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An Augmented Reality Based Mobile Software to Support Learning Experiences in Computer Science Courses

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Abstract

Objective of this study is to improve educational processes in abstract or technical courses, by providing a mobile Augmented Reality (AR) tool. This tool is a mobile software system aiming to provide a supportive, e-learning material for students. By using the tool, students can view 3D animations, and special-made videos to have more idea about a course subject, or have a chance to improve their knowledge on the related course content. In order to achieve this, students are enabled to use mobile device camera interface on special signs placed in course books or any other supportive, physical materials that are given by course lecturers. Additionally, it is also possible to watch course materials after focusing on some physical objects in the real-life. Consequently, the software tool has aimed to ensure an effective learning experience by employing advantages of mobile devices and forming interactive sessions between virtual and real environment.

Keywords: augmented reality; e-learning; mobile software; computer science

1. Introduction

Augmented Reality (AR) includes many advantages enabling designing and developing effective solutions to improve life standards. Researchers think that AR can allow improving people's perceptions, knowledge, and interaction with the real-world and it can also lead to improved productivity in real-world tasks [1, 2]. Because

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of this, AR has a wide range of fields in which it can be used to provide solutions or innovative approaches for especially real-world based problems. In the related literature, it has been shown that AR can be applied for different tasks – problems in the modern life [1, 3 – 5]. In this sense, education is one of the most popular fields in which AR applications are often performed. More specifically, the e-learning technique in the education field is one of the most remarkable application areas within today's AR oriented solutions.

When the subject is examined in the context of e-learning solutions, it is also a remarkable aspect to provide effective solutions via e-learning applications, for improving learning experience on abstract or technical courses. Developments and improvements within e-learning technique have an important role on ensuring better educational processes and improving the associated literature. Because of this, researchers have been in a remarkable effort to examine and apply this technique from different perspectives. At this point, AR has been today's one of the most popular perspectives to improve effectiveness of the e-learning on courses including abstract or technical subjects to be learned. It can be expressed that the AR can improve learning processes in such courses, by using its effectiveness on affecting students' many senses and enabling them to experience the learning approach, which is enhanced with real-word based practices, serendipitous explorations and discoveries [6 – 8]. Regarding to the interaction with the real-world, new developments in mobile technologies have a vital impact on existence of the AR. It is clear that today's advanced mobile devices take the AR to a high level of application in especially e-learning. If the recent literature is taken into account, it can be seen that there are many different kinds of research works, which have been done within the related concept [9 – 16].

In the sense of the explanations above, objective of this study is to improve educational processes in abstract or technical courses, by providing a mobile AR tool. Briefly, this tool is a mobile software system aiming to provide a supportive, e-learning material for students. By using the tool, students can view 3D animations, and special-made videos to have more idea about a course subject, or have a chance to improve their knowledge on the related course content. In order to achieve this, students are enabled to use mobile device camera interface on special signs placed in course books or any other supportive, physical materials that are given by course lecturers. Additionally, it is also possible to watch course materials after focusing on some physical objects in the real-life. Consequently, the tool has aimed to ensure an effective learning experience by employing advantages of mobile devices and forming interactive sessions between virtual and real environment.

2. An AR based mobile software to support learning experiences in CS courses

In this study, the tool – mobile software system has been employed for Computer Science courses. Because of its scope on theoretical and applied studies on foundations of information and computation, Computer Science comes with a wide spectrum of abstract and technical subjects, which are known as difficult to be learned among students. So, it is important to enable students to gain necessary knowledge and practical aspects in courses of this field, by using better educational techniques. At this point, authors think that using an AR based e-learning tool will result to an effective approach on reaching to the educational objectives.

In order to understand the usage of the tool – mobile software system, it is better to explain more about it.

2.1. Using features and functions

Regarding to the software system, students are enabled to use an application on their mobile devices. It is important that this application has been developed for iOS, Android, and BlackBerry OS. So, students should install the compatible version for their mobile devices.

The usage of the application is very simple. After the log-in process to the system, students can choose an active course from the list on the interface. After choosing a course, a list of AR based sessions are viewed to be chosen. List of courses and the AR session lists are created with another application of the software system, which is used by lecturers, or system developers working collaboratively with lecturers.

After choosing an AR based session, students are informed via some directives to enable the session. A typical session may include a 3D animation, special-made videos or any material (image, document, link to a Web page…etc.), which can be activated after the appropriate interaction with the real-world. Fig. 1 represents some photos from the application on different mobile devices.

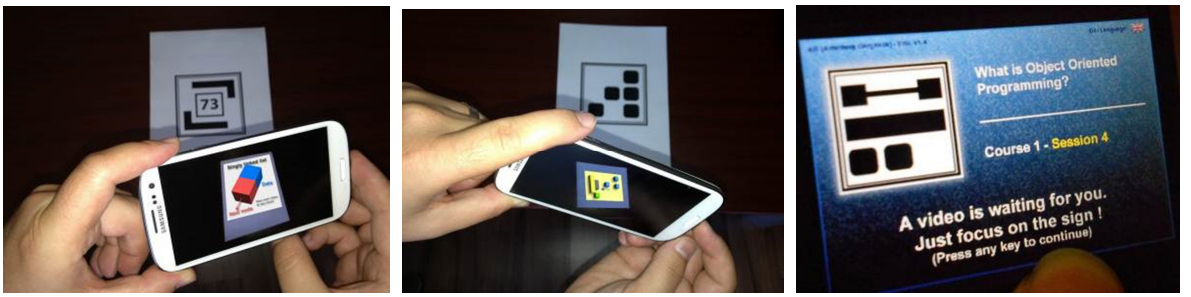

Fig. 1. The application on different mobile devices.

The application has been built on a total AR based approach. But it is also possible to provide simple link buttons to enable students to reach an additional document, or file without any AR interaction.

2.2. Application approaches in course activities

During course activities, there are some application approaches, which are used to achieve the AR interaction mechanism provided by the mobile software system. Students are directed to apply these approaches to perform their AR based e-learning sessions. The related approaches are:

- *Using special-designed course books provided by lecturers:* In addition to the course notes included, these books also include some directives and special visual signs to ensure AR interaction when it is necessary.
- *Using special visual signs:* Lecturers can provide special visual signs as printed or in image file formats (Fig. 2). Additionally, it is also possible to provide the signs as stickers, which can be located on traditional course books. In this way; course books, which are already in use, are kept in the educational process.
- *Using special objects:* Lecturers can provide some objects (like colored shape blocks) that can be used along AR interaction sessions.
- *Focusing on physical objects in the real-life:* It is possible to enable an AR session via a physical object in the real-life. As different from special objects, physical objects are already located in the real-life. Thus, it is possible to direct students to use a certain shape – structured object like university – faculty logo, case of a course book, or a certain colored and shaped object in the real-life, to active an AR session.

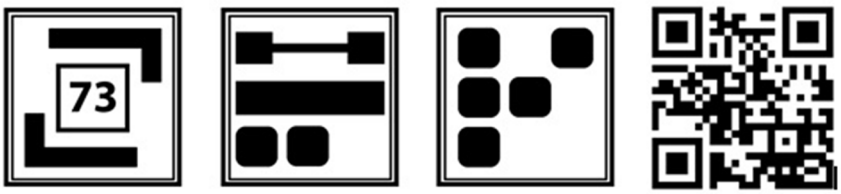

Fig. 2. Some examples for special signs, which can be used along AR based activities.

3. Evaluation

In order to provide an applied evaluation process to obtain scientific findings, the mobile software system has been used along one term in especially abstract and technical courses of Computer Science based departments. More details on this process are explained as follows:

3.1. Experimental evaluation

A total of 200 students from Computer Engineering, Computer Education, and Computer Technologies departments of different universities have taken part in the experimental evaluation. 100 of these students formed the experimental group in which the AR based mobile software was used to support learning process. On the other hand, remaining 100 students formed the control group in which some different e-learning approaches (like using an LMS supported with online video conferences) were employed as supportive factors. The groups were formed as balanced, according to the chosen students' academic success levels. At the end of the experimental evaluation, similar findings have obtained for all courses taken into consideration along the process. As an example, Table 1 shows the findings for the course(s) on Object Oriented Programming.

Table 1. The findings for the course(s) on object oriented programming.

Group	Number of students	Students passed the OOP course(s)*	Mean	Median	Standard Deviation
Experimental	100	84	73,88	74,00	14,19
Control	100	61	60,28	60,80	19,80

* Number of students, whose success grade [which is calculated via (0,4 * visa exam grade) + (0,6 * final exam grade)] is equal or bigger than 60

3.2. Survey-based evaluation

At the end of the term, students, who have taken part in the experimental group, have also filled a survey to express their opinions on a total of 10 statements about the educational process with AR based e-learning tool (mobile software system). Table 2 shows the survey statements and received responses on the Likert Scale.

Table 2. Survey statements and the received responses.

No	Statement Total responses for;*	1	2	3	4	5
1	"I enjoyed the educational process performed with support of this tool – application."	0	0	7	10	83
2	"It was easier to learn difficult subjects, thanks to this tool – application."	0	1	5	14	80
3	"It was difficult to use the tool – application."	78	11	9	2	0
4	"With this tool – application, I felt more self-confident about learning course subjects."	0	0	6	13	81
5	"By using this tool – application, it was more effective to learn OOP."	0	3	5	16	76
6	"I prefer using this tool – application rather than other e-learning approaches."	0	2	6	13	79
7	"I don't want to take part again in such an educational process."	80	17	3	0	0
8	"Materials (animations, videos…etc.) viewed on the tool – application were attractive."	0	0	1	18	81
9	"My academic achievement level has been improved, thanks to this tool – application."	0	0	3	17	80
10	"This tool – application has enabled me to learn faster."	0	2	5	16	77

* Likert Scale: 1 → "strongly disagree"; 2 → "disagree"; 3 → "no opinion"; 4 → "agree"; 5 → "strongly agree"

Findings obtained via experimental and survey-based evaluation sessions show that the designed mobile software system has improved students' academic achievements and ensured an effective way, which makes it simpler, and more enjoyable to learn abstract, technical subjects related to the Computer Science field.

4. Conclusions and Future Work

This paper has explained a study on the usage of an AR based e-learning tool – mobile software system in the context of Computer Science courses. Importance of the study is associated with research efforts performed to evaluate effectiveness of AR on improving learning experiences among abstract or technical courses. It has been tried to find out if usage of AR can give a rise to better learning experiences for especially difficult courses, and the intersection of both virtual and real environment can form a better way for learning rather than using other e-learning approaches. According to the findings obtained via evaluation works, the software system has shown effective and successful performance on improving learning experiences, and been accepted as better and more enjoyable way according to other e-learning approaches. Regarding to the future work, it has been planned to improve the tool – software system by adding new using features and functions. Additionally, the system will also be employed in different kinds of studies to evaluate the effectiveness in different cases.

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