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Analysis of Students' Ability to Use the Pl@ntNet Application in Project-Based Biology Learning at State High School No. 8, Tidore Islands

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A B S T R A C T
This study aimed to analyze students' ability to use the Pl@ntNet application in project-based biology learning at SMA Negeri 8 Tidore Kepulauan. The study used a descriptive quantitative approach with 18 students working in three project groups. The results showed that students' ability was in the very good category, with scores of 90.3% for performance observation, 90.3 for project products, 92.5 for the written test, and 95.1 for the practical test (average 92.1). All three project groups were also in the very good category, with scores of 92, 83, and 96. It can be concluded that project-based biology learning supported by Pl@ntNet provides hands-on practice that enables students to identify plants and produce good project products, while verification and the use of literature sources still need strengthening.

INTRODUCTION

Biology instruction, particularly regarding plant diversity, requires students to observe and identify organisms firsthand. However, identifying plant species solely through textbooks or conventional teaching methods often poses a challenge for students (Sepriana et al., 2026). This difficulty is understandable because accurately identifying plants is challenging, even for professionals (Bonnet et al., 2020). Therefore, the learning process requires tools that allow students to practice identifying plants in their surrounding environment.

The Pl@ntNet app is one such tool. This app was developed as a scientific and participatory platform based on artificial intelligence that helps users identify plants using a smartphone (Bonnet et al., 2020). A number of studies in Indonesia and abroad have examined its use in learning, including its impact on learning outcomes in plant identification (Pujianto et al., 2020; Silitonga & Abdullah, 2026), its effectiveness in teaching Spermatophyta through field activities (Muchsin et al., 2021), its use in out-of-classroom learning for biodiversity education (Coskunserce, 2024), and its impact on high school students' learning retention (Sepriana et al., 2026). The latter study also indicated that this app is easy to use and beneficial for students (Sepriana et al., 2026).

On the other hand, Project-Based Learning (PjBL) is viewed as a suitable approach for such activities. PjBL is student-centered, involves collaboration, and produces tangible outcomes (Kokotsaki et al., 2016; Krajcik & Blumenfeld, 2006), and is linked to the development of 21st-century skills (Bell, 2010). The integration of PjBL and Pl@ntNet has been tested, for example, in project-based training activities at vocational high schools where students successfully identified seven plant species from various families and described their morphological characteristics (Fadhillah et al., 2025).

Nevertheless, existing studies largely focus on learning outcomes or retention of specific subject matter. Studies that detail students' ability to use Pl@ntNet in project-based learning—from operating the application, taking photos of samples, interpreting results, verifying findings, to recording and communicating results—remain limited, particularly in schools in island regions such as the Tidore Islands. The verification aspect deserves special attention because the app's identification results still need to be cross-checked against morphological characteristics and reference sources (Bonnet et al., 2020).

Based on the above, this study aims to analyze students' ability to use the Pl@ntNet app in project-based biology learning at State Senior High School 8 in the Tidore Islands. The study employed a quantitative descriptive approach with 18 students working in three project groups, and data were collected through performance observations, project product assessments, written tests, and practical tests. The research results are expected to provide an overview of students' competency levels as well as areas that need improvement, serving as a basis for teachers to design project-based learning supported by plant identification applications.

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The introduction section is here; you can provide the logical and phenomenological reasoning of conducting your research. It is also mandatory that you put a clear explanation of your paper's contribution to knowledge enrichment. It could present in the description of a niche sample (capturing unique samples), theory enrichment, or exciting results (novelty-if available). A short and straight to the point introduction is critically essential in this paper.

You have to type with Book Antiqua 12, single-spaced, and justified. At the end of this part, you must provide us with your research aims or questions, but bear in mind, not to give them numbers, just put them in one paragraph or assimilate them with another part of the introduction section.

This paper used in-note in referencing articles. You could write it as follows: (Diener, 2000), as for an article with more than one author (Haerani, Parmitasari, Aponno, & Aunalal, 2019). Should you want to cite more than several papers, arrange them alphabetically from A-Z, not the year of publishing as follows (Caprara & Zimbardo, 2004; Lusardi, Mitchell, & Curto, 2010; Sabri & MacDonald, 2010). The use of a reference tool, such as Mendeley, is also mandatory.

THEORETICAL REVIEW

Pl@ntNet is an artificial intelligence-based science and citizen science platform that helps users identify plants through photos taken with a smartphone (Bonnet et al., 2020). This platform was developed because identifying and naming plants is a difficult task, even for professionals (Bonnet et al., 2020).

Pl@ntNet's strengths in education lie in its ease of use and benefits for students, including its ability to support memory retention (Sepriana et al., 2026). This app allows students to practice identifying plants directly in their surroundings, not just through textbooks.

Project-Based Learning (PjBL) is a learning approach that centers learning activities around projects. Students investigate meaningful questions or problems, collaborate over a specific period of time, and produce tangible products as evidence of their understanding (Krajcik & Blumenfeld, 2006; Kokotsaki et al., 2016). In the literature review, PjBL is understood as a student-centered approach, while teachers act as facilitators who guide the process (Kokotsaki et al., 2016).

METHODOLOGY

Type and Research Approach

This study employs a quantitative descriptive approach. Its objective is to describe the level of students' proficiency in using the Pl@ntNet application in project-based biology learning, without providing a control group or testing the relationships between variables. The data consist of scores, which were then converted into percentages and grouped into categories.

Research Location and Time

The research was conducted at State Senior High School 8 Tidore Islands in 2026, specifically from [month] to [month], over [number] sessions covering the topics of [biodiversity / classification of living organisms / ...].

Research Subjects

The research subjects were 18 students in grade [X/XI/XII …] who worked in three project groups (Groups A, B, and C). The subjects were selected using the [total sampling / purposive sampling: …] technique because [reason, e.g., all students in that grade participated in the activity].

Variables and Operational Definitions

The research variable is a single variable, namely the students' ability to use the Pl@ntNet app in project-based biology learning. This ability is defined as the students' proficiency in carrying out a series of plant identification activities with the help of the app, which is measured through five indicators.

Table. 1 Variables and Operational Definitions

No	Indicator	Explanation
1	Operating the app	Opening the app, selecting an organ, taking or uploading a photo, viewing the results
2	Taking a sample photo	Photographing an organ with proper focus, lighting, and background
3	Interpreting the results	Reading the scientific name, family, and match level, and understanding their meanings
4	Verifying results	Comparing results with morphological characteristics and reference sources, then drawing conclusions
5	Recording and communicating	Recording identification data and presenting it in a coherent manner

Research Procedures

1. Preparation phase: obtaining research permits, developing and validating instruments, and preparing project-based learning materials and a guide for using Pl@ntNet.
2. Implementation phase: implementing project-based learning, including defining core questions, planning the project, creating a schedule, carrying out and monitoring the project (students identify plants in the school environment using Pl@ntNet), assessing outcomes, and conducting an evaluation. [Adjust according to the syntax you use.]
3. Data Collection Phase: observing performance during activities, assessing project products after presentations, and administering written and practical tests at the end of the learning process.
4. Analysis and Reporting Phase: processing scores, determining categories, drafting a discussion, and drawing conclusions.

Data Collection Techniques and Instruments

Instrument Technique Subject that is assessed Content and score. Performance observation Observation sheet of 18 students 5 indicators, score 1-4, maximum score of 20. Product assessment Rubric project product rubric 3 groups 6 aspects (accuracy of identification, completeness of data, photo documentation, use of literature, systematics, presentation and cooperation), score of 1-4, maximum of 24. Written test Multiple-choice questions and description 18 students 8 PG questions (score 1 per correct answer) and 3 description questions (score 0-4), maximum 20 practical tests Identification tasks of 3 plants and rubrics 18 students 4 aspects (application usage procedures, photo quality, accuracy of recording, verification and conclusion), scores of 1-4, maximum 16.

Table 2. Data Collection Techniques and Instruments

Technique	Instrument	Subjects Assessed	Content and Scoring
Performance observation	Observation sheet	18 students	5 indicators, scores 1-4, maximum score 20
Product assessment	Project product rubric	3 groups	6 aspects (identification accuracy, data completeness, photo documentation, use of literature, systematic organization, presentation and teamwork), scores 1-4, maximum 24
Written test	Multiple-choice and essay questions	18 students	8 multiple-choice items (1 point per correct answer) and 3 essay items (scores 0-4), maximum 20
Practical test	Identification task for 3 plants and rubric	18 students	4 aspects (procedure for using the application, photo quality, accuracy of recording, verification and conclusion), scores 1-4, maximum 16

Data Analysis Techniques

The data were analyzed descriptively using the following steps.

1. Achievement percentage = (score obtained ÷ maximum score) × 100%.
2. Written test score = ((multiple-choice score + essay score) ÷ 20) × 100; practical test score = (score ÷ 16) × 100; project product score = (total score ÷ 24) × 100.
3. Mean and frequency distribution for each indicator, aspect, and instrument.
4. Determination of categories:

Table. 3 Data Analysis Techniques

Percentage	**Category**
81-100%	Very good
61-80%	Good
41-60%	Fair
21-40%	Poor
≤20%	Very poor

5. Data triangulation: the results of the four instruments were compared to examine the consistency of the picture of students' abilities.

RESULTS

The ability of students at SMA Negeri 8 TIKEP to use the Pl@ntNet application in project-based biology learning

The results of the analysis of the ability of students at SMA Negeri 8 TIKEP to use the Pl@ntNet application in project-based biology learning are presented in Table 2 below.

Table 4. The ability of students at SMA Negeri 8 TIKEP to use the Pl@ntNet application in project-based biology learning

No	Nama	Total	Persentase (%)	Kategori
1	M	17	85	Sangat baik
2	RM	19	95	Sangat baik
3	DS	16	80	Baik
4	RS	20	100	Sangat baik
5	M	19	95	Sangat baik
6	SD	16	80	Baik
7	MI	17	85	Sangat baik
8	RM	19	95	Sangat baik
9	RS	20	100	Sangat baik
10	MM	19	95	Sangat baik
11	SG	16	80	Baik
12	RU	19	95	Sangat baik
13	RM	16	80	Baik
14	SN	17	85	Sangat baik
15	MT	19	95	Sangat baik
16	NU	17	85	Sangat baik
17	MD	19	95	Sangat baik
18	SU	20	100	Sangat baik

Category criteria: 81–100% — very good; 61–80% — good; 41–60% — fair; 21–40% — poor; ≤20% — very poor. A score of 80% falls into the "good" category, not "very good," because the upper limit of the "good" category is 80%.

Based on the data in Table 2, it is evident that the students' overall proficiency is categorized as "very good" (90.3%, with an average score of 3.61 out of 4). The highest-scoring indicator was "operating the application" (100%), and the lowest-scoring indicator was "verifying results" (79.2%). The difference between them is 20.8 points. Four indicators were categorized as "very good," while one indicator (verification) was categorized as "good." No student scored below 3 on any indicator. All students demonstrated all five competencies, with differences only in completeness and independence. Indicators 3 and 5 had the same percentage (88.9%) with the same score distribution (10 students scored a 4 and 8 scored a 3).

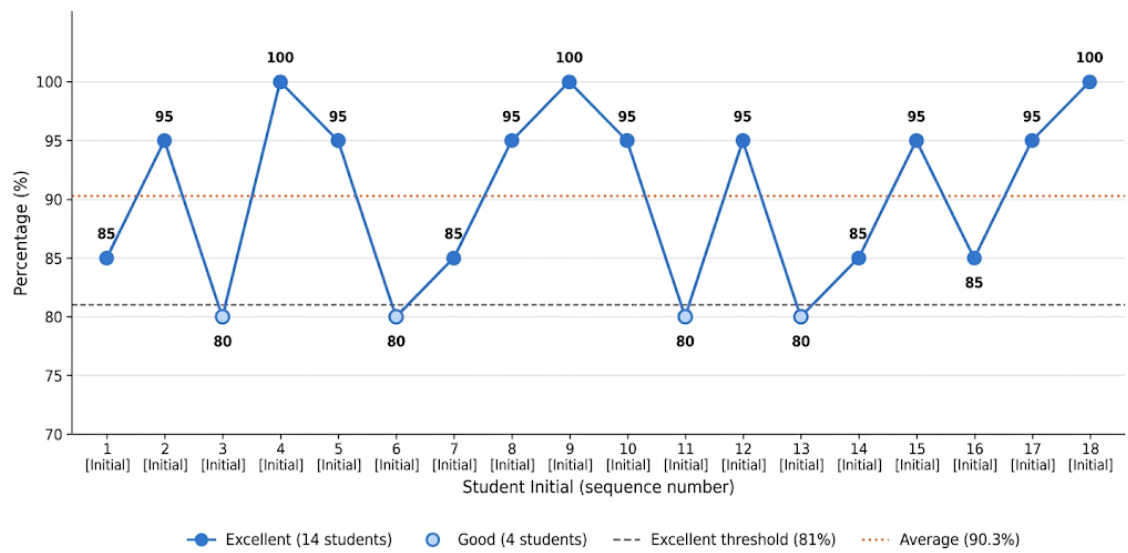


Figure 1. Graph showing the proficiency of students at State High School 8 TIKEP in using the Pl@ntNet app in project-based biology instruction

The data reveals three fairly consistent groups, The 100% group excels in all indicators, including verification. They are the only ones to achieve a score of 4 on indicator 4, suggesting that verification ability appears to be the primary differentiator between high and moderate proficiency. The 85–95% group. This group is strong in technical aspects (indicators 1 and 2), but generally scores a 3 on the verification indicator. For some students in the 85% range (M. Rijal, Murni, Sriyanti, Najrah), indicators 3 and 5 also scored a 3. The 80% group (Dellia, Sitna, Sitna, Rasdi). All four scored a 3 on indicators 2, 3, 4, and 5. This pattern reveals a correlation: suboptimal photo quality can affect identification results, leading to less-than-optimal performance in interpretation, verification, and documentation as well. This group is the one most in need of guidance.

Table 5 Performance by Performance Observation Indicator

No	Indicator	Total Score	Average	Percentage	Category
1	Operating the application	72/72	4,00	100,0%	Very good
2	Taking sample photos	68/72	3,78	94,4%	Very good
3	Interpreting results	64/72	3,56	88,9%	Very good
4	Verifying results	57/72	3,17	79,2%	Good
5	Recording and communicating	64/72	3,56	88,9%	Very good
	Overall	**325/360**	**3,61**	**90,3%**	**Very good**

The results of observations of 18 students at State High School 8 in Tidore Kepulauan City showed that their ability to use Pl@ntNet in project-based biology learning fell into the "very good" category, with an average score of 90.3%. A total of 14 students (77.8%) were in the "very good" category, and 4 students (22.2%) were in the "good" category. No students fell into the "adequate" category or below, and no indicator received a score below 3. This means that all students were able to demonstrate all five aspects of competence,

with differences only in the levels of independence and completeness. This achievement aligns with the characteristics of students who are already familiar with smartphones. Project-based learning also provides opportunities for repeated hands-on practice, allowing technical skills to develop through experience.

Table 6. Distribution of Performance Observation Categories

Score	Count	Category
100	3	Very good
95	7	Very good
85	4	Very good
80	4	Good
Total	**18**	**-**

Thus, 14 students (77.8%) were rated "very good," and 4 students (22.2%) were rated "good." No students were rated "fair" or below.

Project Product Assessment Results

Table 7. Project product scores by group

Group	Total Score	Score / Value	Category
A	22	92	Very good
B	20	83	Very good
C	23	96	Very good
Average	**21.67**	**90.3**	**Very good**

Table 8. Project Product Outcomes by Aspect

Aspect / Indicator	Group A	Group B	Group C	Percentage	Category
A1 Accuracy of identification	4	3	4	91.7%	Very good
A2 Data completeness	3	3	4	83.3%	Very good
A3 Photo documentation	4	4	4	100%	Very good
A4 Use of literature	4	3	3	83.3%	Very good
A5 Systematics and neatness	4	3	4	91.7%	Very good
A6 Presentation and teamwork	3	4	4	91.7%	Very good

The evaluation of the product aspects of this project measures 6 key indicators (A1–A6) on a scale of 1 to 4:

Maximum Score Per Aspect: 12 points total across 3 groups (maximum score per group = 4).

Average Overall Achievement Across All Aspects: 90.28%, with all aspects (100%) falling into the "Very Good" category. All groups (A, B, and C) received the maximum score of 4. This indicates that all groups used the Pl@ntNet app to document local plant samples with great care, clarity, and accuracy. A1 Accuracy of Identification, A5 Organization & Neatness, and A6 Presentation & Collaboration (91.7%): Each aspect received a total score of 11 out of 12. This indicates that the majority of groups demonstrated precise taxonomic analysis skills, structured report writing, as well as very strong team coordination and communication skills during presentations. A2 Data Completeness and A4 Use of Literature (83.3%): Each aspect received a total score of 10 out of 12. Although this was the lowest percentage among the other aspects, the score of 83.3% still met the "Very Good" qualification. This serves as a minor evaluation note for improving the depth of scientific references and the detail of data descriptions in future learning activities.

Group Achievement Distribution by Aspect: Group C (23/24 points): Excelled in nearly all aspects, with only a minor note regarding the use of literature (A4). Group A (22/24 points): Demonstrated high proficiency in identification accuracy, documentation, literature use, and neatness (score of 4). Group B (20/24 points): Very strong in photographic documentation and presentation/teamwork (score of 4).

The results of this indicator assessment show that the use of the Pl@ntNet app successfully improved various dimensions of the students' skills. Students are not only technically skilled in identifying and documenting local flora, but are also able to collaborate, compile reports systematically, and present them very well.

DISCUSSION

Overall Achievement

The average achievement of 90.3% indicates that the students at State High School 8 Tidore Islands demonstrated very good proficiency in using Pl@ntNet for project-based biology learning. Pl@ntNet was developed as an artificial intelligence-based platform that helps users identify plants via smartphones (Bonnet et al., 2020), making it suitable for exploration activities within the school environment. These results align with those of other studies reporting that this application is easy to use and beneficial for high school students in biology learning (Sepriana et al., 2026). Project-based activities using Pl@ntNet at the vocational high school level also showed that students were able to identify plants from various families and describe their morphological characteristics (Fadhillah et al., 2025). The graph shows that the ability of students at State High School 8 Tidore Kepulauan to use Pl@ntNet in project-based biology learning falls into the "very good" category (average 92.1%). The four instruments measured different aspects: the process during the activity (observation), the final product, understanding (written test), and practical skills (practical test). Since all four instruments yielded the same category, the conclusion that the students' proficiency is "very good" is supported by multiple data sources (triangulation), not just a single measurement.

These findings align with other studies reporting that Pl@ntNet is easy to use and beneficial for biology learning (Sepriana et al., 2026), as well as with project-based activities that enable students to identify plants and describe their morphological characteristics (Fadhillah et al., 2025).

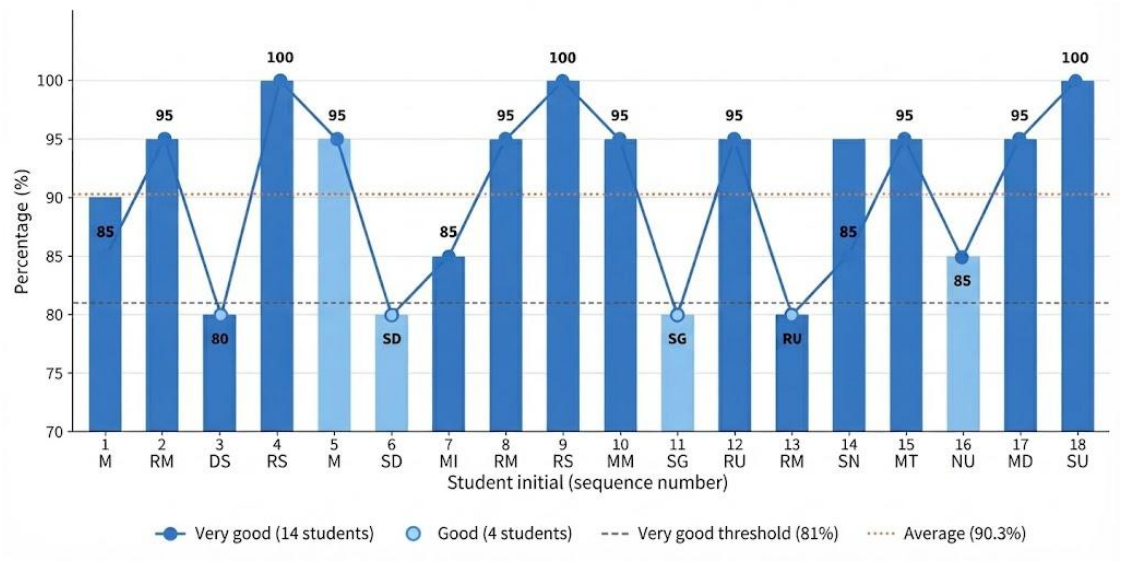


Figure 2. Overall data on the competency achievements of 18 students

Indicator 1. Operating the Pl@ntNet App

All students (18 students) received a score of 4. This means they were able to open the app, select an organ, upload or photograph a sample, and read the results without assistance. The Pl@ntNet app's simple interface and the students' familiarity with smartphones likely contributed to this achievement. In other studies, ease of use has also been cited as one of the app's strengths (Sepriana et al., 2026). It should be noted that because all students scored the maximum, this indicator does not distinguish between students' abilities (ceiling effect). In future studies, the descriptors for this indicator could be made more challenging.

Indicator 2: Taking photos of samples (94.4%)

Fourteen students scored a 4, and four students scored a 3. The majority took photos of organs with proper focus, lighting, and background. Photo quality is important because photos serve as the primary input for identification in the app; thus, blurry photos or organs that are not clearly visible can reduce the accuracy of the results. The four students who scored a 3 still need training in one aspect of photography, such as lighting or background.

Indicator 3: Interpreting results (88.9%)

Ten students scored a 4 and eight scored a 3. Most were able to read the scientific names, families, and match scores, but some were still unable to fully explain their meanings—particularly that the match score represents the application's level of confidence, not certainty. Interpreting taxonomic information requires an understanding of scientific terminology that goes beyond simply operating the app. This aligns with findings that identifying plant species solely

from textbooks or through conventional learning often poses difficulties for students (Sepriana et al., 2026), so teacher guidance remains necessary when students review identification results.

Indicator 4: Verifying results (79.2%) as the lowest-scoring indicator

Only three students scored a 4, while the other fifteen scored a 3. According to the rubric, a score of 3 means students have compared the app's results with morphological characteristics or reference materials and drawn reasonably accurate conclusions, whereas a score of 4 requires both (morphological characteristics and at least one reference source). Thus, most students have performed verification but have not yet followed both approaches. This finding is consistent with the project product assessment, where the aspect of using literature for verification was also the lowest-scoring aspect (83.3%). Two different data sources point in the same direction (triangulation), so verification can be viewed as the aspect most in need of strengthening.

Indicator 5: Recording and Communicating (88.9%)

Ten students scored a 4 and eight scored a 3. Most had recorded complete data (local name, scientific name, family, organ, location) and presented it coherently. Recording and communicating results are integral to project-based learning, which involves collaboration, communication, and the creation of tangible products (Kokotsaki et al., 2016; Krajcik & Blumenfeld, 2006). Students who still scored a 3 generally recorded and presented their results, but their data or presentation was not yet fully complete.

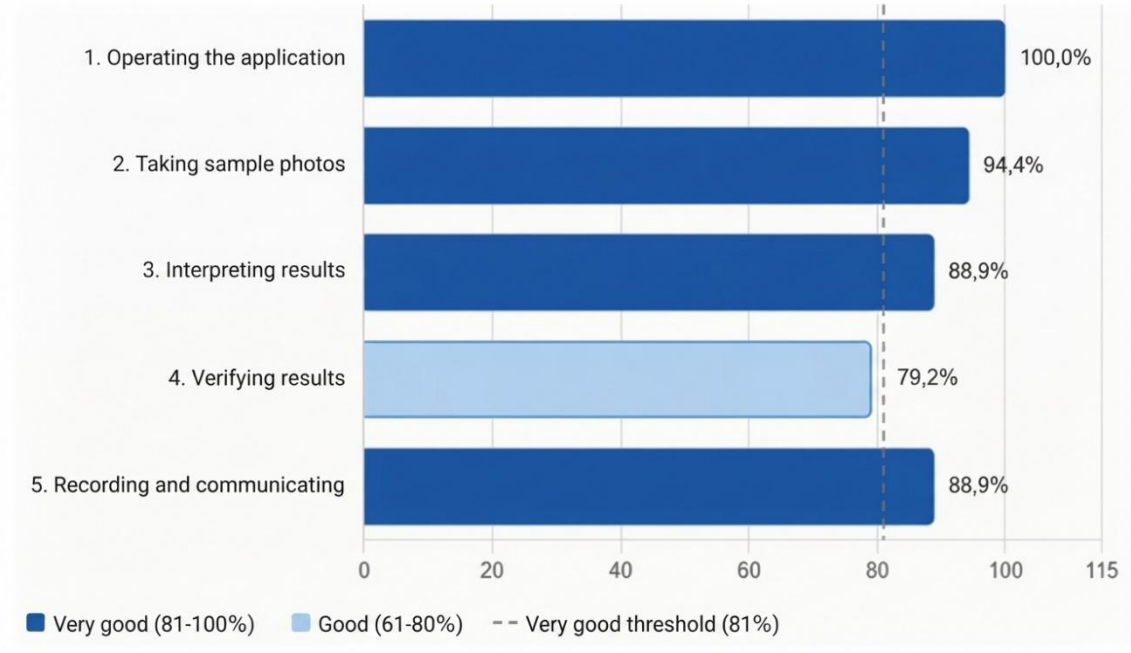


Figure 3. Graph showing achievement of the five indicators

Practical test as the highest achievement

The practical test achieved the highest score (95.1%), and all students were categorized as "very good" with scores ranging from 14 to 16 out of 16. This test assessed procedures performed hands-on: using the app, photographing organs,

recording results, and verifying them. Project-based learning provided ample opportunities to practice these steps, resulting in well-developed procedural skills. Additionally, the practical assignments focused on three plants within a limited timeframe, and the scores varied within a narrow range (only 14, 15, and 16), leading to consistently high and uniform results.

Performance and project product observations as the lowest outcomes

Performance and project product observations both scored 90.3%. This numerical similarity is a statistical coincidence, as the two instruments produced the same score ratios (325/360 and 65/72), not because they measure the same thing. Although the lowest, the results for both remain very good, and the reasons for the slightly lower scores appear to be consistent. In the observations, the indicator for verifying results was the lowest (79.2%, "good" category), while operating the application achieved 100%. In the project product, the aspects of data completeness and the use of literature for verification were both 83.3%, the lowest compared to other aspects, while photo documentation reached 100%. This recurring pattern across the two different instruments suggests that technical skills (operating the app and taking photos) are mastered more quickly than analytical skills (verifying, completing data, and using reference materials). Verification requires students to compare the app's results with morphological characteristics and literature sources, thus demanding a higher level of scientific literacy. This is important because accurately identifying plants is difficult, even for professionals, so the app's identification results still need to be checked (Bonnet et al., 2020).

CONCLUSIONS AND RECOMMENDATIONS

The proficiency of students at State High School 8 in Tidore Islands in using the Pl@ntNet app for project-based biology learning was rated as "very good," with performance observation scores of 90.3%, project outcomes of 90.3, written test scores of 92.5, and practical test scores of 95.1 (average 92.1). The highest proficiency was observed in technical skills, specifically operating the application (100%) and taking photos of samples (94.4%), while verifying identification results (79.2%) and ensuring data completeness and the use of references in project products (83.3% each) still need improvement.

FURTHER STUDY

Further research is recommended to examine the impact of Pl@ntNet-assisted project-based learning through a quasi-experimental design that includes a control group as well as pre- and post-tests. Future studies could also involve a larger number of participants and schools to ensure the results can be generalized. Since verification skills were found to be the weakest aspect, it is necessary to develop and test instructional materials that strengthen verification skills and the use of reference sources. The use of questionnaires and interviews is recommended to explore the perceptions and challenges of students and teachers, along with the refinement and validation of the instruments. Additionally, the accuracy of Pl@ntNet regarding the local flora of North Maluku and the long-term sustainability of students' skills warrant further study.

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