The Mobile Application Based on Augmented Reality for Learning STEM Subjects

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Abstract. App store is full of programs, which are based on augmented reality. A lot of studies showed that augmented reality has a lot of benefits for user's ability to learn new things or their increase in motivation. However, the majority of these programs are dedicated for entertainment and just several of them are designed for learning processes. The authors have developed an app based on an augmented reality, which aims to provide scientific formulas for math, physics and chemistry subjects and by this to ease the exercise solving. The target group is K12 learners in school. The app was uploaded to the app store for both, iOS and Android operating systems. Further researches have to be done on finding the impact of this type of programs. If the impact would be positive, the authors suggest improving an app by adding more specific topics.

Keywords: Augmented reality · Mobile application · STEM · Learning

1 Introduction

In Lithuania, the education system is quite static and lacks different learning methods and styles. Students are not involved in a learning process and it reflects in the way how they generate information in the future. The Stanford Teaching Commons indicate that active learning is meaningful not only for a child but for a student also. It indicates that when students are engaged in active learning, they are more fascinated with learning a subject and learn more, whether it is a practice, discussion or some application [1].

A not new term in the field of technology is augmented reality. It incorporates virtual reality into the real world and is interactive [2]. Apart from its advantages, AR is not widely used in an educational process, in Lithuania. Another issue here is that a lot of teachers do not imagine how VR and AR technologies can be incorporated into learning processes. One of the simplest ways to do it is a mobile application for learning [3].

The use of mobile applications for studying in Lithuanian schools and universities is still not so popular. The old methods used, without any teaching interactions and the advantages of the new emerging technologies remain untouched. Another problem with the usage of mobile learning applications related to the fact that there are quite a small amount of educational content applications in the market, especially when talking about STEM subjects.

R. Damaševičius and G. Vasiljevienė (Eds.): ICIST 2018, CCIS 920, pp. 476–482, 2018.
https://doi.org/10.1007/978-3-319-99972-2_39

2 Methodology

First of all, the literature on the augmented reality-based mobile applications models used for education in the world was overviewed. In the second part of the article, the mobile application "KTU Decode" was introduced and briefly presented. For the research part, were taken two focus groups to evaluate the effectiveness of the "KTU Decode" application. It was done by evaluating the results while learning with not AR or VR related applications and learning with the "KTU Decode". Results were briefly presented in the diagrams and described. All in all, the authors have made the conclusions with some recommendations and future perspectives.

3 Literature Review

When people hear an augmented reality, it mostly is associated with the use of games and fun experiences. However, in the whole world, there are a thousand good practices of augmented reality usage in the educational process. The cheapest way for all students to have interactive and emerging new technologies in their everyday learning process is mobile applications based on augmented reality [4]. These applications are usually free and require just a smartphone and the camera [5].

In 2014, two IT developers from Malaysia have created an augmented reality-based mobile application for learning science subject in primary schools. Their application called iSains and had two topics: moon phases, day, and night. The application let students see different moon phases in 3D through their textbooks. The authors had claimed that further researches have to be done to know the exact effect on pupils learning process and more topics should involve making this augmented reality-based application more useful [6].

Research on an augmented reality-based mobile application for learning made in 2014, in Taiwan. The research took the place at natural science course in elementary school. The authors have constructed an augmented reality-based learning system, which was created by using these tools: JAVA, Oracle, Xcode. The operating principle of the system based on the GPS location of the students and it guided them to the ecology areas where they could do the special tasks. Pupils could use the camera to capture the images of the real environment and later on students can edit images, according to the tasks and share them with their community through the WIFI. In the test presented feedbacks from 57 pupils. Results have revealed that students showed higher motivation in learning, lesson attendance and confidence [7].

In 2015, Bernadette Perry from Canada created and implemented a prototype of an "Explorez", which is an augmented reality-based mobile learning tool to help students to learn the French language. This prototype implemented into a first-year University French-language class. The author asked students about their experience using this learning-tool and all of them were positive. Majority of the students have identified that it was a great experience and it was very nice to get out of a class, even just through the mobile phones. They liked the concept that everything is going on in a real environment but with some added augmented reality elements. Perry has identified that there

should be further researches on the feedbacks after a long time but for this day increased students motivation to learn is clearly seen [8].

The benefits of augmented reality are obvious and easily acceptable. Without the benefits listed above, there are much more. For example, in engineering graphics lessons, augmented reality book used for students to see different objects from 3D perspectives and to solve complementary problems. The questions and problems defined in that way, that students would be able to train their mental rotation abilities. After the test, researchers claimed that augmented reality-based learning has a positive effect on students' spatial abilities improvement [9].

Other researches about augmented reality-based mobile learning applications revealed that this type of tools increase collaborative learning [10], motivation to perform learning activities [11], improve learning attitude and learning outcome [12], enrich ideas [13] and engage concurrence and satisfaction [14].

After an overview of the previous researches, there can be claimed that mobile applications based on VR or AR are widely used and contributes to better study results. However, in Lithuania, such examples are not seen and not a lot of researches were done to see if this type of learning may be included in Lithuanian educational system.

4 Overview of "KTU DECODE"

"KTU Decode" is an augmented reality-based mobile application, which purpose is to complement the presence of the Kaunas University of Technology: agendas for math physics and chemistry. With the help of this app, in the agendas, users can see virtual formulas. In every different agenda, users can see formulas for the specific wanted theme. The application reflects virtual formulas for specific themes and with the help of it, it is easier to solve exercises.

The target group of the application is higher classes for learners at school. The aim of the app is to ease the solving of exercises by using formulas for math, physics and chemistry.

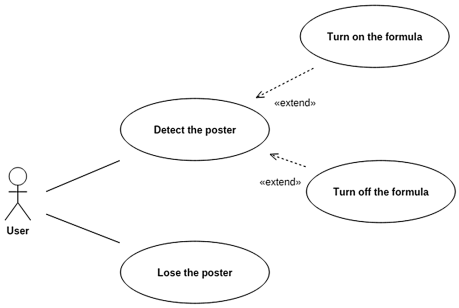


Fig. 1. Use case diagram.

In the figure above (Fig. 1) you can see the use case diagram. In the program one user engaged, that can do several tasks. The entire task is listed in the figure and described below.

Poster detection. To detect the poster it is necessary to turn on the app and to allow it to use your device camera. After the camera directed to the poster, the app detects what kind of poster it is and formulas appear in the screen.

Turning on the formulas. Each of the posters has different themes and formulas that are complimenting one specific poster. A user is able to choose themes and by pressing on them to turn on the layer of scientific formulas, that can be switched.

Turning off the formulas. A user, which already turned on the layer of formulas, by pressing on the same theme twice, can turn off an additional layer of formulas.

Lose of the poster. When the poster is lost, a user cannot turn on or turn off the scientific formulas.

5 The Model of "KTU Decode"

The app is based on two main components: "Unity 3D" game engine and "Vuforia" the library of an augmented reality platform. The logic of an app was written in C# language. In the figure below (Fig. 2) is the model of the app.

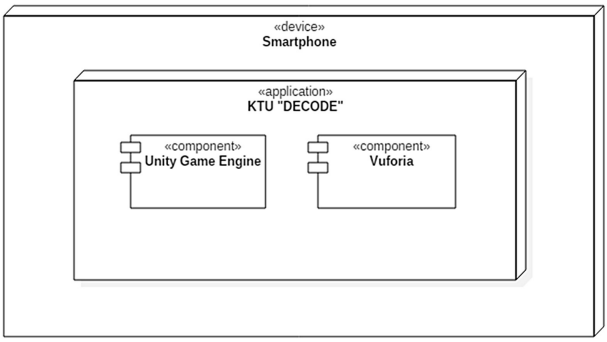


Fig. 2. Deployment diagram of the app.

The process is starting with the "Vuforia" which uses a camera of the smartphone to locate points of the interests. The points transferred to Unity game engine in which a content of an augmented reality is drawn.

For the use of "Vuforia", the unique app licensee identification is the must. This identification generated in "Vuforia" management interface by registering the app in progress. The license identification must be transferred to "Vuforia" configurable file in "Unity 3D" game engine.

The app of "KTU Decode" does not use in "Vuforia" platform provided, points of interests, based on cloud computing. As points for an app, posters were used (Fig. 3). The worksheets of the posters were uploaded to the "Vuforia" database through its management interface.

Fig. 3. Screen view of the app in the mobile.

The system processes these posters and gives the quality rate as a feedback. The quality rate is the explanation of how good the points of interests will be followed. Processed databases of images were downloaded and implemented into the project.

The app was uploaded into an "App store" and "Google Play" stores and is free to download. When uploading the app to "iOS" operational system, "Unity 3D" tools have been used for generating "XCode" environment.

6 The Experiment on the Mobile Application Effectiveness

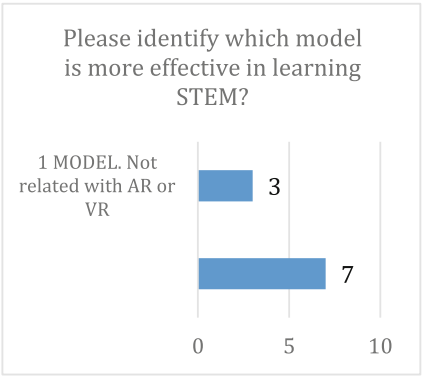
To evaluate the effectiveness of the mobile application taken two aspects: existing applications for educational needs and learning results.

There do exist many applications for learning, but there are not so many related to VR and AR. For the experiment, there were taken two types of applications 1st model (not related with AR or VR) and the 2nd model related with AR and VR (see Fig. 4).

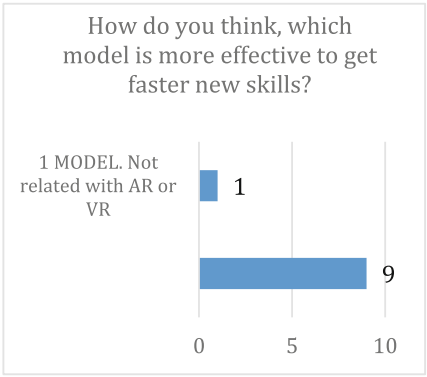
To evaluate "KTU Decode" were invited experts, who provided their opinion about the models' integration into practice.

For the experiment, there were taken two different models to evaluate the effectiveness of the KTU Decode application. There was created the questionnaire for the experts to compare that two methods of implementation. The 1st group used 1 METHOD, the 2nd group used 2 METHOD.

Finally, we can declare that the 2nd model is more useful in learning STEM subjects. Totally 7 respondents declared the functionality of the 2 model is more effective in a learning process and totally 9 experts declared that this model is more effective to get new skills.



a) Evaluation of effectiveness learning in STEM.



b) Evaluation on the effectiveness to get new skills by the model.

Fig. 4. Expert's evaluation results.

7 Conclusions

As the great number of studies showed that an augmented reality can help students to remember everything better and to engage in the learning process, the authors have decided to try to create the simple mobile application, which would be based on an augmented reality. The augmented reality-based mobile application created to help students to solve exercises for math, physics and chemistry faster and easier. The authors have uploaded the app into the app stores for both, iOS and Android operating systems. "KTU Decode" is free to access and use by students.

However, no studies were done to investigate the benefits of the app: if it is useful or how to improve it; if the app help to solve exercises faster or not. The future research can be done by investigating the impact of this kind of programs for students. For the app improvement, the authors suggest adding more topics/themes.

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