Bioscientist: Jurnal Ilmiah Biologi
https://e-journal.undikma.ac.id/index.php/bioscientist

March 2026 Vol. 14, No. 1
e-ISSN: 2654-4571
pp. 23-30

The Utilization of the PlantNet Application in Biology Learning and Its Impact on Senior High School Students' Learning Retention

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Received: December 2025; Revised: February 2026; Accepted: February 2026; Published: March 2026

Abstract: This study aimed to determine students' retention levels before and after the implementation of the PlantNet application and to analyze the effect of the PlantNet application on students' retention in biology learning at SMA Negeri 1 Aek Natas. The study employed a quantitative approach with descriptive analysis. The research participants consisted of 61 tenth-grade students, including 31 students from class X2 and 30 students from class X3. The research instruments included a questionnaire measuring students' perceptions of the use of the PlantNet application and a retention test designed to assess short-term retention, long-term retention, and conceptual understanding. The collected data were analyzed using percentage analysis to determine the achievement level of each indicator.The results indicated that the use of the PlantNet application was categorized as very good, with the ease-of-use indicator reaching 91.7% and the usefulness in learning indicator reaching 88.8%. Regarding student retention, short-term retention reached 83.4%, long-term retention reached 84.2%, and conceptual understanding reached 84.6%, all of which were classified as good. These findings suggest that the PlantNet application is not only easy to use and beneficial for biology learning but also contributes to strengthening students' memory retention and improving their conceptual understanding of the learning material. Therefore, the integration of the PlantNet application has strong potential to serve as an effective instructional medium for enhancing students' retention in biology learning.
Keywords: Plantnet App; student retention; biology learning

How to Cite: Sepriana, Chastanti, I., & Nazliah, R. (2026). The Utilization of the PlantNet Application in Biology Learning and Its Impact on Senior High School Students' Learning Retention. *Bioscientist: Jurnal Ilmiah Biologi*, *14*(1), 23–30. https://doi.org/10.33394/bioscientist.v14i1.19466

https://doi.org/10.33394/bioscientist.v14i1.19466

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INTRODUCTION

Learning retention is a key indicator of successful learning, reflecting students' ability to store, maintain, and recall previously learned information over time. It involves not only memory capacity but also conceptual understanding, cognitive engagement, and information-processing processes occurring during learning activities (Mayer, 2014; Tamam & Fikriyah, 2024). In science education, retention is particularly important because scientific concepts are often complex and require deep understanding to be applied in different contexts (Bransford, Brown, & Cocking, 2000). Therefore, identifying effective instructional strategies that enhance learning retention has become an important focus in contemporary education.

One factor influencing learning retention is the quality of instructional media. Interactive and innovative media can increase student engagement, strengthen conceptual understanding, and help learners connect new knowledge with prior knowledge (Mayer, 2014). Studies indicate that digital learning media significantly improve student motivation, participation, and learning outcomes compared with conventional lecture-based instruction (Fitriani & Prasetyo, 2025; Sung, Chang, & Liu, 2016). In addition, digital technologies create more visual, contextual, and interactive learning environments that support stronger memory performance and retention.

In biology education, the classification of living organisms, particularly plant species identification within biodiversity topics, often poses challenges for students. This topic requires observational skills, morphological analysis, and understanding of taxonomic concepts that are difficult to master through theoretical explanations or textbook-based learning alone (Yudasmara & Purnami, 2015). When learning activities lack concrete experiences, students often struggle to recognize organism characteristics and recall previously learned information, resulting in low retention.

Low retention in biology learning is frequently linked to limited student engagement and insufficient instructional media that support higher-order thinking and real-world learning experiences (Majid, 2022). From a theoretical perspective, the use of digital media aligns with the *Cognitive Theory of Multimedia Learning*, which states that integrating visual and verbal information enhances comprehension and memory (Mayer, 2014). It also supports constructivist learning principles that emphasize active knowledge construction through meaningful learning experiences (Jonassen, 1999).

Indonesia, as one of the world's megadiverse countries, possesses a vast diversity of plant species, providing significant opportunities for environment-based biology learning. However, many students still experience difficulties identifying plant species when learning relies primarily on textbooks or static images. Septaria & Fatharani (2022) reported that students encounter challenges in studying biodiversity due to limited identification tools and inadequate visualization, which reduces conceptual understanding and retention.

Advances in information and communication technology have enabled the integration of digital applications in biology learning. Such technologies can enhance student engagement and provide authentic learning experiences through exploration and direct observation of biological objects (Nasution et al., 2023). International studies also indicate that artificial intelligence–based species identification tools can improve observational skills, taxonomic understanding, and scientific literacy (Bonnet et al., 2018).

One digital tool that can support biology learning is PlantNet, an image-recognition-based plant identification application. This application allows users to identify plant species by capturing images of plant parts such as leaves, flowers, or fruits and matching them with an extensive database of plant species. Developed through collaboration between botanists and technology experts, PlantNet facilitates easier recognition of plant biodiversity (Joly et al., 2016). In educational contexts, it can support contextual learning, improve understanding of plant morphology, and enhance field observation activities.

Previous studies have shown that the use of plant identification applications such as PlantNet can improve students' plant identification skills, taxonomic understanding, and biology learning outcomes (Aegustinawati & Sunarya, 2023; Mursidah et al., 2019). Its advantages include ease of use, a broad species database, and support for exploration-based learning in natural environments, making it a potentially effective instructional medium for biodiversity learning.

However, research examining students' learning retention after using plant identification applications remains limited, particularly at the senior high school level. Most previous studies focus on short-term learning outcomes or identification skills, while long-term retention has received less attention, indicating a research gap that requires further investigation.

Preliminary observations at SMA Negeri 1 Aek Natas revealed that approximately 70% of students experience difficulties in identifying plant species both in classroom learning and field observations. These challenges are mainly caused by limited

instructional media supporting direct plant identification. Interviews with teachers and students also indicated that learning activities are still dominated by textbook use and memorization methods, resulting in limited contextual understanding and low retention of plant morphology concepts.

Therefore, the use of the PlantNet application is considered a promising instructional alternative to improve students' learning retention in biodiversity topics. Accordingly, this study aims to analyze the effectiveness of the PlantNet application in enhancing students' learning retention in biology learning at SMA Negeri 1 Aek Natas.

METHOD

This study employed a quantitative approach presented descriptively. The method was used to analyze the use of the PlantNet application and to describe students' learning retention through numerical data measurements analyzed using descriptive statistical techniques. The research was conducted at SMA Negeri 1 Aek Natas, North Labuhanbatu Regency, in November 2025. The study focused on biology learning supported by the PlantNet application.

The research variables consisted of the use of the PlantNet application and students' learning retention. The use of PlantNet was examined in terms of ease of use and perceived usefulness in learning, whereas students' retention was assessed through short-term retention, long-term retention, and conceptual understanding. A descriptive research design was selected to portray the actual conditions of PlantNet application use and the level of student retention without administering any specific treatment to the research subjects.

The population of this study comprised all tenth-grade students of SMA Negeri 1 Aek Natas in the 2025/2026 academic year, totaling 123 students distributed across four classes. The research sample was determined using purposive sampling, in which participants were selected based on specific criteria aligned with the research objectives. These criteria included: (1) classes currently studying biodiversity material, (2) classes that had utilized the PlantNet application in learning activities for at least two sessions, and (3) classes whose schedules aligned with the research implementation period. Based on these criteria, the sample consisted of Class X-2 (31 students) and Class X-3 (30 students). Therefore, the total number of participants involved in this study was 61 students. This sample was considered representative for describing the use of the PlantNet application and students' learning retention in biology learning.

The research instrument used was a Likert-scale questionnaire. The questionnaire consisted of two sections: the PlantNet application usage questionnaire and the student retention questionnaire. The PlantNet usage questionnaire included indicators of ease of use and learning usefulness, while the student retention questionnaire covered indicators of short-term retention, long-term retention, and conceptual understanding. Each statement item was structured as a closed-ended statement with four response options: strongly disagree, disagree, somewhat agree, and agree.

The research procedure began with a preparatory stage, including obtaining research permission and providing students with explanations regarding the research objectives and the procedures for completing the questionnaire. Subsequently, the PlantNet application was implemented during biodiversity learning activities for two sessions, each lasting 90 minutes. Students used the PlantNet application installed on their smartphones in small groups to identify plants within the school environment, under the guidance of the biology teacher. After the learning activities were completed,

the questionnaire was distributed to the selected sample students to be completed based on their experiences using the PlantNet application during biology learning.

Data obtained from the questionnaire responses were analyzed using quantitative descriptive analysis. Each response was assigned a score based on the Likert scale, and the scores were then summed for each indicator. The resulting scores were subsequently converted into percentages to determine the level of PlantNet application usage and student retention. The percentage results were interpreted based on the classification criteria presented in Table 1.

Tabel 1. Percentage interpretation criteria

Percentage Range (%)	Interpretation
81–100	Very Good
61–80	Good
41–60	Moderate
21–40	Poor
0–20	Very Poor

RESULTS AND DISCUSSION

Based on the results of the study conducted at SMA Negeri 1 Aek Natas, the data obtained included students' responses regarding the use of the PlantNet application and the level of student learning retention in biology learning. The research data are presented in Table 2 and Figure 1.

Table 2. Results of the questionnaire on the use of the PlantNet application

Indicator	Percentage	Category
Ease of Use	91.7%	Very Good
Usefulness	88.8%	Very Good

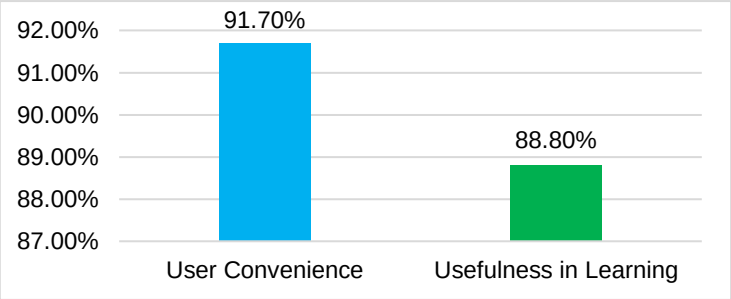

Figure 1. Graph of PlantNet application usage

Based on the data presented in Table 2 and Figure 1, the results of the questionnaire analysis indicate that the ease-of-use indicator of the PlantNet application obtained a percentage score of 91.7%, which falls into the very good category. This result indicates that students were able to operate the PlantNet application easily without encountering significant technical difficulties, thereby enabling the learning process to proceed more effectively. A high level of ease of use is an important factor in the acceptance of educational technology, as technologies that are easy to use tend to be adopted more quickly and utilized more optimally by students (Davis, 1989; Surbakti et al., 2022).

Meanwhile, the usefulness indicator in learning obtained a percentage score of 88.8%, which is also categorized as very good. Based on the data presented in Table 1 and Figure 1, this finding indicates that the PlantNet application provides tangible benefits in helping students understand biological concepts, particularly in plant

identification and classification. By utilizing technology-based applications, students are able to connect theoretical concepts with real objects in their surrounding environment, making the learning process more contextual and meaningful (Arsyad, 2017).

These findings are consistent with previous studies. Research by Pujianto et al. (2020) and Surbakti et al. (2022) demonstrated that the use of the PlantNet application positively influences students' learning outcomes. In addition, Muchsin et al. (2021) reported that integrating the PlantNet application into environment-based learning can enhance student engagement and learning effectiveness. Therefore, this application promotes active and student-centered learning, where students are not merely passive recipients of information but actively participate in constructing knowledge.

Student retention in this study aimed to determine students' ability to retain information and biological concepts after learning with the PlantNet application. Student retention was measured using a test instrument developed based on three indicators: short-term retention, long-term retention, and conceptual understanding. The measurement of retention was conducted to evaluate the effectiveness of the PlantNet application in supporting students' memory and comprehension of learning materials. The results of the retention data analysis are presented in Table 3 and Figure 2.

Table 3. Student retention results

Indicator	Percentage	Category
Short-term Retention	83.4%	Good
Long-term Retention	84.2%	Good
Conceptual Understanding	84.6%	Good

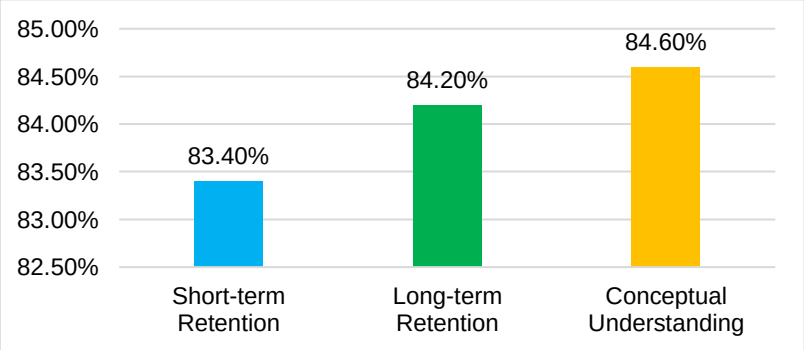

Figure 2. Graph of student retention

Based on the data presented in Table 2 and Figure 2, the results show that the short-term retention indicator obtained a percentage score of 83.4%, categorized as good. The long-term retention indicator achieved 84.2%, also categorized as good, while the conceptual understanding indicator obtained 84.6%, which is likewise categorized as good. These findings indicate that students were able to retain and understand biological learning materials effectively after using the PlantNet application.

The good level of short-term retention indicates that students were able to remember learning materials effectively immediately after the learning process. The presentation of learning materials through visual media and direct activities, such as those facilitated by the PlantNet application, supports the encoding process during the initial stage of learning, making it easier for students to remember the material (Mu'minah et al., 2023; Al Irsyadi et al., 2025).

Meanwhile, the good level of long-term retention indicates that students were able to retain information for a longer period. Learning experiences involving active engagement and visualization can strengthen information storage in long-term memory (Santrock, 2018). This finding is consistent with the study of Agustianda et al. (2024), which reported that the use of appropriate learning media and strategies can improve student retention in both the short term and long term.

The good level of conceptual understanding suggests that students did not merely memorize the learning materials but were also able to understand and relate biological concepts meaningfully. Meaningful learning leads to stronger conceptual understanding and longer-lasting memory retention (Slavin, 2019). Thus, the use of the PlantNet application assists students in constructing knowledge meaningfully, which positively impacts both retention and conceptual understanding in biology learning.

In addition, the ease of use of the PlantNet application contributes to increased student motivation and learning independence. Applications that are easy to operate allow students to focus more on observing and analyzing learning objects without being hindered by technical difficulties (Daryanto, 2016; Aeni & Widodo, 2022).

The usefulness of the PlantNet application in biology learning is reflected not only in improved learning outcomes but also in more contextual learning experiences. Through the image-based plant identification feature, students can directly relate biological concepts to their surrounding environment. This contextual learning approach encourages students to actively observe, analyze, and draw conclusions, thereby making the knowledge gained more meaningful and longer-lasting in memory. These findings reinforce previous research indicating that environment-based learning can enhance student engagement and understanding (Pujianto et al., 2020; Muchsin et al., 2021).

The good levels of both short-term and long-term retention indicate that the PlantNet application effectively supports the reinforcement of students' memory processes. Information obtained through direct and visual learning experiences is easier to remember compared to abstract learning, thereby facilitating the transfer of information into long-term memory (Santrock, 2018). Furthermore, the strong level of conceptual understanding suggests that students were able to integrate new knowledge with prior knowledge. This process enables students not only to recall the material but also to explain and apply the learned concepts in different contexts. Therefore, the use of the PlantNet application functions as an effective learning tool for enhancing short-term retention, long-term retention, and students' conceptual understanding in a sustainable manner.

CONCLUSION

The use of the PlantNet application was proven to be effective and had a positive impact on students' learning retention in Biology learning at SMA Negeri 1 Aek Natas. This finding is evidenced by the achievement of short-term retention, long-term retention, and conceptual understanding, all of which fall within the good category. In addition, the aspects of ease of use and perceived usefulness of the application were classified in the very good category. Therefore, the PlantNet application can assist students in understanding and remembering plant identification material more effectively. These results indicate that the research objective—to analyze the effectiveness of the PlantNet application in enhancing students' learning retention—has been successfully achieved.

RECOMMENDATION

Biology teachers are encouraged to utilize the PlantNet application as a supporting instructional medium in plant-related topics to help improve students' retention and conceptual understanding. Students are also recommended to use this application as an independent learning tool to support their learning process. Future researchers are advised to expand this study by involving a larger sample size, incorporating additional research variables, or applying different research designs in order to obtain more comprehensive findings.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to SMA Negeri 1 Aek Natas for providing support and facilitating the implementation of this research. The authors also extend their appreciation to all students and teachers who participated in this study.

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