

Evaluation of Smartphone Microscope Applications for Use in Middle Year Biology Classroom

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Abstract: With the introduction of smartphones in everyday life, educators have gained access to a variety of new applications and technologies. These innovative applications could be a valuable tool for teaching Science and especially Biology, since they could further attract the students' interest in the lesson and help them recognize how Biology is correlated with their everyday life. In this project smartphone microscope applications are evaluated for the middle year Biology classroom for 1st formers. The applications were chosen due to the curriculum given by the Greek Ministry of Education for students that age. Criteria of evaluation included easy usage, relevance with the teaching objectives, consistency with Science standards, graphics and the ability of controlling and changing parameters. The microscope applications were then used in class where a sample of students worked with them to investigate the validity of the conclusions of the evaluation.

Key words: microscopes, smartphone, biology, STEM

1. Introduction.

Nowadays, smartphones influence many fields and especially education (Buck, McInnis & Randollph, 2013). Undoubtedly they consume a big part of students' daily life as evidence shows that almost 80%-85% of teenagers aged 12–15 years old own cell phones (Esmaeili, Eydgahi & Amanov, 2015). Smartphones can adapt in all learning environments and offer the opportunity for personalized learning experience (Vandoninck, Nouwen & Zaman, 2017). They can also allow students to gain access and collect information even outside the classroom, get answers to real life problems, while at the same time help them culture skills such as cooperation and communication (Kadry & Roufayel 2017). Furthermore, due to the fact that a device can be low cost and able to support many applications, it could replace the expensive laboratory equipment of a school laboratory (Esmaeili et al., 2015; Vandoninck, Nouwen & Zaman, 2019). Especially for teaching Biology, smartphones and tablets can overcome many of the challenges that occur during the execution of an experiment. Biology is based on experimentation as a nonstop evolving science. Experimentation ideally is an integral part of the educational process, necessary for the understanding of and the connection with basic concepts and phenomena. The microscope is also an important part of a school lab through which students can develop observation and thinking skills. Unfortunately, the microscope is expensive and many schools can't afford it. Moreover, it can't be carried outside the lab and consequently students can't collect data outside the classroom, share them with each other and

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work them out. Currently there are many microscope applications available for smartphones. These applications can be a beneficial tool for the Biology lab for middle year students.

2. Choosing the Appropriate Application — Evaluation Criteria

Educators these days have at their disposal a long list of applications which sometimes makes it difficult for them to choose the appropriate one (Arnold, 2018). In the previous project “Smartphone applications that could be used for the Biology lesson for 1st formers” (Arvaniti et al., 2019) an evaluation formula was developed for smartphone applications. This formula is based on a combination of guidelines that derived from the criteria suggested by Dee Lanier of EdTech Team, Harry Walker (Walker, 2011) and Apple (Apple, 2013). Thus the result was the formula available at the following link: <https://drive.google.com/open?id=1OP69JvZrnSoM72WVWBIE8CLRCsIeQTzUshTxdQDh57Q>. The main evaluation aspects were A. Educational planning - if it serves the teaching goals, gives feedback and helps with speculation and if it offers the possibility for differentiation in learning, B. Targeting the appropriate level for the age of the students — whether the content and graphics are appropriate for that age and if it motivates students to use the app, C. Easy to use — if there are instructions, if it is easy to navigate in the application and to install on all devices and if the language is Greek, D. Innovation — if it introduces innovative educational practices and suggests new ways for students to learn and E. Cost — whether the application is free or low cost. The formula uses a scale from 1 (meets minimum criteria) to 4 (meets all the criteria) and is used to describe at which point each application has the features that comply with the main evaluation aspects. As a prerequisite for an application to be considered appropriate was to reach at least number 3 in the scale.

3. Applications Evaluation

A total of 9 applications were evaluated (Arvaniti et al., 2019) that were chosen from a long list of Biology applications, at first according to their association with the mandatory laboratory exercises in Biology for middle year. According to the instructions given by the Greek Ministry of Education, the mandatory laboratory exercises in Biology for 1st formers for the school year 2018 – 2019 are as follows: Microscopic observation of plant and animal cells, the importance of light for photosynthesis and transport of substances in plants, and the effects of exercise on respiratory rate. Hence, the search included applications for microscope, photosynthesis and heart rate measurement. Google play gave plenty results from which there were chosen to be evaluated those with the most positive reviews and a graphic environment easy to use. The results of the evaluation were as follows: A. Microscope: Cozy Magnifier & Microscope (1/4), Realistic Microscope (2/4) and Microscope Camera (3/4) B. Photosynthesis: Biology Photosynthesis (3/4), Photosynthesis (1/4) and Plant Nutrition (4/4) C. Heart rate measurement: Heart Rate (3/4), Heart Rate App (2/4) and Instant Heart Rate (2/4).

The complete analysis of the evaluation along with the relevant process, is accessible through the paper of Arvaniti et al. (2019) which was posted in the Proceedings of the 6th Conference of Neos Paidagogos.

4. In Class Evaluation of Smartphone Microscope Application

The smartphone microscope application was chosen for in class evaluation, since the school’s Biology laboratories are equipped with real microscopes that could offer the opportunity for real time comparison of the

results coming from the application and those coming directly from the lab equipment. The microscope is one of the most important scientific equipment, since it allows the observation of structures not visible to the eye. Its discovery lead the way for further discoveries in all scientific branches and the public access in microscopy, either through schools or through commercial toys and educational products, has increased in recent years. Most of the applications focus only on the utilization of the microscope and say little or nothing about its principles of operation and thus the students lack a large educational part that microscopy can offer (Wicks et al., 2018).

The evaluation of the applications took place in the school laboratory as part of the Biology course and it was conducted by a group of 30 MYP year two students. At the beginning there was an in class conversation on the proper use of technology. Parents were informed by email about the procedure to be followed. They were asked to sign a consent form for the use of smartphones in the classroom as smartphones are generally not allowed in Greek schools. During the evaluation the students were informed through a presentation for the relevant applications and the goals of the in class use of cell phones. Next, students were able to work with the applications and collect their data. The students observed leafs and parts of insects both with the applications (Figure 1) and with the laboratory optical microscope. Once the task was completed, there was a discussion on their experience of using the applications and came to conclusions regarding the practical evaluation of applications beyond the evaluation rubric.

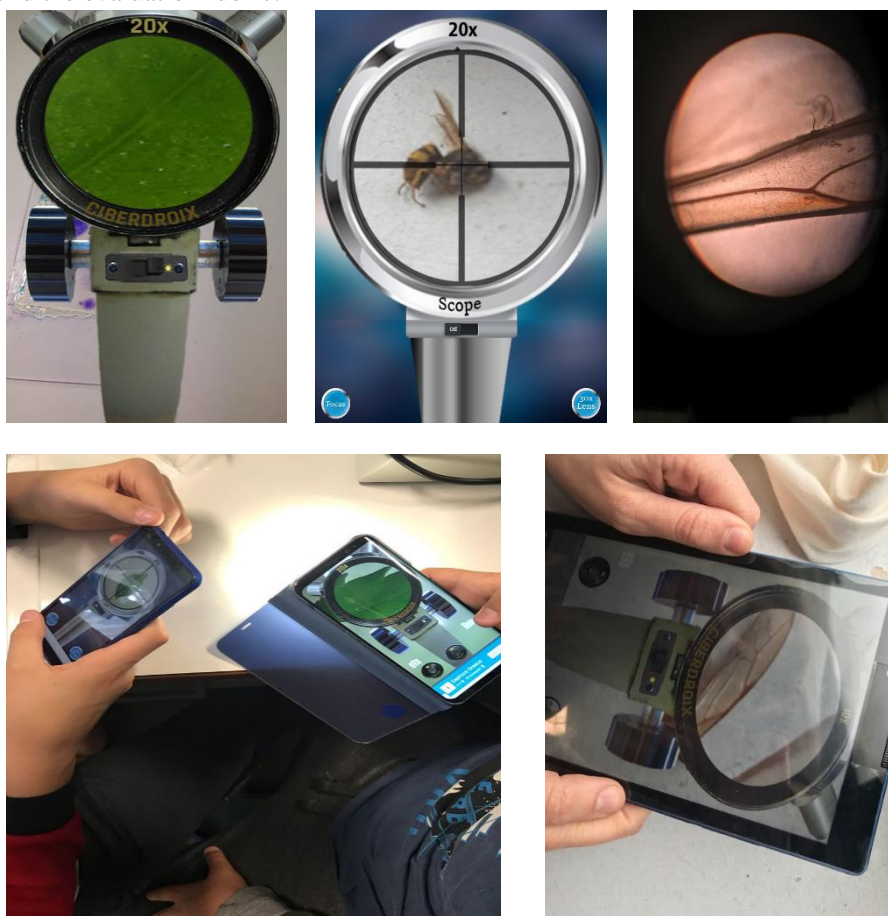


Figure 1 Photos from the Use of the Application for the Observation of a Bee

5. Results of Classroom Assessment

Conclusions drawn from student feedback are presented in the diagrams below, which show that the most suitable microscope application is indeed the microscope camera with a percentage of 64 (64%), i.e., 19 students out of 30, considering it to be partially achieving the teaching objectives, as it presents a brief history of the microscope and offers the use of four types of microscopes. Moreover, it made it easy for them to switch lenses between 5x, 10x, 20x and 30x with proper graphics and clear in-app navigation at no cost. In addition, most of the students would use this app even after the class was dismissed, as they found it very enjoyable to collect data and were impressed with the ability to take such pictures outside the classroom. Finally, comparing the images observed through the application and those observed through the laboratory microscope, 36% believe that these applications could right on replace the actual microscope (Figure 2).

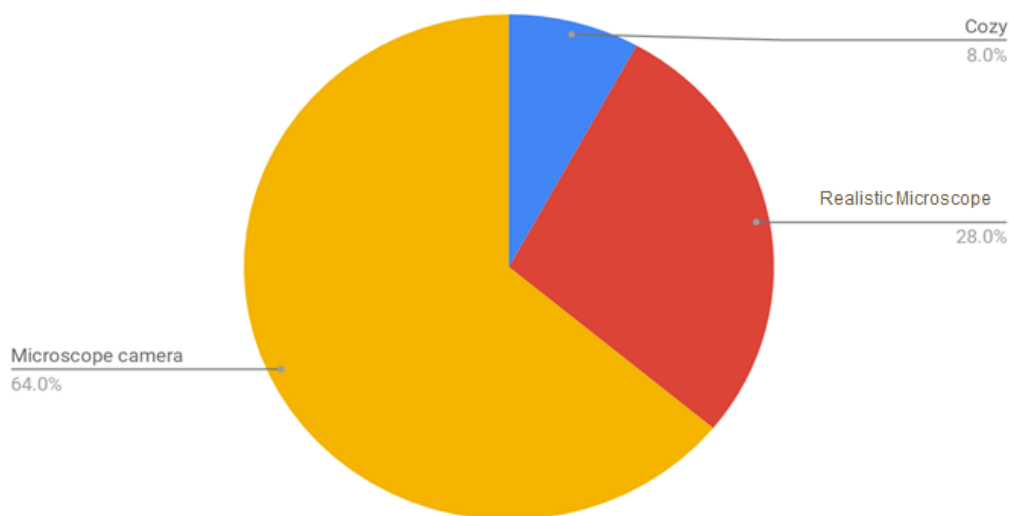


Figure 2 Evaluation of Microscope Applications in the Classroom Results

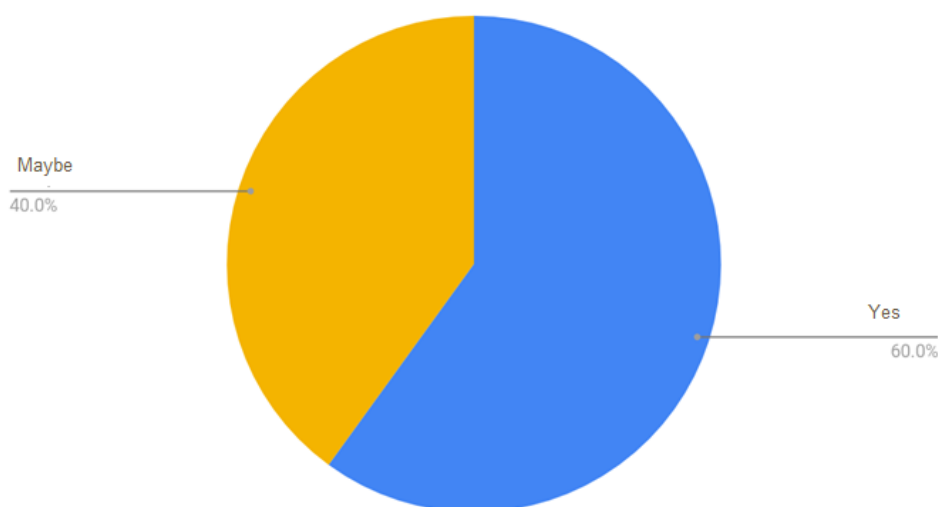


Figure 3 Would You Use the Applications at Home?

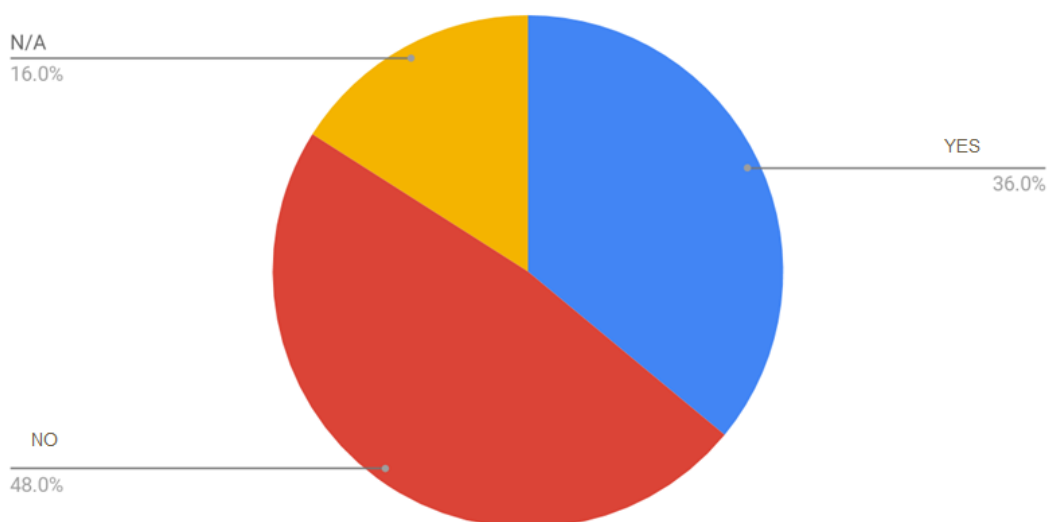


Figure 4 Do You Believe That the Smartphone Microscope Applications Can Replace the Optical Microscope in the School Biology Lab

6. Conclusions

Smartphones are undoubtedly a big part of students' everyday lives, although their full utilization and integration into the educational process is currently hampered by existing legislation. Nevertheless, their use as an educational tool can help students develop a wealth of skills (Vandonink, 2019; Norris 2011). Choosing the right application for classroom use however is usually a difficult process as there are many options available (Clayton & Murphy 2016). The innovation of this project lies in the in classroom application evaluation and the evaluation rubric, with the guidelines of the relevant evaluation formula which can be a useful tool for any teacher who wishes to evaluate an application and then proceed with its use in the classroom. Most of the microscopy applications applied in the classroom meet the requirements of the evaluation formula. The main conclusion from evaluating in-class applications was that the optical microscope is an important educational tool that can hardly be replaced by the use of mobile applications as it offers clarity. For school laboratories that cannot provide students with a visual microscope, these applications are a valuable tool. In addition, the ease of use of cell phones even out of class and the ability to collect, process and store data are some of the features that are attractive to students and motivate them to explore the science of Biology even during after school hours.

Another important point that emerged from the above assessment is the fact that no application is in Greek or can be translated into the speaking language of students. Furthermore, the instruction manuals are not clear to students. Particularly the matter of the language for the subject of Biology where the students have to learn new terms is important. For this reason, it is essential to create worksheets before using the applications in the classroom. It is also worth mentioning that none of the applications evaluated have any innovative educational practice and the ability to differentiate learning is limited. Designing educational applications should be done in collaboration with teachers who take these factors into account, thereby opening up new horizons for students to learn using their cell phones in a different way.

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