification and classification materials.

METHODS

1. Research Design

This research was conducted in September 2022 in the Sumber area, Cirebon Regency, West Java. This research is an exploratory-descriptive research. The data collection technique used is VES (Visual Encounter Survey) (Cochran, 1977). VES is the most suitable method used for this research because of the uneven contours of the data collection site and the uncertain existence of the object of observation (Triyono, 2018). The observation area is divided into four areas, namely the playground area, the garden area, the pool area, and around the rice fields. Every plant found is recorded and inventoried for identification.

2. Tools and Materials

The tool used is the Redmi Note 9 Smartphone with the following specifications: (1) MIUI 12.5 E OS, (2) MediaTek MT6769Z Helio G85 (12nm) chipset, (3) Octa-core (2x2.0 GHz Cortex-A75 & 6x1.8) CPU GHz Cortex-A55), (4) GPU Mali-G52 MC2, (5) camera resolution 48 MP, f/1.8, 26mm (wide), 1/2.0", 0.8µm, PDAF, (6) memory 128GB, 6GB RAM , (7) IPS LCD display, 450 nits (typ).

The applications used in this research are Google Lens, Pl@nt Net, Picture This, and Leaf Snap. These four applications are available for the IOS or Android operating system. The requirements for installing these four applications are: (1) minimal operating system to install Google Lens i.e. Android Marshmallow (6.0) or later, (2) Android version 5.0 and iOS 11.0 or later for Pl@ntNet app, (3) Android version 5.0 and iOS 13.0 or later for the Picture This app, (4) Android version 5.0 and iOS 11.0 or later for the Leaf Snap app. These four applications require an internet connection to be able to display object scan data.

The plant species identified included mosses, ferns, dicots, and monocots. Moss plants include, leaf mosses, liverworts, and hornworts. fern plants include, spike fern, horsetail, and wire fern. Dicotyledonous plants include mango, durian, and papaya plants. Monocot plants include rice, corn, and coconut.

3. Research Procedure

Plant identification was carried out directly on site using the Google Lens, Pl@nt Net, Picture This, and Leaf Snap application. Identification time is carried out in the morning and afternoon in order to get maximum object photos. The distance to identify objects in low-level plants is ± 15 – 25 cm, and ± 3m for high-level plants. The identification results obtained from the use of the application are then matched with identification support books and internet searches at https://www.eFloras.org to determine the ability of the four applications to identify plants.

4. Data Analysis

Data analysis was carried out in a quantitative descriptive, namely to record and describe each observation result obtained. Data were analyzed based on the type of plant group (mosses, ferns, dicots, and monocots). Data analysis includes calculating the speed and average speed of the application and providing points for object detection based on shape and color as well as completeness of taxonomy information (division, class, order, family, genus, and species) and then the point is calculated the total number by category. Object detection speed is calculated using a stopwatch and other criteria are calculated manually based on object detection by the application. The points given are [1] if the application can detect and present information and [0] if the application cannot detect and present information. The data analysis was assisted by the Microsoft Excel program.

RESULTS AND DISCUSSION

The Google Lens, Pl@ntNet, Picture This, and Leaf Snap apps show different results in identifying objects. These four applications are able to identify plants based on the Artificial Intelligence (AI) capabilities possessed by these applications. The results of identification using the Google Lens, Pl@ntNet, Picture This, and Leaf Snap applications are presented in Figures 1-4 below.

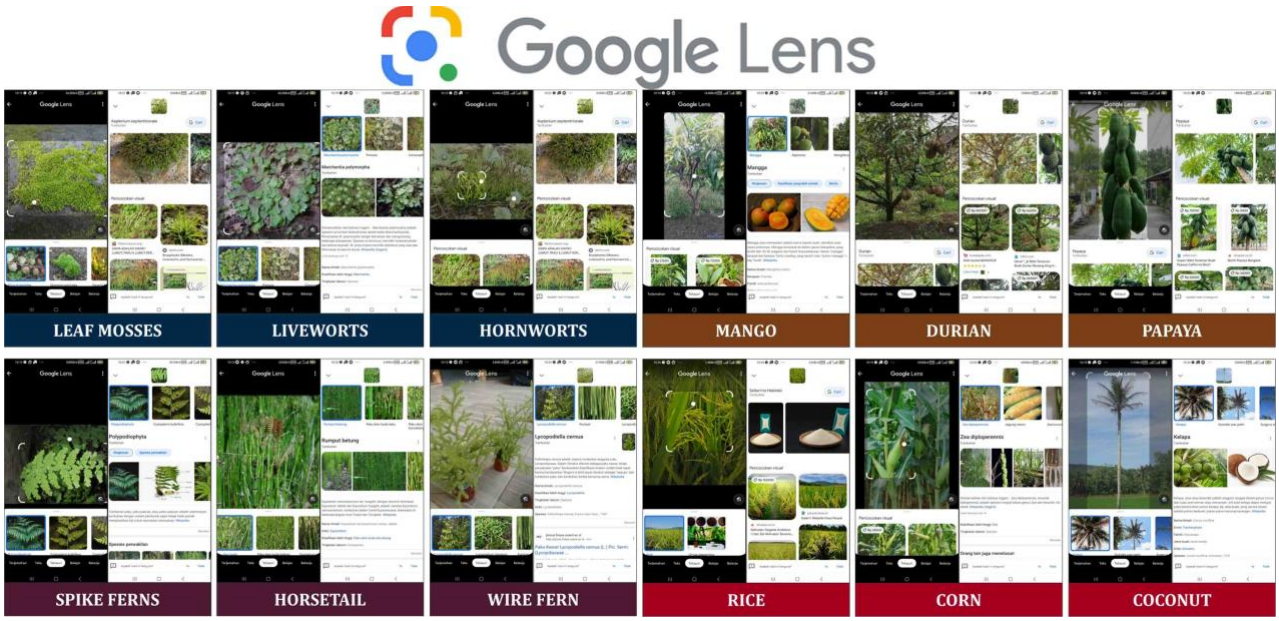

Figure 1. Plant Identification Results with the Google Lens Application

Figure 1 shows the appearance of the Google Lens application when it is used to identify plants. The appearance of the Google Lens application looks simple and easy to use. Users simply point at the object using the device's camera, then the Google Lens application will scan and display the results of the object's scan. Even though it is not a specific application created to identify plants, the Google Lens application is able to present the results of identifying mosses, ferns, dicots and monocots quite well.

Unlike the pl@nt net application in figure 2. The pl@nt net application is an application specifically designed to identify plants. The appearance of the pl@nt net application is more complex than the Google Lens application. Meanwhile, the scan results of the objects that are displayed are also more complete compared to the Google Lens application. The pl@nt net application is also able to present the identification results of mosses, ferns, dicots and monocots fairly well.

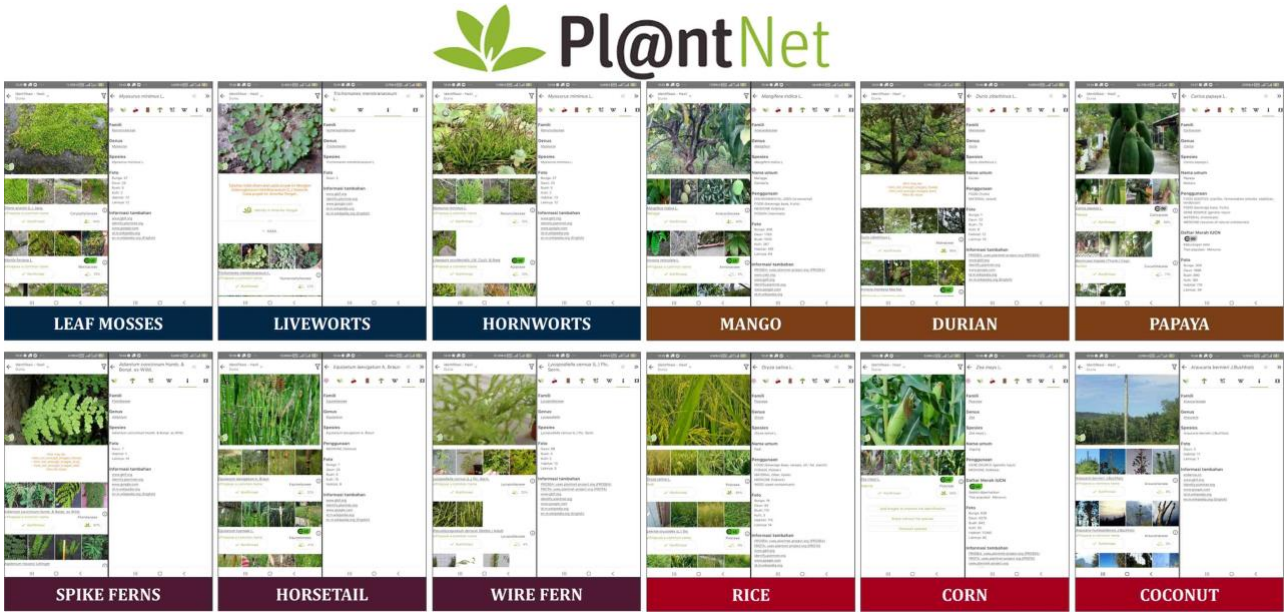

Figure 2. Plant Identification Results with the Pl@ntNet Application

The next plant identification application is the picture this application. This application is an application designed to identify plants that are able to present complete information on identified objects. Not only displaying scan results, this picture application provides information up to taxonomic information related to these plants. The identification results of mosses, ferns, dicots and monocots using the picture this application are presented in Figure 3.

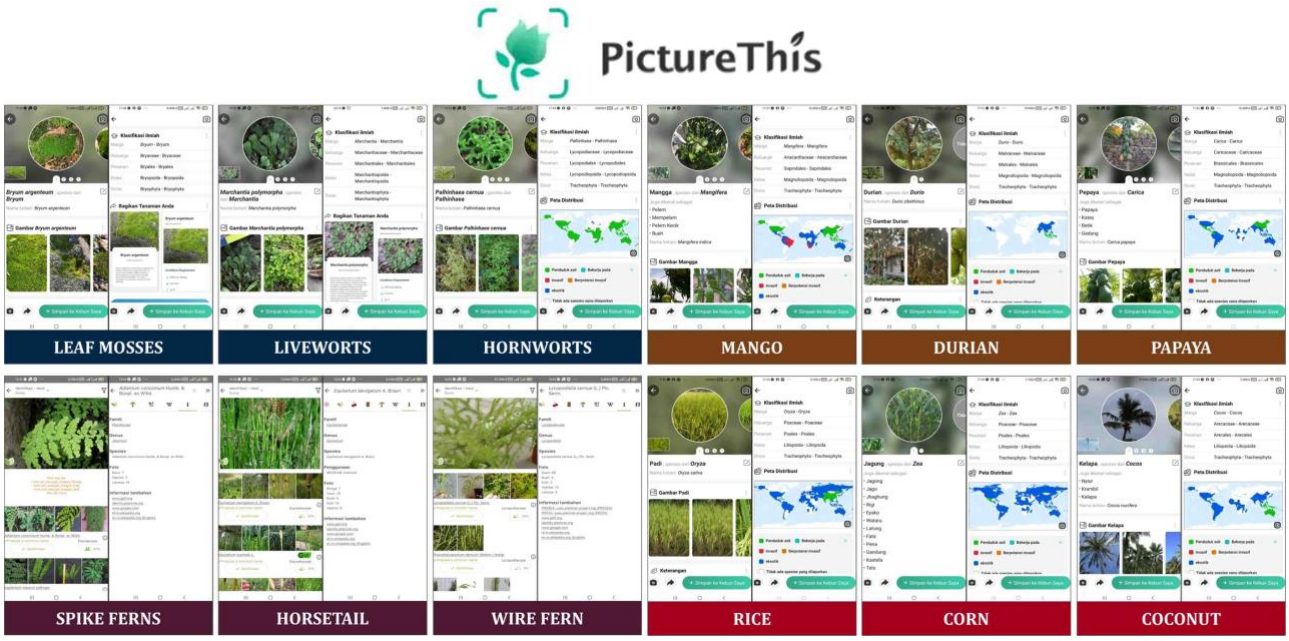

Figure 3. Plant Identification Results with the Picture This Application

The last plant identification application is the leaf snap application. The results of identification of mosses, ferns, dicots and monocots using the leaf snap application are presented in Figure 4. The leaf snap application has an attractive appearance and is easy to use. In plant identification, this application is also able to identify plants quite well in identifying objects and presenting information related to the scanned plant. However, the information displayed is not as complete as the picture this application where taxonomy-related information is not presented in detail in this application.

Figure 4. Plant Identification Results with the Leaf Snap Application

Object Detection Speed by Application

The speed of the Google Lens, Pl@ntNet, Picture This, and Leaf Snap applications in identifying plants was tested using a stopwatch. The results show that the four applications have different speeds. In terms of object detection speed, the Google Lens and Picture This applications are the first and second ranked applications in terms of speed. The results of testing the speed of the Google Lens, Pl@ntNet, Picture This, and Leaf Snap applications are presented in Figure 5 below.

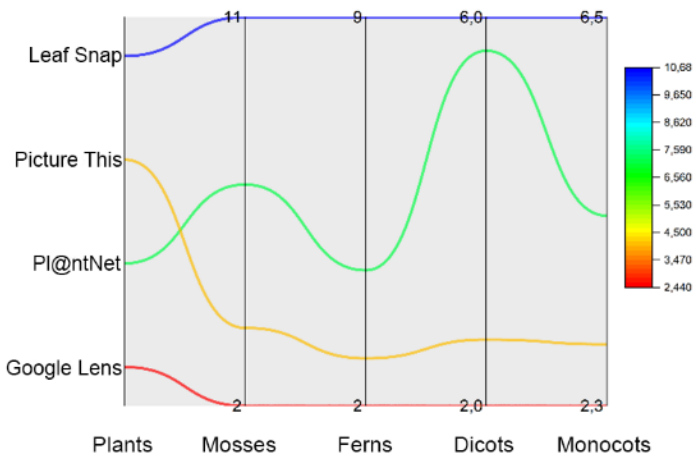

Figure 5. The average speed of Google Lens, Pl@ntNet, Picture This, and Leaf Snap apps

Object Detection Accuracy Based on Shape and Color

In addition to speed, the accuracy of the Google Lens, Pl@ntNet, Picture This, and Leaf Snap applications was also tested in this study, namely the accuracy of the application in detecting objects based on shape and color. Some applications show inaccurate results in detecting the shape of objects. However, in detecting object color, these four applications have the same level of accuracy in recognizing object color. Applications that are accurate in detecting objects based on shape and color in this study are the Google Lens and Picture This applications. The results of the object detection accuracy test based on shape and color are presented in Figures 6a and 6b below.

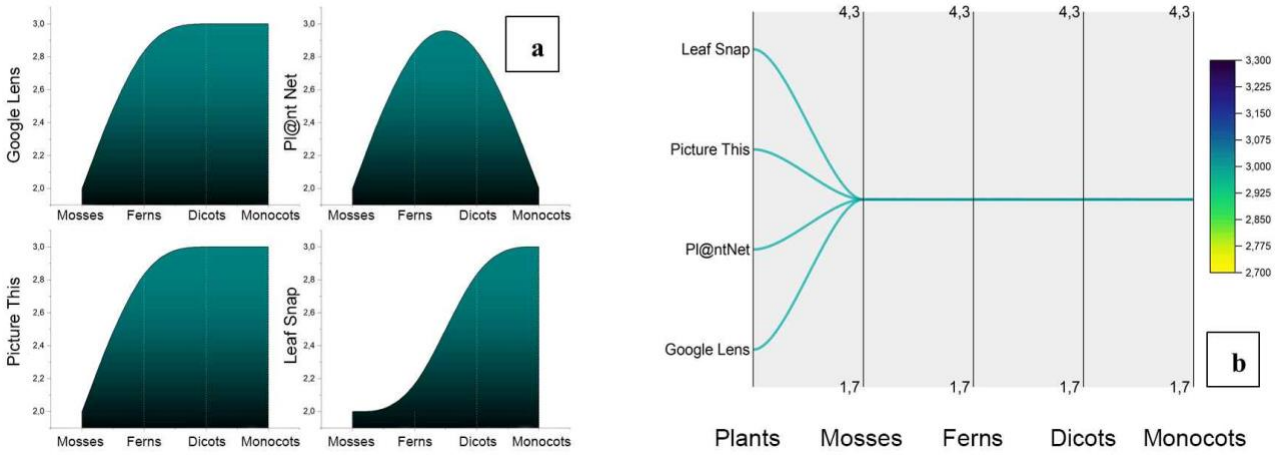

Figure 6. (a) the accuracy of the application in detecting objects based on shape, (b) the accuracy of the application in detecting objects based on color.

Completeness of Taxonomy Information presented by the Application

The complete taxonomy information presented by the Google Lens, Pl@nt Net, Picture This, and Leaf Snap applications is presented in Figure 7. The ability of applications to present plant taxonomic information is very diverse and only one application is capable of providing complete plant taxonomic information, namely the Picture This application.

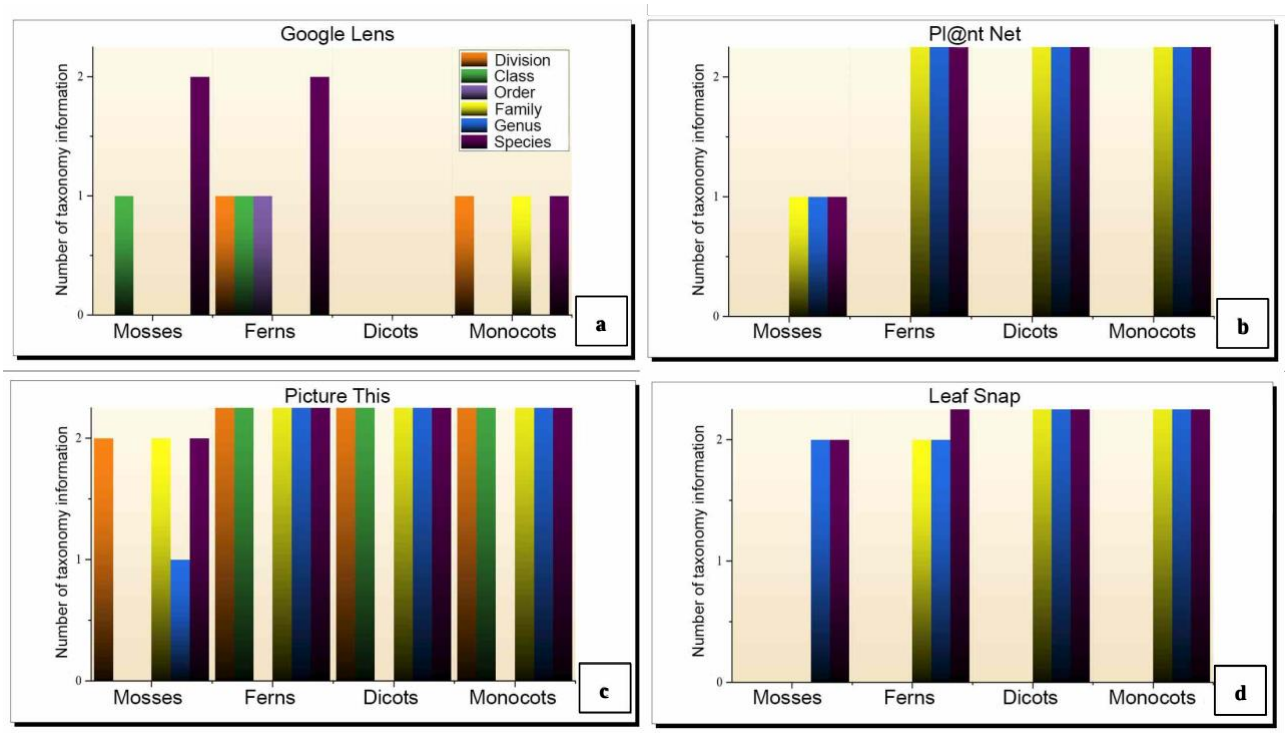

Figure 7. (a) Google Lens app taxonomy information, (b) Pl@ntNet app taxonomy information, (c) Picture This app taxonomy information, and (d) Leaf Snap app taxonomy information.

Characteristics of Google Lens, Pl@ntNet, Picture This, and Leaf Snap Applications

Google Lens

Google Lens is an AI-powered technology that uses smartphone cameras and deep machine learning to not only detect objects in front of the camera lens, but also understand them and offer actions such as scan, translate, shop, and more. Google Lens allows users to point their phone at an object, such as a specific flower and then ask the Google Assistant what the object is pointing at. Users will not only be notified of the answer, but will also receive object-based suggestions, such as the nearest florist, in the case of flowers (Hall, 2022).

Pl@nt Net

According to the developer, PlantNet is a sharing and image capture application for plant identification. Among other features, this free app helps identify plant species from photos. Plant species that are well-described in the botanical reference database can be easily recognized. The application works on more than 20,000 species of flora, the species list is available through the application. PlantNet app downloads are available for iOS (iPad and iPhone) and Android devices (Pl@ntNet, 2022).

Picture This

Plant Identifier allows users to take pictures of real plants and flowers and submit them for identification. This app is a plant encyclopedia that recognizes more than 1,000,000 different types of plants with 98% accuracy. Users can also learn facts and care information for plants, trees, flowers and shrubs (Picture This, 2022).

Leaf Snap

Leaf Snap is a free app that identifies all kinds of plants, from flowers and bark to fruit and trees. Users can use this app to identify attention-grabbing houseplants or perhaps plants that need some TLC; the application will provide a guide for treatment. With more than 32,000 plant taxa from around the world in its database, Leafsnap can offer a nearly unlimited number of plant identifications as the most high-tech, comprehensive and accurate plant identification application ever created (Ivanchenko, 2022).

Based on the results of testing the Google Lens, Pl@ntNet, Picture This, and Leaf Snap applications which include speed of object detection, accuracy of detecting objects based on shape and color, and completeness of taxonomic information, the four applications show different abilities. In terms of object detection speed, the Google Lens and Picture This applications are the first and second ranked applications in terms of speed. Likewise in terms of accuracy in detecting objects based on shape and

color, Google Lens and Picture This also show good performance in terms of object detection accuracy. However, different results are shown in terms of taxonomic information presented by this plant identification application. In terms of the completeness of taxonomic information, only the Picture This application provides taxonomic information in a sufficiently complete manner. Meanwhile, the Google Lens, Pl@nNet, and Leafsnap applications do not present taxonomy information properly.

Google Lens is a fast and accurate application for detecting objects based on shape and color, but the completeness of the information presented, especially related to taxonomic information, does not seem to be presented in full for this application. The information displayed is generally in the form of advertising information, or other information that has nothing to do with the purpose of identifying plants because the Google Lens application is not an application specifically designed for plant identification. However, previous research has shown that the Google Lens application can be used as an application to identify plants (Alamsyah et al., 2020; Bilyk et al., 2020).

Pl@ntNet, Picture This, and Leaf Snap are applications specifically designed and developed to provide plant-related information. Based on developer information, the Pl@ntNet application can provide information on more than 20,000 plant species, meanwhile, Picture This can provide 1,000,000 plant species, and Leaf Snap more than 32,000 taxa of various plant species. Based on the test results, the Picture This application ranks first, followed by Pl@ntNet in second place, and Leaf Snap in third place in terms of speed and accuracy of detecting objects based on shape and color.

The accuracy of the Google Lens, Pl@ntNet, Picture This, and Leaf Snap applications in detecting objects based on shape (leaves, flowers, fruit) shows different results. In this case, the Google Lens and Picture This applications are superior in detecting objects based on shape. In low-level plants, especially mosses, the ability of these four applications has the same difficulty in detecting objects. This is because moss plants are plants that have abstract shapes and small sizes. Meanwhile, for ferns, dicots, and monocots, the four applications can detect them well, because the shapes (leaves, flowers, fruit) are generally large in size so they can be recognized well by the application. Different in terms of the ability to detect objects based on color, these four applications are able to recognize object colors well.

Picture This app performs differently when it comes to presenting taxonomy information. Only the Picture This application was able to provide sufficiently complete taxonomic information on the various plant species tested (mosses, ferns, dicots and monocots). The taxonomic information presented is also valid information when compared with taxonomic information contained in the literature and also internet searches at https://www.eFloras.org. Although not completely complete, the taxonomic information presented is the best compared to the Google Lens, Pl@ntNet, and Leaf Snap applications.

The results of identifying applications in this study may differ from experiments conducted with different devices because the application will run well if the compatibility of the application meets the minimum requirements for using the application. Apart from that, the quality of the camera, processor, and RAM of the device also affects the results of application identification.

Appropriate Application Recommendations for Identification and Classification of Plants in Biology Learning

Based on the test results of the four applications, the most likely application for biology learning and practicum on plant identification and classification is the Picture This application. This application is available for free and is available for Android or IOS devices. The speed of the application in scanning moss plants is 4.10 seconds, ferns is 3.0 seconds, dicot plants are 2.68 seconds, and monocot plants are 2.65 seconds. Thus it can be said that the Picture This application only takes less than 5 seconds to scan objects. Picture This application is also an application that is accurate in detecting objects based on shape and color. This can be seen in Figure 6a which shows that of the 12 samples of objects scanned, only 1 object has inaccurate results. Meanwhile, in terms of completeness of taxonomy information, the Picture This application is the most complete application that presents taxonomic information compared to the other three applications. Based on the data in Figure 7c, of the 12 samples of objects scanned, order information is not displayed in the Picture This application, nor is class information on lower plants. However, taxonomic information regarding division, class, family, genus, and species is shown in samples of ferns, dicots, and monocots.

Implementation in Biological Learning

The implementation of augmented reality-based android plant identification applications can be used in biology learning on plant identification and classification materials. Teachers can use the Picture This application as a support for learning activities. In learning and practicing plant classification, the teacher can make LKPD (student activity sheets) to explore the surrounding environment and discover what diversity of plants exist in that environment based on the steps of plant classification, namely: (1) Identification of plants, (2) grouping of plants, and (3) naming of plants. Teachers can apply the VES method to re-test the four applications so that students have skills in digital literacy. Teachers can also integrate this Augmented Reality-based android plant identification application with various methods or learning models (problem-based learning, project-based learning, cooperative learning, inquiry, discovery, etc.) to measure or improve learning outcomes (Aldya & Arifendi, 2021) or student skills such as science process skills (Tematan & Mago, 2021), scientific literacy (Susilawati & Sugandi, 2018), digital literacy (Rizkamariana et al., 2019), critical thinking, communication, and other skills.

CONCLUSION

Based on testing and data analysis regarding the ability of the Google Lens, Pl@ntNet, Picture This, and Leaf Snap applications in identifying plants, it can be concluded that the Picture This application is a fast, accurate application, and can provide complete taxonomic information to identify and classify plants. Thus, the Picture This application is an application that can be recommended to be used as a support in learning activities and biology labs on plant identification and classification materials.

ACKNOWLEDGMENT

Thank you 1) for Dr. Sunyoto Eko Nugroho, M.Si., and Dr. Agung Tri Prasetya, M.Si., who have provided direction and guidance for this research. 2) For Prodi PGSD STKIP Nahdlatul Ulama Indramayu, Indonesia who have provided support for research activities.

REFERENCES

Alamsyah, M. R. N., Pamungkas, S. J., Meganingrum, A. R., & Nur, L. S. (2020). Studi Anthophyta di Kota Magelang sebagai Sumber Pembelajaran Saintifik pada Perkuliahan Biosistematika Tumbuhan. *Bioedusiana: Jurnal Pendidikan Biologi*, *5*(2), 160–175. https://doi.org/10.37058/bioed.v5i2.2337

Aldya, R. F., & Arifendi, R. F. (2021). Botanical application: Android-based learning media to enhance interest in learning plant material. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan*, *6*(01), 17–25. https://doi.org/10.33503/ebio.v6i01.1246

Aring, R. D., Naharia, O., & Lihiang, A. (2018). Pendekatan Jelajah Alam Sekitar (JAS) Pada Pembelajaran Biologi Topik Identifikasi Spermatophyta Terhadap Hasil Belajar Siswa di SMA Negeri 3 Tondano. *JSME (Jurnal Sains, Matematika & Edukasi)*, *5*(2), 218–222. http://ejournal.unima.ac.id/index.php/jsme/article/view/326

BAPPENAS. (2003). *Indonesian Biodiversity Strategy and Action Plan 2003-2020: IBSAP*. Bappenas.

Bilyk, Z., Shapovalov, Y., Shapovalov, V., Megalinska, A., Zhadan, S., Andruszkiewicz, F., Dołhańczuk-Śródka, A., & Antonenko, P. (2020). *Comparing Google Lens Recognition Accuracy with Other Plant Recognition Apps*. *2*, 20–33. https://doi.org/10.5220/0010928000003364

Cochran, W. G. (1977). *Sampling Techniques Third Edition*. 448. https://www.wiley.com/en-us/Sampling+Techniques%2C+3rd+Edition-p-9780471162407

Febriansyah, R. (2019). *Inventarisasi Tumbuhan Lumut di Kawasan Air Terjun Parangkikis Desa Gambiran Kecamatan Pagerwojo Tulungagung (Sebagai Sumber Belajar Materi Keanekaragaman Hayati)*.

Hall, C. (2022, March 23). *What is Google Lens and how does it work? - Pocket-lint*. Pocket-Lint. https://www.pocket-lint.com/apps/news/google/141075-what-is-google-lens-and-how-does-it-work-and-which-devices-have-it

Hannah, A., Xu, X., Zhou, Z., Hu, Y., & Joy, J. W. (2020). *Picturethis and Picture Insect : High Accuracy AI Species Identification APPs In Comparison to Others Materials & Methods Picture Insect References*

Picturethis Results Acknowledgements. 285.

Ivanchenko, V. (2022, February 10). *Leafsnap Is an App That Identifies Plants of All Kinds*. Treehugger. https://www.treehugger.com/leafsnap-is-a-new-app-to-identify-trees-4858781

Kemendikbud. (2016). Peraturan Mentri Pendidikan dan Kebudayaan Republik Indonesia Nomor 22. Tahun 2016. In *Menteri Pendidikan dan Kebudayaan Republik Indonesia*. Menteri Pendidikan dan Kebudayaan Republik Indonesia.

Kumar, N., Belhumeur, P. N., Biswas, A., Jacobs, D. W., Kress, W. J., Lopez, I. C., & Soares, J. V. B. (2012). Leafsnap: A computer vision system for automatic plant species identification. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *7573 LNCS*(PART 2), 502–516. https://doi.org/10.1007/978-3-642-33709-3

Lee, Y., Chao, C., & Chen, C. (2017). The influences of interest in learning and learning hours on learning outcomes. *Global Journal of Engineering Education*, *13*(3), 140–153. http://wiete.com.au/journals/GJEE/Publish/vol13no3/01-Lee-Y-J.pdf

Leu, P. L., Naharia, O., Moko, E. M., Yalindua, A., & Ngangi, J. (2021). Karakter Morfologi dan Identifikasi Hama pada Tanaman Dalugha (Cyrtosperma merkusii (Hassk.) Schott) di Kabupaten Kepulauan Talaud Propinsi Sulawesi Utara. *JURNAL ILMIAH SAINS*, *21*(1), 96–112. https://doi.org/10.35799/JIS.21.1.2021.32737

Masropah, S. M., Juhanda, A., & Ramdhan, B. (2022). Analisis Keterampilan Literasi Digital Siswa SMA Melalui Penggunaan Google Lens pada Konsep Tumbuhan Berbasis Gender. *BIODIK*, *8*(3), 115–124. https://doi.org/10.22437/BIO.V8I3.18976

Mittermeier, R. A., Goettsch Mittermeier, C., Myers, N., Robles Gil, P., Conservation International., Cemex, S. A. de C. V., & Agrupación Sierra Madre. (1999). *Hotspots : earth's biologically richest and most endangered terrestrial ecoregions*. 430. https://www.nhbs.com/hotspots-earths-biologically-richest-and-most-endangered-terrestrial-ecoregions-book

Muchsin, A., Nurfadilah, Z., Riandi, R., & Supriatno, B. (2021). Efektivitas Metode Field Trip Dengan Aplikasi PlantNet Pada Materi Spermatophyta Sebagai Alternatif Inovasi Pembelajaran. *Biodik*, *7*(3), 20–27. https://doi.org/10.22437/bio.v7i2.13126

Nuraini, N., Bania, A. S., Faridy, N., & Nursamsu, N. (2022). Identification of Ornamental Plants Via Google Lens Based on Intersemiotic. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1243–1251. https://doi.org/10.29303/jppipa.v8i3.1627

Picture This. (2022). *PictureThis - Plant Identifier - Apps on Google Play*. https://play.google.com/store/apps/details?id=cn.danatech.xingseus&hl=en_US&gl=US

Pl@ntNet. (2022). *PlantNet Plant Identification - Apps on Google Play*. https://play.google.com/store/apps/details?id=org.plantnet&hl=en&gl=US

Prasvita, D. S. (2012). *Medleaf: Aplikasi Mobile untuk Identifikasi Tumbuhan Obat Berbasis Citra dan Teks*. http://repository.ipb.ac.id/handle/123456789/57699

Pujianto, A. A., Degeng, I. N. S., & Sugito, S. (2020). Pengaruh penggunaan aplikasi Plantnet dan gaya belajar terhadap hasil belajar. *Jurnal Inovasi Teknologi Pendidikan*, *7*(1), 12–22. https://doi.org/10.21831/jitp.v7i1.31365

Rifai, M. R., Kurniawan, R. A., & Hasanah, R. (2020). Persepsi Mahasiswa dalam Menggunakan Aplikasi Plantnet pada Mata Kuliah Klasifikasi Makhluk Hidup. *VEKTOR: Jurnal Pendidikan IPA*, *1*(1), 29–38. https://doi.org/10.35719/vektor.v1i1.4

Rizkamariana, F., Diana, S., & Wulan, A. R. (2019). Penerapan Project Based Learning untuk Melatih Kemampuan Literasi Tumbuhan Abad 21 pada Siswa SMA. *Assimilation: Indonesian Journal of Biology Education*, *2*(1), 19–23. https://doi.org/10.17509/aijbe.v2i1.15203

Santri, D. J., Amizera, S., & Anggraini, N. (2021). Respon Mahasiswa Terhadap Penerapan Aplikasi Berbasis Android Sebagai Penunjang Kemampuan Identifikasi Tumbuhan Berbiji (Spermatophyta). *Prosiding Seminar Nasional Pendidikan IPA Tahun 2021*, *2006*(2015), 1–12. http://conference.unsri.ac.id/index.php/semnasipa/article/view/2157

Shapovalov, V. B., Shapovalov, Y. B., Bilyk, Z. I., Megalinska, A. P., & Muzyka, I. O. (2019). The Google Lens analyzing quality: an analysis of the possibility to use in the educational process. *Undefined*, *2547*(53), 117–129. https://doi.org/10.31812/EDUCDIM.V53I1.3844

Sofian, S. R. A., Subchan, W., & Sudarti. (2022). Penerapan Model Discovery Learning Berbantuan Google Lens Untuk Meningkatkan Aktivitas Dan Hasil Belajar Siswa Pada Materi Klasifikasi Makhluk Hidup. *Jurnal Teknologi Pendidikan*, *11*(2).

Sugandi, M. K., Rasyid, A., Gaffar, A. A., Studi, P., Biologi, P., Majalengka, U., Studi, P., Biologi, P., & Wiralodra, U. (2020). Aplikasi Plantnet Sebagai Media Identifikasi Morfologi. *Seminar Nasional Pendidikan, (2020) FKIP UNMA*, 769–777. https://prosiding.unma.ac.id/index.php/semnasfkip/article/view/388

Susilawati, Y., & Sugandi, M. K. (2018). Student's Skills on Identifying Plants at Universitas Majalengka Environment as Competency of Plant Morphology Subjects. *Bioedusiana*, *03*(01), 29–37. https://jurnal.unsil.ac.id/index.php/bioed/index

Tamaela, K., Sopacua, G., Sopratu, P., & Selehulano, K. (2020). Inventarisasi Tumbuhan Lumut Di Kawasan Air Potang-Potang Negeri Itawaka Kabupaten Maluku Tengah. *Jurnal Ilmiah Wahana Pendidikan*, *6*(4), 611–618. https://doi.org/10.5281/ZENODO.4297891

Tematan, Y. B., & Mago, O. Y. . (2021). Pengembangan LKPD Berbasis Keterampilan Proses Pada Materi Klasifikasi Tumbuhan Untuk Melatihkan Keterampilan Proses Sains Siswa Kelas X SMAS Katolik St. Gabriel Maumere. *JURNAL PENDIDIKAN MIPA*, *11*(2), 181–185. https://doi.org/10.37630/JPM.V11I2.491

Thomas, J. W. (2000). Review of Research on Project-Based Learning. *Interdisciplinary Journal of Problem-Based Learning*, *22*(1), 1–18. http://dx.doi.org/10.1038/s41539-019-0045-1

Triyono. (2018). *Teknik Sampling dalam Penelitian*. https://doi.org/10.31227/OSF.IO/DCQ8U

Utomo, Y. W. (2011, November 30). *Baru 20 Persen Flora yang Teridentifikasi*. Kompas. https://sains.kompas.com/read/2011/11/30/18112181/Baru.20.Persen.Flora.yang.Teridentif

Widia, V., Indihadi, D., & WS, R. (2016). Pengaruh Metode Karya Wisata Terhadap Hasil Belajar Siswa Tentang Ekonomi Masyarakat Sekitar. *PEDADIDAKTIKA: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, *3*(1), 117–128. https://ejournal.upi.edu/index.php/pedadidaktika/article/view/5099

Zahro, H. Z. (2016). Analisis Tekstur untuk Identifikasi Tumbuhan Obat Menggunakan Klasifikasi Support Vector Machine. *Industri Inovatif : Jurnal Teknik Industri*, *6*(2), 33–40. https://ejournal.itn.ac.id/index.php/industri/article/view/909