The Google Lens analyzing quality: an analysis of the possibility to use in the educational process

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Abstract. Biology is a fairly complicated initial subject because it involves knowledge of biodiversity. Google Lens is a unique, mobile software that allows you to recognition species and genus of the plant student looking for. The article devoted to the analysis of the efficiency of the functioning of the Google Lens related to botanical objects. In order to perform the analysis, botanical objects were classified by type of the plant (grass, tree, bush) and by part of the plant (stem, flower, fruit) which is represented on the analyzed photo. It was shown that Google Lens correctly identified plant species in 92.6% cases. This is a quite high result, which allows recommending this program using during the teaching. The greatest accuracy of Google Lens was observed under analyzing trees and plants stems. The worst accuracy was characterized to Google Lens results of fruits and stems of the bushes recognizing. However, the accuracy was still high and Google Lens can help to provide the researches even in those cases. Google Lens wasn't able to analyze the local endemic Ukrainian flora. It has been shown that the recognition efficiency depends more on the resolution of the photo than on the physical characteristics of the camera through which they are made. In the article shown the possibility of using the Google Lens in the educational process is a simple way to include principles of STEM-education and "New Ukrainian school" in classes.

Keywords: Google Lens, plant recognition, New Ukrainian school, STEM-education, augmented reality, digital education.

1 Introduction

The school biology course is quite complicated because it includes a huge number of abstract concepts and terms [4]. In addition, the school biology course also involves the study of species diversity learning [7]. Ukraine has a rich biota with more than 25,000

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species of plants (5,100 vascular plants, more than 15,000 mushrooms and mollusks, more than 1,000 lichens, almost 800 mosses and about 4,000 algae) and 45,000 species of animals (more than 35 000 insects, almost 3 500 other arthropods, 1800 protozoa, 1600 roundworms, 1280 flatworms and 440 ringworms among more than 44 thousand invertebrates, about 200 fish and roundworms, 17 amphibians, 21 reptiles, about 400 birds and 108 mammals from the vertebrates) and is characterized by a certain endemism. A school teacher cannot perfectly know all kinds of species. He may face the problem: "the students brought a photo of a plant or animal and want to determine the species of this plant or animal". One of the ways to solve it is the use of a Google Lens. The absence of the answer will lead to decreasing of student's motivation which is even more important than the fact of absence of the answer.

According to the concept of a new Ukrainian school, students need to develop information and digital competencies, which involves the confident and meaningful use of information technology to receive, transmit information [3]. Google Lens allows students to set their own, in their convenient mode, during field or classroom classes, with both informational competence as well as competence in science and technology.

2 Literature review and problem statement

2.1 General situation on the necessity of Google Lens in curricula

The world is becoming digital and technological, which directly affects the learning process and it creates challenges to education. The classical educational environment is stable, based on pedagogical traditions, involves the formation of hard skills. In Ukraine, the classical educational environment is represented by curricula on various subjects that are required for the performance of all teachers, a list of textbooks that are recommended for use during the educational process and a number of legislative acts of the Ministry of Education and Science. However, considering the New Ukrainian school concept, educational society faces challenges on the implementation of virtual instruments (learning environment) [2; 3].

Unlike classical educational environment, virtual learning environment is constantly changing in connection with the constant scientific and technical process, it is aimed at the development of creativity [12]. Virtual learning environments include digital programs and websites. The most program helps to analyze experimental data, mathematically process them. Thanks to them, you can successfully apply a learning model through a study in which a student analyzes the results obtained by himself or others by establishing experimental data as if discovering the basic laws of nature. Special and most modern of them are those which include elements of virtual and augmented reality due to their ability to increase student's motivation [6; 19]. Previously, we substantiated the need to implement Google Lens approach in the educational process [16]. However, there wasn't shown the efficiency of Google Lens. Therefore, this work aims to analyze the possibility of Google Lens using in educational institutions to provide STEM-research projects on botany. To achieve the aims next tasks were indicated:

1. To evaluate the general quality of the Google Lens's recognition technology related to plants.
2. To understand and show the main factors which effect on the recognition in real-life research to give advice in the process.
3. To modify the pedagogical method of the plant's analysis based on the obtained knowledge.
4. To summarize up and analyze the results and evaluate the possibility of Google Lens implementation in the school botany research.

Thus, the object of the research is the pedagogical method of plant kind determination. The mechanism of plant determination by Google Lens was the subject of the study.

2.2 Description of the Google Lens and its role in education

Mobile phone nowadays is a powerful scientific instrument [13]. However, the potential of it still not fully understood and presented. One of the companies who are creating new digital software which can be used in education is Google who creates instruments such as Google Lens. Google Lens is an image recognition technology based on neural networks and developed by Google. Having determined the species of animal or plant, one can further study its biological properties. The main positive aspects of using Google Lens in our opinion are:

1. Provided by the possibility to use personal phones any time of the research.
2. Interaction with any objects include biological
3. The possibility of research any object any time including during expeditionary researches
4. Creation of interaction between real and virtual worlds.

Google lens is integrated into both Google Photos and Google camera which can be used on any Android devices with Android 4.4 or higher or IOS. The access to Google Lens instrument is presented in Figure 1.

Google Lens can be used in different parts of education such as Biology, Mineralogy, Architecture and history and Marketing to achieve additional information about the object and increase the motivation of the students (table 1).

Table 1. Using Google Lens in different fields of education

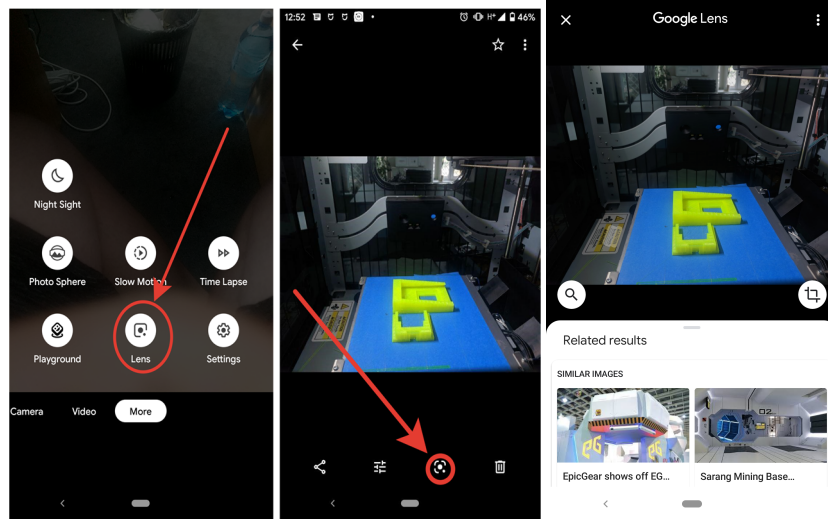| Field of science	Way of using
Biology	Nowadays Google Lens is characterized by the possibility of biology objects recognition (animals, plants, etc.)
Mineralogy	Google lens can use the color and the structure of the minerals to analyze it (not available now, but we think it will be provided in the future)
Architecture and history	Analyzing the building and monuments
Marketing	Analyzing and searching for different real-life products such as clothes

Fig. 1. Google Lens instrument access

3 Materials and methods

3.1 Model experiment

To provide experiment and compare results with keys for each plant, 500 photos from online-classifier "The list of plants of the Dneprovskiy district of Kiev" (Fig. 2) were taken. The online-classifier contains the pictures of each kind of the plants and its determination names. Photos were characterized by the method described in 3.2 due to the different quality of the photos and collected by a method described in 3.3.

Fig. 2. The list of plants of the Dneprovskiy district of Kiev

3.2 The general method of photo analysis

Photo's quality is an important factor to Google Lens. Therefore, it is necessary to classify each photo by main quality components – composition, resolution, digital noise. Main photos quality criteria are presented in table 2.

Table 2. Main photos quality criteria

Quality	Analyzed object`s resolution, Mpx	Gray noise	Color noise	Analyzing object
Bad	<0.3	High	High	Not clearly visible
Middle	0.3–3	Middle	Middle	Clearly visible
Good	>3	Low	Low	Perfectly visible

3.3 Data collection and analysis

To collect data, we developed the database with front-end and back-end development. Each photo was classified by the image quality using the method described in 3.2 and its characteristics such as type (tree, bush, grass) and presented part of the plant (flower, leaf, stem, fruit). The mark of the analyzing process was inputted too. The input interface is presented on Fig. 3.

Fig. 3. The input interface

The output interface looked like a table to provide the visualization and dynamic of the research process. The output interface is presented in Fig. 4.

Google Lens propose a few results of the analysis to the user. Therefore, the results of Google Lens were classified on 0, 1, 2 or 3 points. Sometimes cropping of the photos was used, in this case, one point was deducted. The keys of Google Lens results evaluation are presented in table 3.

Table 3. Main photos quality criteria

Points	Description
0	The object wasn't detected at all
1	A genus of the object was recognized and presented in top 6 results but species wasn't correctly recognized
2	a) a genus of the object was recognized and presented in top 3 results but species wasn't correctly recognized b) Genus and species of the object was recognized and presented in top 6 results
3	Genus and species of the object was recognized and presented in top 3 results

Results were collected on the database. To provide an analysis of the requests to a database prepared and provided. The requests were prepared to take into account the aims of the work. To process the results MS Excel 365 was used.
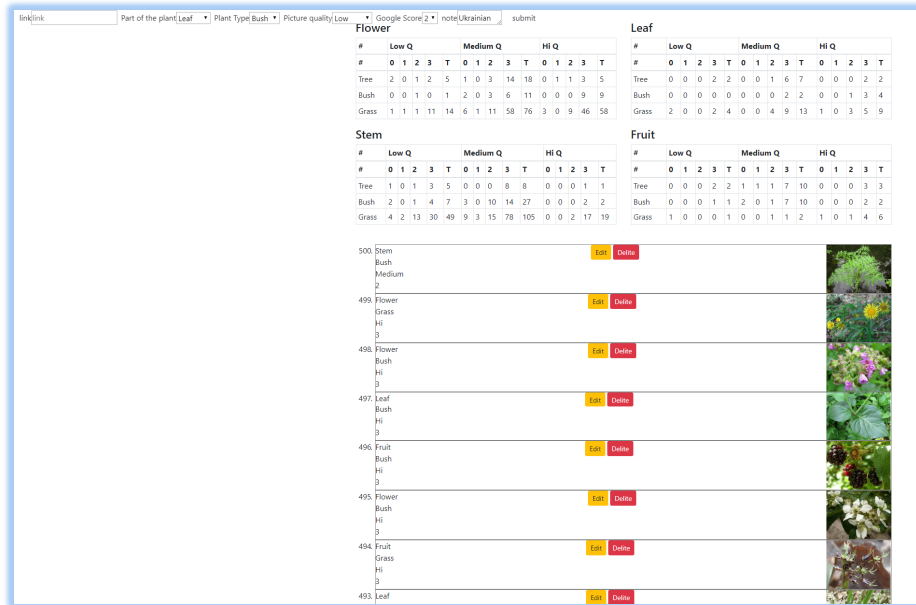
Fig. 4. The output interface

4 Results and discussion

4.1 The general accuracy of the Google Lens

The general inaccuracy of Google Lens analysis was 8.4 % on the modeling experiment. This result proves the possibility of Google Lens using in the educational process and it can help pupils to conduct their own researches; in 92.6 % of cases, it can help to find the right answer. It is worth note that this accuracy is much higher than the accuracy of the teacher's answers.

In 72.8 % of cases, Google Lens gives a totally correct answer (finding object was in the top 3 of results) which is high. In 17 % of cases, it shows the correct results in the top 6 of the results and just in 1.8 analysis results were not so much correct (in the top 6 of the results without correct genus recognizing but with correct species recognizing). General results are presented on Fig. 5.

4.2 Analyzing the importance of the criteria

Photos quality. As it was expected, as higher quality of the photo than better analysis results. However, even the low quality of the photos has a huge chance to be rightly analyzed. Just 14.3 % of photos with low quality weren't recognized compared to 4.2 % of incorrect results in the case of high-quality photos. Google lens was totally accurate in 80.83, 72.7, 62.6 % of cases with high, medium and low quality, respectively. The dependency of the accuracy of Google Lens analysis quality of photo's quality is
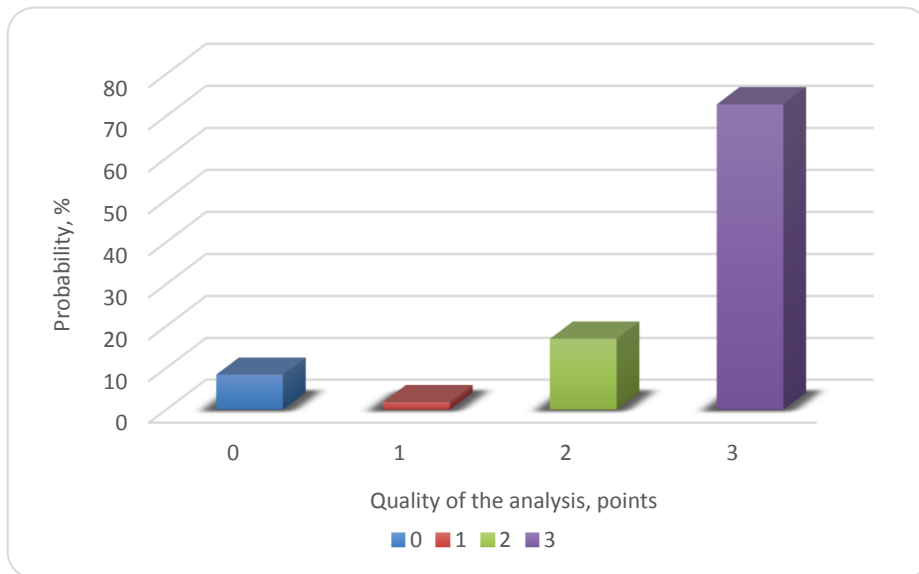
presented in Figure 6.

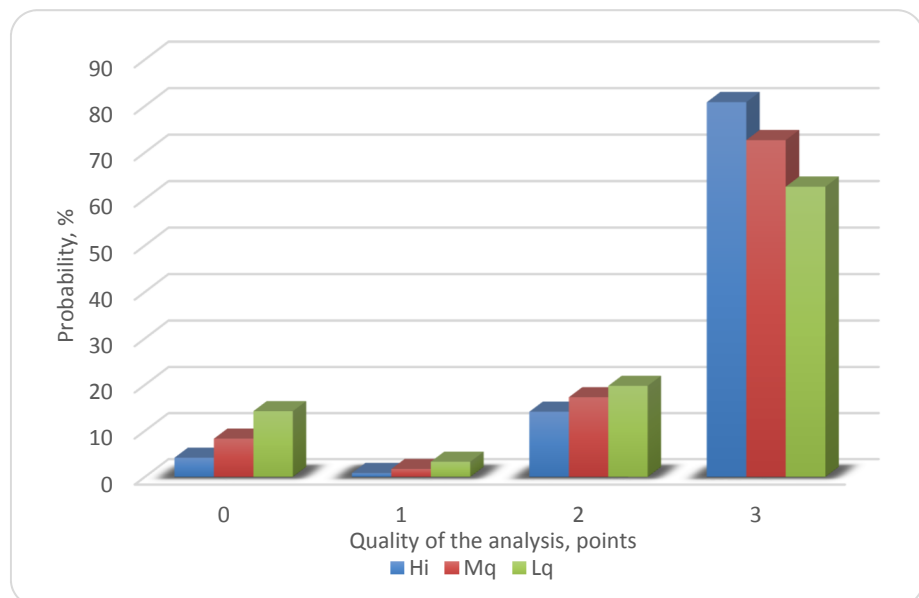**Fig. 5.** General Google Lens accuracy

Fig. 6. The dependency of the accuracy of Google Lens analysis quality of photo's quality

Therefore, using a better camera and making a better photo can increase analysis quality, however, Google Lens algorithms work with low-quality photos enough fine and it means that Google Lens instrument can be used on any device even with a bad camera which can afford each student.

Parts of a plant. Google Lens algorithms better analyze flowers of the plants than other parts and it was characterized by an inaccuracy level of 7.1 %. The worst result of the Google Lens analysis was observed under fruit analysis. It may be related to the similarity of some fruits between each other. It was characterized by inaccuracy level of 16.2 %. However, totally correct analysis results were similar for steams, leaves and fruits of the plants and it was 70.9, 70.5, 70.3 %, respectively. Significantly higher was the level of the totally correct analysis results in cases of flower analysis with an indicator of 76.0 %. Therefore, to obtain better results if it possible provide analysis of the flowers of the plants. The dependency of the accuracy of Google Lens analysis quality of analyzing part of the plant is presented in Figure 7.

Fig. 7. The dependency of the accuracy of Google Lens analysis quality of analyzing part of the plant

Plant type. Google Lens analysis shows similar results for both totally accurate and inaccuracy for grass and trees and they were 74.4 and 7.8 % for grass, respectively, and 76.4 and 8.3 % for trees, respectively. Much worse Google Lens results were characterized for bushes. The inaccuracy of it was 10.4 % and the quantity of totally correct results was 64.6 %. Dependency of the accuracy of Google Lens analysis quality of analyzing plant type is presented in Figure 8.

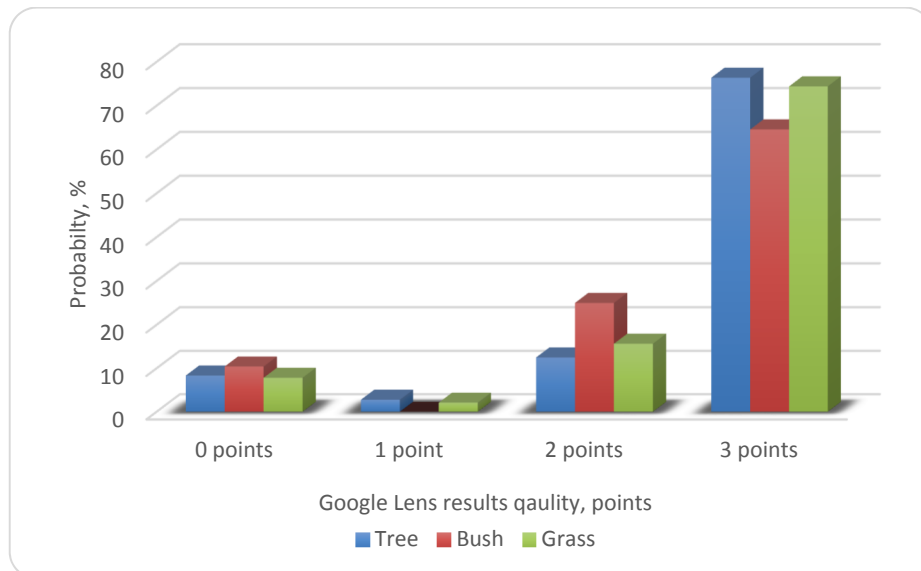**Fig. 8.** The dependency of the accuracy of Google Lens analysis quality of analyzing plant type

4.3 Discussion

General specific of analysis.

It's worth note, that there were some examples of Ukrainian species of plants weren't recognized at all. This fact was obtained due to the integration of the Lens with different internet services where wasn't information about specifically kinds of plants. Thus, the results will be even better in the regions where more information about the plants in English.

High analyzing results were obtained under analyzing of the flowers of grasses (for example, Taraxacum officinale) where the quantity of inaccuracy analyzed samples were 0 % and quantity of totally successfully analyzed samples was 93 %.

Not surprisingly, the results of the brush's analysis at all were bad. However, the worsted was characterized for fruits and stems of the bushes and level of inaccuracy was 22.2 % of them. The lowest level of total accuracy analyzed results were characterized for stems of the bushes. For all other samples, results were close to average. This means that using Google Lens for fruits and stems of the bushes do not guarantee the perfect results. However, it still characterized by a respectively high level of analyzing the accuracy and it can be used to obtaining information. General results of Google Lens analysis are presented on the fig. 8.

Google Lens isn't analyzing the environment; therefore, it can make mistakes based on this fact. For example, this fact was obtained under analyzing of the water mint photos.

Low indicator of analysis quality on the fruit analysis may be explained by an algorithm of analyzing a shape of the fruit firstly and then looking on its specific. Therefore, for example, guelder-rose was analyzed as grapefruit. Some photos where

colors were differed compared to real-life samples and in those cases, Lens makes mistakes to. It was observed under analyzing of Gladiolus where colors were less saturated than in real-life and Heliopsis helianthoides where samples were more saturated. In those cases, Google Lens makes mistakes in the species not in the genus.
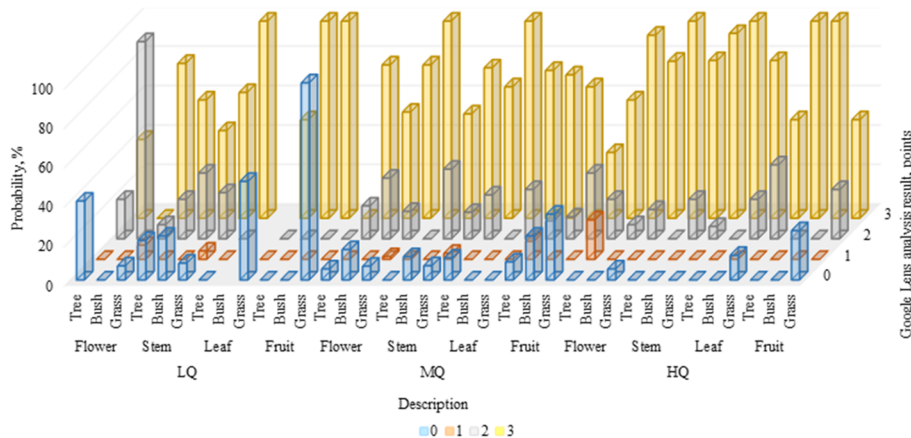

Fig. 9. General results

Therefore, it seems like, a shape is an effect on the genus determination. Color and specific of the plant parts are rather affected on the species determination of genus.

Google Lens is looking for eye-catching object and there were cases where plant part was less eye-catching than other objects and Lens makes mistakes. And this effect even more affected than other photo quality aspects. It means that even not camera or its lens plays the most important role in photo quality but photography skills. To decrease its effect cropping photo may be used. However, this fact will stimulate students to increase their photography skills.

Google Lens in STEM-education.

Google Lens is a powerful STEM-instrument which can provide increasing of knowledge quantity and quality and can increase motivation to education for students-visuals [5; 6]. As was noted before, it has a huge potential of implementation in different educational fields and can provide transdisciplinarity of the educational process through the integration of it with Wikipedia (default) and other resources (by picture search).

The teacher can achieve even better results by providing "find-mistakes" challenge with excellent students. Under it, students will try to find mistakes in the analyzing of the Google Lens.

It is worth note that one of the priorities of the Ukrainian secondary school is STEM-education [1; 15; 17; 18] and the New Ukrainian school principals implementation which can be easily achieved by using Google Lens using in classes.

Nowadays each teacher in Ukraine can easily use those methods based on Google Lens through using online-guides located in stemua.science open-source web-portal

and can share own methods based on it [14]. In additions, STEM-principles nowadays are being introduced in university courses due to their efficiency [8; 9; 10; 11; 15].

Conclusions

1. Google Lens shows the high results of analyzing which gives reason to recommend its implementation in the educational process.
2. It is better to plan classes on the gardens due to the fact that Google Lens shows better results on the grass and trees analysis.
3. Based on the results of the article we modernize methods located in the stemua.science.
4. Using of Google Lens in the educational process is a simple way to include principles of STEM-education and "New Ukrainian school" in classes.

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