RouteQuizer
A Geocaching System for Educational Purposes

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Abstract: This article presents a geocaching educational system called RouteQuizer that consists of an Android application, a web application and an online database. It motivates students to visit various geographic points of interest and answer site-related questions of multiple choice type. The android application used by the students, takes advantage of the navigation (GPS) and internet connectivity features of their smartphones. The web application is used by tutors, to create dynamic location-based educational games for their students. The database stores data such as site information and coordinates, questions and answers regarding the area of interest, as well as students' performance results. There are no geographical restrictions and no limits regarding the number of destinations, thus making the application usable from everyone everywhere.

1 INTRODUCTION

Along with the constant development of technology, smartphones came into our lives in the late 2000s. As smartphones were sprawling the market, they started replacing the old cell phones as we knew them a decade ago.

The features of smartphones are such that, excluding their predecessors, they replaced devices that previously were necessary, such as alarm clocks, cameras, radios, GPS devices, flashlights, compasses etc. Considering they cost much less than a laptop or a personal computer, their high portability, internet connectivity and computational power, they are now used for medical, military, tourist and education purposes.

One of the main priorities set by the European Union, in the "Education and Training 2020" strategic framework, is "Open and innovative education and training, including by fully embracing the digital era". Also, the European Union funds a lot of mobile learning programs, such as MOTILL, MLearn and Edumotion, in an attempt to promote the use of smartphones in education (European Union, 2015).

Modern technology, offers more than just being attractive to students; it also enables tutors to implement innovative activities that could benefit the educational process, such as geocaching.

Until now, geocaching required either maps and photographs, or GPS devices, or even a combination of all of them, practices that are thoroughly analyzed and compared in (Ellbrunner, H., et al., 2014), (Jones, T., 2012), (Hamm, B., 2010), (Vitale, J.L., et al., 2012), (Robison, D., 2011), (Christie, A., 2007), (Lisenbee, P., et al., 2015) and (Palmárová, V. and Lovászová, G., 2012).

The GPS and compass features that all smartphones now provide, increased significantly the number of people involved with geocaching. Smartphone applications, such as "Geocaching®" by "Groundspeak Inc.", mentioned in (Ihamäki, P.J., 2012), and also "c:geo" by "c:geo team", are commonly used by millions of users. The fact that geocaching is also widely used by tutors and students for educational purposes, and that all applications mentioned above (and other similar), do not provide the ability to dynamically create new educational activities, have highlighted the need for a specially developed smartphone application, that utilizes the new technological achievements in favor of education.

Such an application, is presented in (Kohen-Vacs, D., et al., 2012). Although we were not aware of the existence of such an application, we followed a similar direction and we created the RouteQuizer system. RouteQuizer system consists of a database, an Android application and a web application. Although it shares some similarities with the prementioned above, it differs mainly because of its

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ability to inform teachers about their students' performance and to implement multiple choice questions on site. Also, RouteQuizer features a simple, yet attractive, user interface in order to get students of all educational levels, as well as students that have no previous smartphone experience, involved. It motivates them, to visit monuments, buildings, and any other point of interest as part of an educational trip or activity, learn while playing a "lost treasure" game, or tour the sights of a city, using their smartphones as a teaching medium. It also provides the tutors a web application, to create specialized activities, that integrate geocaching and education.

1.1 Aims and Objectives

RouteQuizer was developed in order to satisfy the following requirements:

- Simple user interface, so that it can be used by students of several educational levels;
- Provide global geographic coverage;
- Enable the teacher to significantly customize any specific activity;
- Provide information on the performance of each student;
- Be an attractive experience for students, spurring their interest;
- Be supported by all android operating system versions and smartphone models;
- Provide an as safer as possible experience to the students, by making sure they will not get lost;
- Manage to incorporate all the positive aspects that the integration of mobile phones and education can provide, whilst excluding any possible negative consequences.

1.2 Implementation

RouteQuizer application is developed for the Google Android operating system that is used in more than 80% of smartphones worldwide. Along with the application, an online MySQL database was also created, in which all the data are stored. The programming languages that were used are java for the application and PHP for the data exchange between the application and the database.

In order to support the android application, a web application was also developed, using html5 language. The website's purpose is to enable tutors to create or manage activities, to store all activity data needed by the android application, and to inform tutors with the results of the activities that were already completed.

2 MOBILE LEARNING & GEOCAHING

2.1 Mobile Learning

In 2011, UNESCO offered the following definition of mobile learning; "Mobile learning is learning that occurs in or outside of a classroom or formal education setting, is not fixed to a particular time or place, and is supported by the use of a mobile device. Mobile devices range from standard mobile phones to tablet devices and include personal digital assistants, MP3 players, flash drives, electronic-book readers and smartphones" (UNESCO, 2011).

2.1.1 UNESCO Mobile Learning Policy Guidelines

UNESCO encourages nations to adopt mobile learning policies by following its guidelines (UNESCO, 2013): Create or update policies related to mobile learning; train teachers to advance learning through mobile technologies; provide support and training to teachers through mobile technologies; create and optimize educational content for use on mobile devices; ensure gender equality for mobile students; expand and improve connectivity options while ensuring equity; develop strategies to provide equal access for all; promote the safe, responsible and healthy use of mobile technologies; use mobile technology to improve communication and education management; raise awareness of mobile learning through advocacy, leadership and dialogue.

2.1.2 Mobile Learning Benefits

Responding to UNESCO's guidelines, the European Commission, in its growth strategy "EUROPE 2020", in 2015, emphasized on the benefits of mobile learning (UNESCO had also analyzed the benefits of mobile learning since 2013), stating that ICT (Information and Communication Technologies) is found in many studies to motivate learners; there is substantial evidence that ICT, if it is introduced and used in the right way, can improve learner outcomes; while using ICT in education, the learner also acquires digital skills which are pivotal for living and working in today's society; by using different kind of social media, in particular social networking sites, learning can become a more participatory, life-long process; according to available statistics, the proportion of adults not already using internet and social networking sites, seems to be fairly limited and diminishing; the development of smart phones and

computer tablets create new pedagogical challenges and offer increased opportunities for learning at any location.

The smartphone, being a relatively new device, offers a boost to mobile learning, mainly because of its high portability, low cost; especially when compared to laptops, energy efficiency, connectivity, personal feel, pleasant to use touch screen and capability to access information immediately via the internet.

2.1.3 Pedagogical Implications of Mobile Learning

Mobile learning could be adapted to various types of learning, such as (Jacob, S.M. and Issac. B., 2008): Behaviourism; mobile devices can facilitate feedback and reinforcement, when tutors and students are using the devices in tandem. Constructivism; the rich media, simulations and immersive environments it demands, can be provided through mobile devices. Informal or situated learning; mobile devices' portability allow the use of education in all relevant to the study of field environments. Collaborative learning; the advanced connectivity of mobile devices, students and tutors can create and share resources instantly.

2.2 Geocaching Benefits

Geocaching is a modern version of the "Treasure Hunt" game. Participants use GPS devices, and nowadays smart phones, to hide or find geocaches around the world. A geocache is usually a box containing a pencil, a calendar, which is signed by everyone that visits the geocache, and sometimes various small collectibles.

Geocaching, has received wide popularity and offers a wide variety of benefits. The benefits of participating in such an activity, although they vary depending on how one exerts such an activity are huge. Clearly the benefits associated with the natural state of the participant are obvious, but also the benefits related to sociability of the participant are many.

According to (Taylor, J.K., et al., 2010) the benefits that geocaching provides, can be distinguished in three main categories, physical, social and educational benefits.

2.2.1 Physical Benefits

One of the main benefits of geocaching, is that it requires physical activity from its participants, while the level of fitness requirements varies, depending on the person and geocaches selected. Also, the search for geocaches largely develops their sense of orientation, an important part of the process of cache-hunting.

Regardless of the location, the distance and the required level of fitness, the element of adventure which is closely linked to the process of exploration, gives a fairly high level of interest which also has its own benefits. Besides the above, the benefits of the process are also psychological, notably the challenge and the subsequent feeling of success when a geocache is found.

2.2.2 Social Benefits

The discovery of a geocache gives many people the pleasant feeling of achieving a goal. Especially children, build in this way, their self-esteem, especially those who are not very successful in sports and similar activities. Geocaching offers thereby the opportunity to anyone to feel successful, considering that the fitness level required is not as high as a sport.

Moreover, geocaching offers the sense of togetherness, as a target of a group with a common purpose. A geocaching activity, is also ideal for socializing with other participants, making the process of searching more interesting.

When used by a group of children or adults, it is a powerful tool for developing the cohesion and the collaboration of a group, along with the encouragement of communication.

These social skills are paramount for one person, let alone a child. That is why involving geocaching, in the educational progress of young people, can only benefit the students, in a pleasant way for them.

2.2.3 Educational Benefits

Many popular geokryptes are historical or geographic significant places. During their search, participants can acquire a lot of information on this point. This information can be related to the geography of the area, by discovering a side street or a path that had not been investigated in the past, or in an urban environment, a plaque or monument. The participants are also informed about the history and significance of each of the places visited, considering that the curiosity about an area that someone visits, is a natural human tendency.

3 RouteQuizer SYSTEM

A RouteQuizer activity, operates in three stages, of

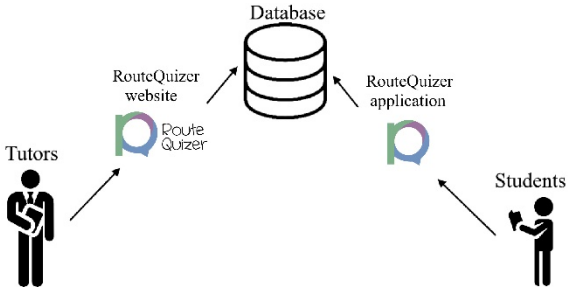


Figure 1: How RouteQuizer works.

which the first and last concern the tutor. The first one is the creation or management of an educational activity that takes place in the system's website. The second is the use of the application by the students on the field, and the third is overseeing their performance, which also requires the use of the website.

The whole system is divided in three main parts; the website, which is built for tutors, the android application that is supposed to be used by groups of students and the online database, in which all the data are stored.

The structure of the database is depicted at the UML class diagram in figure 2. The `activity` class represents the activities that may be designed by `tutors`; each activity is associated with only one tutor. The `point` class represents the points of interest that constitute "destinations" of an activity. The `point-order` attribute determines the order that each point should be visited, while the `information` attribute holds descriptive information for the point in

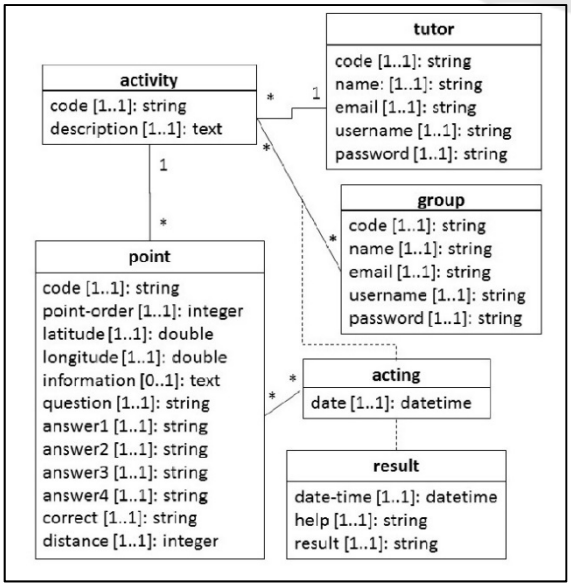


Figure 2: RouteQuizer database UML diagram.

order to navigate students to it. The `question`, the four `answers` and the `right answer` attributes represent the challenge that should be followed through by students, in order to get information for the next "point" to visit. The `distance` attribute defines the maximum distance that the students should approach the point, in order to be able to answer the question. Each time an activity is carried out by a group of students, an object of the `acting` association class is created and linked with the respective `results` (`date`, `time`, and `answer/result` for each question, along with information if the `help` button is used in the application). The rest of the classes' attributes are easy to understand (`name`, `email`, `username`, `password`, `longitude`, `latitude`).

3.1 Creating an Activity

The first thing a teacher needs to do, in order to create an activity, is to collect the coordinates of the points to be included. This can be done using either Google Earth or a portable GPS device on site.

To create a new activity, the tutor also needs to provide all the data that will later be used by the application, using the application's website. First, the creator of the activity (the tutor), has to register and then log in the website's activity managing system. After logging in, every tutor can view, add or edit/delete activities and their associated points. All data are provided by the tutor with the use of forms.

The fields that have to be filled are the following: "Code"; the tutor defines the "Activity Name". This should remain the same in all points related to the particular activity. "Point Order"; the tutor enters the order in which that point will appear. In each new activity that a tutor creates, the first point has to have the point order value of 1, the second a value of 2 and so on. In this way the teacher is able to largely control the route that the students will follow, during the use of the activity. "Latitude"; in this field, he enters the first part of the coordinates. "Longitude"; in this field, he enters the second part of the coordinates. "Information"; information about the point to be visited and hints as to where the point is located. "Question"; the question to be displayed to the students, as soon as they arrive at the point. "Answer 1"; the first possible answer. "Answer 2"; the second possible answer. "Answer 3"; the third possible answer. "Answer 4"; the fourth possible answer. "Right Answer"; the tutor provides the right answer. It is suggested that this area is filled using "copy – paste" of the right "Answer" field, to prevent possible errors while typing. "Distance"; this field is filled by

a number to 999, corresponding to the maximum distance in meters, in which the user must approach, for the question to be displayed.

After all the information concerning a point is inserted, the tutor repeats the process for each point he wants to insert. In this stage, the new activity is ready to be used by the students. In order to register a different activity, he defines a different activity name.

3.2 RouteQuizer Android Application

Before launching the application, the user (student group) has to make sure that mobile data usage and GPS function are enabled.

The first screen that appears, is an introductory image that lasts for 3 seconds, and afterwards the user is asked to register or login in case he has already been registered. Right after logging in, the application welcomes the user, and asks an activity's name. By typing the activity name that the tutor has provided, and selecting "OK", the application loads all data concerning the first destination point, by requesting the online database.

3.2.1 Main Screen

The main screen of the game, is a map that can be zoomed in and out, rotated and centred. The map, displays a blue dot that indicates the current position of the user.

In order to make RouteQuizer more appealing and fun to the students, the position of each destination is not acknowledged. They can get hints, as to where it is located, through the information provided by the tutor. The main tool the users have, is a distance meter. To prevent the users from getting lost, there is also a help button.

More specifically, the main screen of the application consists of four buttons and a distance meter (Figure 3.); the "Center screen button" centers the screen in the user's position. By selecting the "Map type selection button" the user can choose between four different map types, a road map, a satellite map, terrain map and a hybrid map. The "Help button" indicates the destination's position, by adding a red marker and the shortest route on the map (Figure 3.). That way, it prevents the user from getting lost, but at the same time, the tutor is informed, whether the help button has been used or not. The "Information button", creates a window that contains all the information provided by the tutor, helping the user to find the destination point and to get informed about it. In case the text is long, the window contains a scroll bar. The "Distance meter"

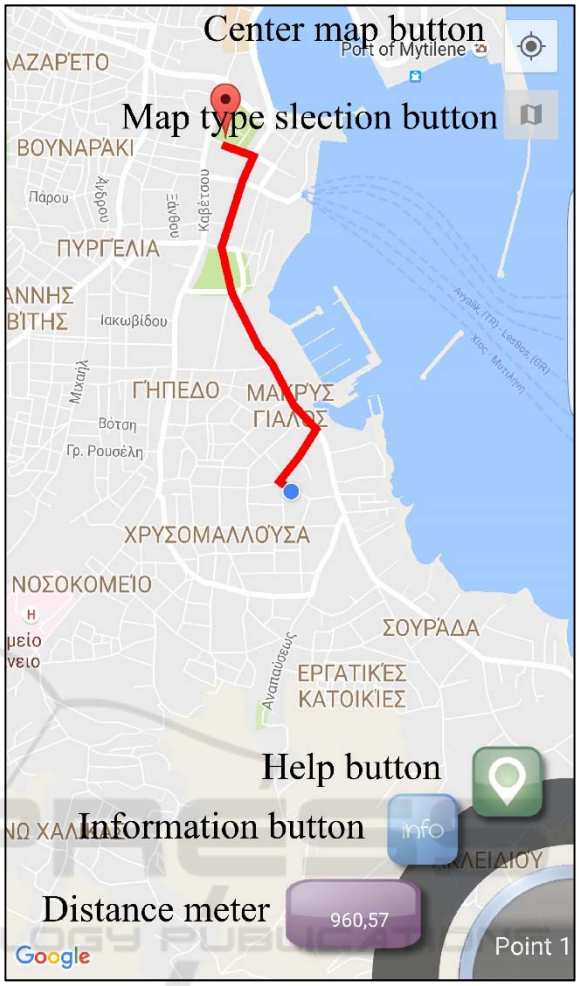


Figure 3: RouteQuizer application main screen.

represents the distance between the user and the destination. That way, the user knows whether he is heading to the right direction or not.

Using the above user interface, and taking advantage of the distance meter and the available information, the students have to reach one point at the time, within a certain distance. That, and also the fact that (unlike all other geocaching applications) only one point is loaded at a time, are a powerful tool in the hands of tutors, because it makes it easy for them to plan a trip exactly as they want to, and to be sure that the students did really visit the points.

Upon arrival at their destination, the smartphone automatically vibrates to notify them that they got there, and a window containing a question and four possible answers appears. Along with the multiple choice question, a new button is also added to the screen (while the help, information buttons and distance meter disappear) (Figure 4.). The students select their answer and press the "Check button" to

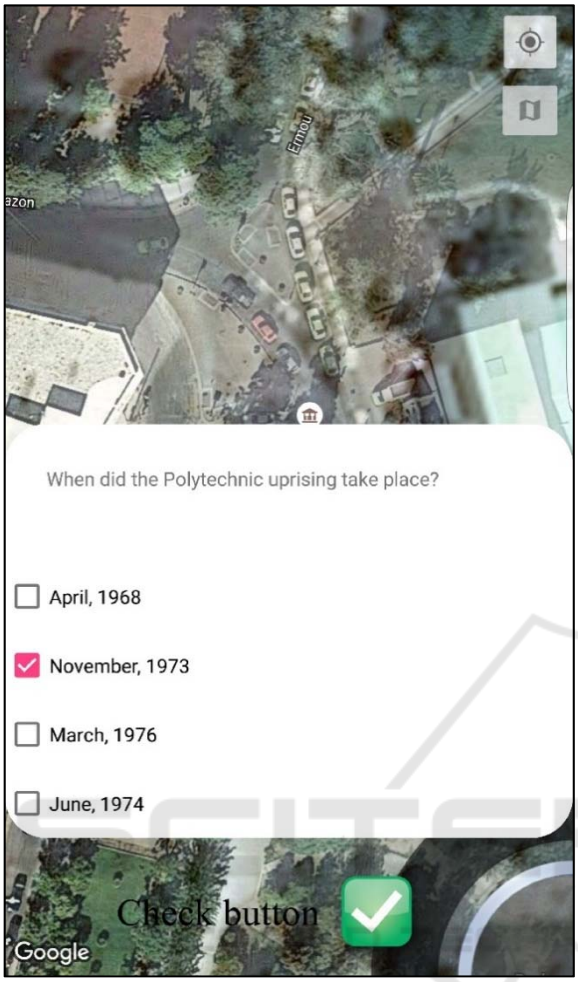


Figure 4: Multiple choice question.

submit their answer. At that point a message informs them if they were right or wrong, in case they were wrong it informs them about the right answer, and also at the same time, their result, the time and date they answered, as well as whether they used help or not, are submitted in the according table of the online database, enabling the tutor to overview students' performance.

All these procedures, last a few seconds, and afterwards, the second point data loads. The students keep visiting their destinations and answering questions, until they answer the final point's question. The application perceives that there are no more points to load, and a game over screen appears, congratulating the students, for discovering all points.

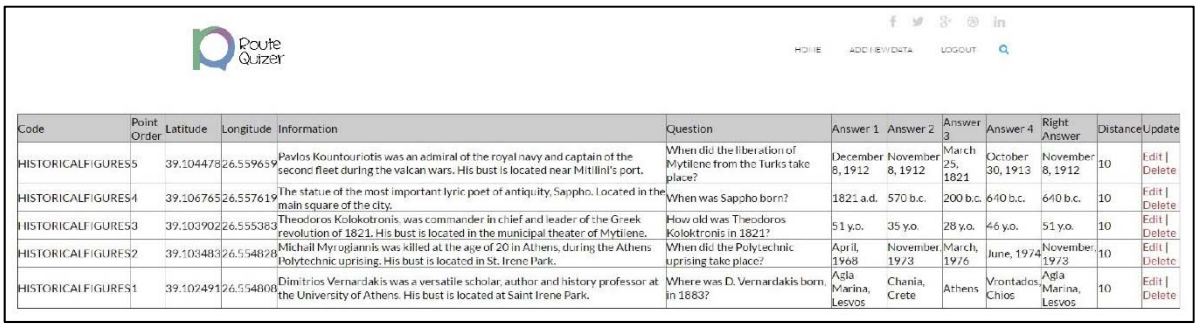
A very significant characteristic of the application is the lack of menus as each screen contains only the most important elements, without confusing the user. That simplicity, translates into a fluent and easy user experience, enabling people that have no previous smartphone experience, to use the application.

3.3 Viewing the Results of an Activity

As mentioned before, the tutor can overview their students' performance. In particular, after logging in the application's website, and selecting the "view results of an activity" button, they are asked to submit an activity's name. As a result, a table containing the following columns appears: "User"; contains the student's username. "Activity name"; "Point"; 1 in case it was the first visited point, 2 if it was the second etc. "Result"; contains either "Correct" or "Wrong". "Help"; contains either "Used Help" or "Did not use help", that indicate whether the user used the help button or not. "Date and Time"; the date and time when the user answered the particular question.

4 CASE STUDY: "HISTORICALFIGURES" ACTIVITY

"HISTORICALFIGURES" activity was created by a University of the Aegean professor, who had no previous familiarity with the RouteQuizer website. Fifteen of his undergraduate students, volunteered to



Code	Point Order	Latitude	Longitude	Information	Question	Answer 1	Answer 2	Answer 3	Answer 4	Right Answer	Distance	Update
HISTORICALFIGURES5		39.104478	26.559659	Pavlos Kountouriotis was an admiral of the royal navy and captain of the second fleet during the valcan wars. His bust is located near Mitilini's port.	When did the liberation of Mytilene from the Turks take place?	December 8, 1912	November 8, 1912	March 25, 1821	October 30, 1913	November 8, 1912	10	Edit | Delete
HISTORICALFIGURES4		39.106765	26.557619	The statue of the most important lyric poet of antiquity, Sappho. Located in the main square of the city.	When was Sappho born?	1821 a.d.	570 b.c.	200 b.c.	640 b.c.	640 b.c.	10	Edit | Delete
HISTORICALFIGURES3		39.103902	26.555383	Theodoros Kolokotronis, was commander in chief and leader of the Greek revolution of 1821. His bust is located in the municipal theater of Mytilene.	How old was Theodoros Kolokotronis in 1821?	51 y.o.	35 y.o.	28 y.o.	46 y.o.	51 y.o.	10	Edit | Delete
HISTORICALFIGURES2		39.103483	26.554828	Michail Myrogiannis was killed at the age of 20 in Athens, during the Athens Polytechnic uprising. His bust is located in St. Irene Park.	When did the Polytechnic uprising take place?	April, 1968	November, 1973	March, 1976	June, 1974	November, 1973	10	Edit | Delete
HISTORICALFIGURES1		39.102491	26.554808	Dimitrios Vernardakis was a versatile scholar, author and history professor at the University of Athens. His bust is located at Saint Irene Park.	Where was D. Vernardakis born, in 1883?	Agia Marina, Lesvos	Chania, Crete	Athens	Vrontados, Chios	Agia Marina, Lesvos	10	Edit | Delete

Figure 5: "HISTORICALFEAGURES" activity data, RouteQuizer website.

participate in the activity. They were separated in three groups of five, and asked to complete the activity.

It includes five points, all of which are busts or statues of famous historical figures of Lesvos Island and Greece. The aim was to further acknowledge the history of their country and Mytilene city.

The activity was created using the RouteQuizer website (Figure 5), its name was handed over to the students, and they were asked to start the activity at a certain time, from different point in the city.

4.1 Result Evaluation

As a result of the "HISTORICALFIGURES" activity, the three groups managed to visit all the points they were asked to.

It took team 1, 43 minutes to complete the activity, team 2, 36 minutes and team 3, 42 minutes. Team 3 answered four out of five questions correctly, while teams 1 and 2 answered three questions correctly each. The first team used help once, the second twice and the third three times.

After completing the activity, all participants were asked to fill an evaluation sheet, the conclusions of which are shown in table 1.

Table 1: Evaluation sheet results.

Subject	Evaluation
Smartphone familiarity	All except one of the participants were experienced smartphone users, although 5 of them did not use an android smartphone.
Previous geocaching experience	2 of the students had previously participated in a geocaching game.
RouteQuizer operation	No students faced any problems registering, logging in and loading the activity.
RouteQuizer user interface	13 of the students found the application's user interface appealing.
Point searching difficulties	Half of the students found it easy to locate the points, while the other half found it challenging.
Knowledge acquisition	All students claimed that they learned something new while playing.
Overall experience	12 of the students would use the application again.

All three groups of students, reported that they followed, almost the same route, in order to visit all destinations. The way the application works, presenting one point at a time, and providing the distance parameter choice, enables tutors to largely predetermine the route their students are going to follow.

5 CONCLUSIONS

Although the developing process of RouteQuizer has been very challenging, due to the many objectives we had to achieve and the constant modification of the android platform, it accomplished everything we aimed for.

The system complies with the standards set by UNESCO and EU, and offers all mobile learning as well as all geocaching benefits described by (Taylor, J.K., et al., 2010).

It is easy to use, and does not confuse the users with complex menus and irrelevant settings. That way, even students with no smartphone experience, can easily complete an activity, not worrying about how to operate the application.

It offers tutors, many customization capabilities, mainly through the use of the required distance, but also by the absence of geographical constraints.

Provides information on student's performance, not only on whether they answered correctly, but also if they used help to reach their destination and the exact date and time they responded to each question.

It is an attractive user experience. The way in which the application presents the destinations, providing information and the distance to be travelled, adds a degree of difficulty that makes the destination search fun for the students. Also, the existence of "help" choice, ensures that the search will be safe, preventing the students from getting lost.

The application is supported by all android operating system versions that are in use today but also in the future (Android 2.1 and Android 6.0.1). According to Google's data, versions 2.1 till 6.0.1 cover all currently used android smartphones.

It is perfectly executable regardless of the mobile phone model. Due to the variety of many different smartphones in the market, (different manufacturers, screen sizes, resolutions and performance), the actions to be taken in order to create a compatible application are many, and relate primarily to meet different screen resolutions, which the RouteQuizer application has fully addressed and tested successfully, by creating all images in five different sizes.

Exploits every positive aspect a smartphone can possibly offer during the educational process, such as portability, which is basically the most important contribution of the mobile phone in general, but also particularly in the specific application, connectivity, as it communicates with the database without requiring any action from the user, it is pleasant to use, due to the simplicity of the user interface, and all the information is transferred directly to the device

without requiring excellent mobile network.

No negative effect on the pupil. Because of the fact that the application is used exclusively on the field, and not in the classroom, it does not distract students in any way from the educational process. At the same time, proper organization of students in groups, can avoid potential adverse effects of the mobile phone, such as inequality between students, bullying, as the use of the mobile phones is limited on the field, loss of concentration and loss of collegiality, since the students are encouraged to work together to achieve the objective, which is to reach their destination, and correctly answer the question.

5.1 Future Work

As in all applications, there are many capabilities of improvement, especially for an application like this, which introduces something innovative, and a new way of utilizing new technology. Below several ways to improve the application are proposed.

- The creation of a forum, where tutors would exchange experiences and ideas for creating better activities for their students;
- Translation of the system in many different languages;
- Embedding Google Maps on the website, so that the tutors can add markers to the points they want, instead of collecting the coordinates using Google Earth;
- Enabling tutors to provide photographs and videos along with the information.
- Development of an iOS (Apple's operating system, used in iPhones) version of the application.

Furthermore, we plan to hold several activities in which students and teacher of various educational levels will participate, in order to acquire more feedback and make RouteQuizer even better.

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