Unnes.J.Biol.Educ. 12 (3) (2023)

Journal of Biology Education

http://journal.unnes.ac.id/sju/index.php/ujbe

The Effect of Analyzing Images Using The PlantNet Application and TGT on Motivation, Classification Abilities, and Data Presentation in Plantae Material

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Info Article

History Article:

Received : October 2023
Accepted : October 2023
Published : November 2023

Keywords:

TGT, PlantNet Application, Motivation, Classification Ability, Data Presentation

Abstract

Learners need to observe various types of plants to achieve basic competencies in the subject of "Plantae." However, teachers find it challenging to manage learning activities outside the school environment. This research aims to: 1) analyze the influence of three different teaching methods on motivation, classification abilities, and data presentation, and 2) determine the most effective teaching method among the three.This study adopts a quantitative approach, specifically quasi-experimental research, using a non-equivalent control group design. The research population comprises all 10th-grade students in the Science Program (MIPA) at MAN 2 Banyumas, totaling six classes. The sample consists of three classes: X MIPA 2, which uses PlantNet + TGT, X MIPA 3, which uses TGT, and X MIPA 4, which employs discussion. Data collection methods include questionnaires, tests, and observation sheets. Data analysis techniques encompass statistical methods such as normality and homogeneity tests, analysis of variance (ANOVA), and post hoc tests.Based on the ANOVA analysis results for all three classes, a significance value of 0.00<0.05 was obtained. This indicates the impact of the techniques of analyzing images using the PlantNet application and TGT, TGT-based learning, and discussion-based learning on motivation, classification abilities, and data presentation. The least significant difference analysis shows that the PlantNet + TGT class had an average motivation score of 48.20, the TGT class had 36.69, and the discussion class had 28.64. The average increase in classification abilities was 35.25 for the PlantNet + TGT class, 21.18 for the TGT class, and 15.58 for the discussion class. In terms of data presentation abilities, the PlantNet + TGT class had an average increase of 25.02, the TGT class had 17.15, and the discussion class had 11.00. This indicates that the PlantNet + TGT class showed significantly higher improvement compared to the TGT and discussion classes.In conclusion, the study results indicate that all three teaching strategies, including the technique of analyzing images with the PlantNet application and TGT, TGT, and discussion, have an impact on motivation, classification abilities, and data presentation. Among these methods, teaching with the technique of analyzing images with the PlantNet application and TGT resulted in the highest improvement in motivation, classification abilities, and data presentation.

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p-ISSN 2252-6579
e-ISSN 2540-833X

INTRODUCTION

The current rapid development of information and communication technology also leads to changes in the way education is conducted, both by educators and learners (Dharma *et al.*, 2013). Teachers should not only possess knowledge but should also master and be able to apply various teaching techniques, strategies, and technologies. This enables learners to acquire 21st-century skills in line with the established graduate competency standards during their educational journey.

In the Plantae subject, there are two basic competencies that must be achieved: 1) KD 3.8, which involves applying the principles of classification to categorize plants into divisions based on observation and the plant life cycle and associating their roles in the continuity of life on Earth. 2) KD 4.8, namely presenting data results of observations, phenetic and phylogenetic analysis of plants, as well as the role of plants in the continuity of life on Earth. For these basic competencies, the abilities of learners to classify and present data are crucial for achieving the intended competencies. The demands relevant teaching strategies and the use of technology to engage learners actively and motivate them throughout the learning process.

In interviews conducted with biology teachers at MAN 2 Banyumas in October 2022, it was found that students lacked motivation and experienced difficulties in analyzing and presenting data in the "Plantae" subject. This information is consistent with the data from the National Educational Assessment Center in 2019, which indicated that the average score for the "Plantae" subject at MAN 2 Banyumas was below the district and national averages, at 72.48 (Ministry of Education and Culture, 2019). Based on the interviews, these challenges are suspected to be caused by the following factors: 1) The extensive amount of material, makes it difficult for students to distinguish the characteristics of each division within the Plantae kingdom. 2) Learning resources for the "Plantae" subject consist mainly of text-based readings and lack attractive and colorful visual examples, which may result in reduced student interest in reading and studying the material. 3) The teaching strategies and media used in the classroom lack variation and innovation. The interview findings align with Suhardi's (2019) statement that a significant portion of the learning process in high schools is conducted through lectures and discussions, with only about 30% of teachers using instructional media. This situation may lead to students being less actively engaged in developing their scientific process skills.

The teacher encounters difficulties in guiding students to directly identify various plants because the school does not provide many live plant examples that students can observe. Additionally, it is challenging for the teacher to manage learning activities outside the school environment due to the longer time required compared to the allocated class time. To address these issues in Plantae subject learning, it is necessary to provide photos of plant specimens as substitutes for live plants that students can observe and analyze. To address this, the image analysis technique with the assistance of the PlantNet application can be employed. PlantNet is an Android-based application designed for identifying plant species. It not only aids botanists in their work but also facilitates educators and students in identifying plant species (Guo *et al.*, 2017). The PlantNet application is designed to identify and gain a better understanding of all types of plants that exist in nature (Pujianto *et al.*, 2020).

The research by Muchsin (2021) concluded that the use of the PlantNet application has a positive impact on the learning outcomes and motivation of 10th-grade students at SMAN 4 Praya (Lombok Tengah) regarding the identification and classification of Spermatophyta plants. The positive impact can be seen on learning outcomes and student motivation. The research findings also indicate that the PlantNet application can make meaningful learning possible without having to visit distant locations for observing actual plants.

The use of image analysis techniques can enhance students' classification abilities. They not only memorize but also use their imagination to identify plants based on their morphological characteristics. To optimize comprehensive learning outcomes, image analysis techniques can be combined with cooperative learning in the form of Teams Games Tournament (TGT). The TGT syntax, according to Slavin (2015), consists of five stages: class presentation, team learning, games, tournaments, and team recognition. The TGT model can increase and cultivate students' learning interest because it incorporates a gaming process that makes the learning experience more enjoyable. Another advantage of TGT is that students in classes

using TGT gain significantly more friends than those in traditional classrooms. Furthermore, TGT can enhance 1) students' perception that their outcomes depend on performance and not luck, 2) cooperative attitudes towards others (verbal and non-verbal cooperation, reduced competition), and 3) student engagement in collaborative learning. However, it is worth noting that TGT implementation requires more time (Slavin, 2008). Kusniawati (2022) stated that TGT helps develop students' minds and thinking, which is expected to increase student motivation.

Based on this, research needs to be conduct to examine the implementation of image analysis techniques assisted by the PlantNet application combined with TGT. The research will involve observing the learning outcomes in classes that use the PlantNet application combined with TGT and then comparing them with classes that only use TGT and with classes that do not use either (i.e., using the discussion method that has been traditionally employed). In line with the advantages of the PlantNet application and TGT, the aspects observed in these three teaching strategies will be motivation, classification abilities, and the ability to present data related to the Plantae subject.

RESEARCH METHOD

This research was conducted at MAN 2 Banyumas in the academic year 2022/2023. The type of research used in this study was a quasi-experimental design with a non-equivalent control group design. The population of this study consisted of all 10th-grade science students at MAN 2 Banyumas, which comprised six classes. The samples used were three classes: X MIPA 2 as the PlantNet + TGT class, X MIPA 3 as the TGT class, and X MIPA 4 as the discussion class. The sampling technique used was purposive sampling. This technique was chosen based on certain considerations, as these three classes were selected due to their relatively similar midterm biology scores. The data used in this research included learning motivation questionnaires, observation results from observation reports, and test results. The data source for this research was the students. Data collection techniques employed in this study included questionnaires, tests, observations, and documentation. Data analysis techniques involved statistical methods, including tests for normality, homogeneity, analysis of variance (ANOVA), and post-hoc tests for the smallest significant difference.

RESULTS AND DISCUSSION

The influence of the three teaching strategies on motivation, classification abilities, and data presentation skills in the Plantae subject was analyzed using One-Way Analysis of Variance (ANOVA). Determining the teaching strategy that results in the highest motivation, classification abilities, and data presentation skills is done through the Least Significant Difference (LSD) analysis.

The influence of learning strategies on motivation, classification abilities, and data presentation ability

Motivation

Based on the analysis of student motivation questionnaires, it is found that the average motivation scores before learning ranged from 41.94 to 43.09, and after learning ranged from 70.71 to 91.31. The analysis results are presented in Table 1.

Table 1. Results of Student Learning Motivation

Motivation Category	Number of Students (%)					
	Before			After		
	PlantNet + *TGT*	*TGT*	Discussion	*PlantNet* + *TGT*	*TGT*	Discussion
Very high	0	0	0	85,71	33,33	0
High	0	0	0	14,28	69,69	14,70
Moderate	57,14	42,42	38,23	0	0	85,29
Low	42,85	57,57	61,76	0	0	0

Based on Table 1, it can be seen that there is a tendency for an increase in motivation scores in all three classes. The percentage of students before the lesson in the PlantNet + TGT class falls into the 'moderate' and 'low' categories. after the leaning, it falls into the 'very high' and 'high' categories. In the TGT class, the percentage of students before the lesson is in the 'moderate' and 'low' categories, but after the learning, it falls into the 'very high' and 'high' categories. In the discussion class, the students have percentages in the 'moderate' and 'low' categories before the lesson, which shift to 'high' and 'moderate' categories after the learning. The results can be obtained that the three learning strategies tend to increase motivation.

The learning motivation scores have been tested for normality and homogeneity, and then a hypothesis test was conducted to determine the influence of the three teaching strategies using an ANOVA test. The results of the ANOVA test are presented in Table 2.

Table 2. Results of the ANOVA test for the motivation scores.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6671.509	2	3335.754	55.369	.000
Within Groups	5964.334	99	60.246		
Total	12635.843	101			

Based on the ANOVA results, it can be observed that the significance value is 0.000, which is less than 0.05. Therefore, H0 is rejected, and Ha is accepted, indicating an influence of all three teaching strategies on motivation.

In this research, in the PlantNet + TGT class and the TGT class, students are given a game in the form of questions related to the characteristics of plants, plant classification, and plant reproduction. Students who can answer questions quickly and correctly are given extra points. In addition, students also participate in tournament stages.

This game can foster enthusiasm and boost students' confidence in their abilities. Students become engaged and active during the learning process. Students have equal opportunities to represent their group at the tournament table as question readers and first players, which makes them less afraid of making mistakes when answering questions. Furthermore, students work together to calculate the scores they have achieved, and the teacher rewards the group with the highest score. In this meeting, students are already accustomed to and very enthusiastic about participating in the learning using the TGT learning model step by step.

The implementation of TGT can increase students' learning motivation. The research results are in line with a study conducted by Sulistyo, Ignatius (2016), which states that the TGT model can increase students' learning motivation, with a success indicator of 75%. During the game and tournament activities, it is clear that all students, whether with low or high abilities, are driven to improve their learning outcomes. The application of the TGT learning model can lead to improved learning outcomes. This happens because of the formation of group work activities (Rukmi, 2020). This statement aligns with the advantages of the TGT strategy mentioned by Taniredja (2011), which includes students freely expressing their opinions and interacting to achieve the desired learning outcomes, increasing students' self-confidence, stimulating students' learning motivation, helping students fully understand the material being studied, and promoting learning interactions within the classroom.

During the discussion class, students are given observation sheets for bryophyta, pteridophyta, and spermatophyta. Students work on these sheets in groups. Afterward, students are encouraged to present the results of their discussions in front of other groups, allowing other groups to also engage in discussions about the material presented by that group. The increase in motivation in the discussion class is due to the application of the discussion method. This is because the implementation of the discussion method makes students actively engage in learning. Students can interact with each other and express their opinions to solve problems. This is consistent with Irwin's statement (2014) that the discussion method can foster students' motivation.

Classification abilities

The 'pass' category is achieved by students who have a posttest score greater than the minimum passing score (KKM), which is 75. The results of classification ability for each indicator after learning are presented in Figure 1.

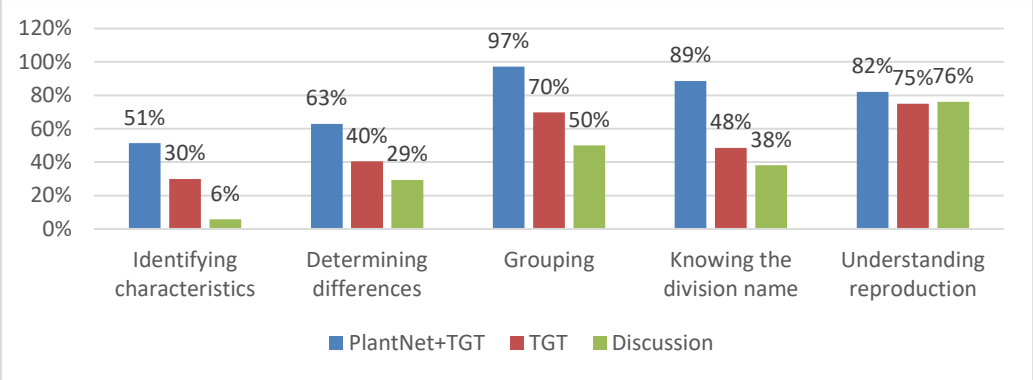

Figure 1. Recapitulation of the results of classification ability for each indicator after learning

Based on Figure 1, it can be observed that the 'grouping plants' indicator has the highest percentage, which is 97% in the PlantNet + TGT class, 70% in the TGT class, and 50% in the discussion class.

The improvement in classification ability scores has been tested for normality and homogeneity, and then a hypothesis test was conducted to determine the influence of the three teaching strategies using an ANOVA test. The results of the ANOVA test are presented in Table 3.

Table 3. Results of the ANOVA test for the improvement in classification ability scores.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7100.964	2	3550.482	29.748	.000
Within Groups	11815.830	99	119.352		
Total	18916.794	101			

Based on the results of the ANOVA, it can be observed that the significance value is 0.000, which is less than 0.05. Therefore, H0 is rejected, and Ha is accepted, indicating an influence of all three teaching strategies on classification ability.

The students have already fulfilled the indicators of classification ability as determined by Soemarwoto (1980), which is the ability to identify the characteristics of each type of plant. In this indicator, the PlantNet + TGT class has a percentage of 51%, the TGT class has 30%, and the discussion class has 6%. The next indicator is determining the differences and similarities in characteristics. For this indicator, the PlantNet + TGT class has a percentage of 63%, the TGT class has 40%, and the discussion class has 29%. in this indicator of grouping plants based on similar characteristics, the PlantNet + TGT class has a percentage of 97%, the TGT class has 70%, and the discussion class has 50%. The next indicator is knowing the names of each group. For this indicator, the PlantNet + TGT class has a percentage of 89%, the TGT class has 48%, and the discussion class has 38%. In all four indicators, the highest percentage is in the PlantNet + TGT class. This is influenced by the observation activities with image analysis techniques using the PlantNet application. Students play an active role in observation through the PlantNet application. During the process, students can observe images of bryophyta, pteridophyta, and spermatophyta in detail, for example, in the case of Gnetum gnemon. The PlantNet application provides detailed images of Gnetum gnemon, including the root, stem, flower, fruit, and leaves. In addition, students can access comprehensive plant classifications in the PlantNet application, which makes it easier for students to identify.

Besides these four indicators, to achieve the basic competence in the plantae material, students must also fulfill the indicator of understanding plant reproduction. During the explanation of the reproduction material, the teacher describes the reproductive process on the chalkboard, and students are also shown images of plant reproduction through a PowerPoint presentation. According to the analysis Figure 1, it shows that the PlantNet + TGT class has a percentage of 82%, the TGT class has 75%, and the discussion class has 76%. The discussion class has a higher percentage than the TGT class. This indicates that the implementation of TGT does not affect the achievement of this indicator.

In the discussion class, students are given the opportunity to exchange opinions. The teacher presents images of Gnetum gnemon, Ginkgo biloba, and Pinus merkusii. With the images displayed by the teacher, students, together with their groups, discuss to identify the characteristics of these species by examining the

root, stem, flower, and fruit structures and then grouping them. The discussion method can improve classification ability. This is because in the discussion method, students have the opportunity to exchange ideas, work closely with their peers, making it easy for them to understand the lesson material received from classmates who have already mastered the material. This is in line with a study conducted by Sri (2018), which found that the discussion method resulted in better learning outcomes than the lecture method on the topic of Temperature and Heat in Grade IX Semester II at SMA Methodist 7 Medan.

The ability to present data

The 'pass' category is achieved by students who have a posttest score greater than the minimum passing score (KKM), which is 75. The recapitulation of the results of data presentation ability for each indicator after learning is presented in Figure 2.

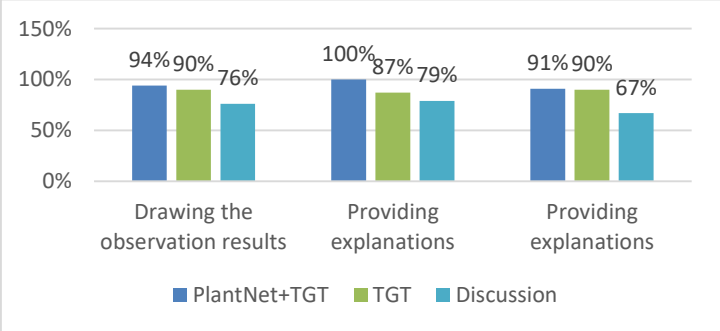

Figure 2. Recapitulation of the results of data presentation ability for each indicator after learning.

Based on Figure 2, it can be observed that the indicator of providing explanations has the highest percentage, which is 100% in the PlantNet + TGT class.

The improvement in data presentation ability scores has been tested for normality and homogeneity, and then a hypothesis test was conducted to determine the influence of the three teaching strategies on data presentation ability using an ANOVA test. The results of the ANOVA test are presented in Table 4.

Table 4. The results of the ANOVA test for the improvement in data presentation ability scores.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3414.865	2	1707.432	26.817	.000
Within Groups	6303.214	99	63.669		
Total	9718.078	101			

Based on the results of the ANOVA, it can be observed that the significance value is 0.000, which is less than 0.05. Therefore, H0 is rejected, and Ha is accepted, indicating an influence of all three teaching strategies on data presentation ability.

In the PlantNet + TGT class, students are given observation reports that involve activities such as drawing plant species, for example, Gnetum gnemon. Then, students show the morphology of the plant and compare it with other plant morphologies. Afterward, students group the plants into the appropriate divisions. The PlantNet application presents various plant images comprehensively, including roots, stems, flowers, and fruits, making it easier for students to observe plants. Learning in the Plantae material is more effective because it can save time. The PlantNet application facilitates students in achieving the basic competencies. This aligns with the research conducted by Rifa'i, et al. (2020), which found that using the PlantNet application for plant morphology identification greatly helps students observe plant structures from various countries, enabling them to learn about different plant types from around the world.

Students can fulfill the indicators of data presentation ability (Figure 2). In the indicator of drawing observation results, the PlantNet + TGT class has a percentage of 94%, the TGT class has 90%, and the discussion class has 76%. The next indicator is providing explanations. For this indicator, the PlantNet + TGT class has a percentage of 100%, the TGT class has 87%, and the discussion class has 79%. In the indicator of giving explanations, the PlantNet + TGT class has a percentage of 91%, the TGT class has 90%, and the discussion class has 67%. In the category of providing explanations, the PlantNet + TGT class has the highest percentage compared to the other two indicators. This is because students play an active role in analyzing plants through images. The PlantNet application provides comprehensive information, including

morphology, habitat, and classification of plant species. Therefore, the ability to provide explanations takes the first place among the data presentation indicators. Drawing ability takes the second place in the hierarchy (Figure 2). This is because the drawing process not only requires knowledge but also demands motor coordination to present an image that accurately represents what the students observe. According to Quilin (2015), drawing requires not only mental processes but also motor coordination to present an image that matches what the students see. Therefore, the drawing process requires further practice to present data in a representative image form. The third indicator in the hierarchy is explaining images (Figure 2). The ability to explain images depends on the cognitive process of the students. Students must connect the information they have gathered to explain the image. One reason for the lower ability of students to explain images is that the mental schema in the students' minds may differ from what they have drawn.

The comparison of the three teaching strategies in terms of motivation, classification ability, and data presentation

Motivation

In the ANOVA results, significance was observed, and then the post hoc test (BNT) was conducted. This test aims to determine which treatment results in the best learning motivation. The results of the post hoc test are presented in Table 5.

Table 5. Results of the post hoc test for the improvement in motivation

Class	Average
PlantNet + TGT	48,20 a
TGT	36,69 b
Discussion	28,64 c

Based on the results of the smallest significant difference test, it is evident that all three classes differ significantly, with a significance value of < 0.05. The average score in the PlantNet + TGT class is significantly higher than in the TGT and discussion classes. Thus, it can be concluded that the PlantNet + TGT class has the most significant impact on improving student learning motivation compared to the TGT and discussion classes.

The average score in the PlantNet + TGT class is higher compared to the TGT and discussion classes (Table 5). This is due to the integration of TGT with the image analysis technique using the PlantNet application. The PlantNet application has an excellent and visually appealing design, complemented with images of plants, which makes it easier for students to understand and thus increases their motivation. This is consistent with the research conducted by Muchsin (2021), which suggests that one of the efforts to enhance students' interest is through the use of learning media, including the PlantNet application.

In the TGT class, the average increase in motivation scores is higher, at 36.69, compared to the discussion class, which has a score increase of 28.64 (Table 5). This is attributed to the use of the TGT strategy. This aligns with the advantages of the TGT strategy outlined by Taniredja (2011), including the freedom for students to express their opinions and interact to achieve desired learning outcomes, increased self-confidence, and the ability to stimulate student motivation, leading to a deeper understanding of the material being studied, thanks to the group work that fosters learning interactions in the classroom.

Classification abilities

The results of the post hoc test for the improvement in classification ability are presented in Table 6.

Table 6. Results of the post hoc test for the improvement in classification ability.

Class	Average
PlantNet + TGT	35,25 a
TGT	21,18 b
Discussion	15,58 c

Based on the results of the post hoc test, it shows that the three classes differ significantly with a significance value of <0.05. The average score of the PlantNet + TGT class is significantly higher than the TGT and discussion classes, and the average score of the TGT class is higher than the discussion class. The PlantNet + TGT class has a significantly higher average classification ability than the TGT and discussion classes, meaning that the PlantNet + TGT class has the best influence on improving classification ability.

The ability to present data

The results of the post hoc test for the improvement in present data ability are presented in Table 7.

Table 7. Results of the post hoc test for the improvement in present data ability.

Class	Average
PlantNet + TGT	25,02 a
TGT	17,15 b
Discussion	11,00 c

Based on the results of the post hoc test, it is evident that the three classes differ significantly with a significance value of <0.05. The average score of the PlantNet + TGT class is significantly higher than the TGT and discussion classes. Furthermore, the TGT class has a higher average score than the discussion class. This means that the PlantNet + TGT class has the best influence on improving the ability to present data.

The improvement in the PlantNet + TGT class can be attributed to the use of image analysis techniques with the assistance of the PlantNet application. PlantNet application helps students actively build their knowledge through plant observation activities. The application also helps streamline the learning process, saving time. This is supported by Surbakti et al. (2022), who stated that the PlantNet application facilitates understanding in plant classification and accelerates the identification process while easing the identification task.

The improvement in the PlantNet + TGT class can also be attributed to the use of the Teams Games Tournament (TGT) learning model. In this model, students are more actively engaged. In this study, students actively participated in discussions and sought various information to complete their tasks well to become the best group in each Plantae subtopic. Besides discussions, students were also actively involved in presentation activities. They presented the results of their group discussions. Throughout the learning process, students were able to understand and find information easily, making it easier for them to achieve the basic competencies. This aligns with the research conducted by Safitri (2017), which found that the TGT learning model improved student engagement and learning outcomes in a high school in Surabaya.

On the other hand, the discussion class had lower average scores for both the ability to classify data (Table 6) and the ability to present data (Table 7) compared to the TGT class. This is because the discussion class only employed the discussion method, which often leads to a passive role for most students, making them mere listeners. This is consistent with the observation that the weakness of the discussion method, as noted by Buchari (2012), is that it may result in some students not actively participating, and participants receive limited information during discussions.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that three teaching strategies, namely a) image analysis technique assisted by the PlantNet application and TGT, b) TGT learning strategy, and c) discussion method, have an impact on motivation, classification abilities, and the ability to present data related to the Plantae subject. The teaching strategy with the image analysis technique assisted by the PlantNet application and TGT has the high influence in improving motivation, classification abilities, and data presentation skills in the Plantae subject.

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