IMPROVING PROGRAMMING LEARNING WITH AUGMENTED REALITY AND GAMIFICATION

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Abstract

Students are immerse in a digital world, in which master classes are not enough; they need to interact with new technological trends. In addition, each student is different and they have his or her own difficulties, consequently sometimes the suggested methods or activities for the study are too general and do not meet the particular needs of each student. For this reason, we need personalized techniques that meet to the student particular needs. In this paper, we propose two mobile applications. One of augmented reality with which the student can review the basic reserved words of any programming language (if, else, while, for, etc.), such as Google Translate. In addition, other mobile application, similar Q12 Trivia game, in which students will have to answer a test of programming questions, with a maximum of 10 seconds to answer each one. In case of failures, the app is ready to send new questions or links of interest to each student focus on the specific difficulties. We will test the use of both applications in university education and carry out a study of student satisfaction, as well as the academic results obtained.

Keywords: Gamification, Education, Learning Process, Augmented Reality.

1 INTRODUCTION

The National Statistics Institute of Spain (INE) published a survey in February 2019, on Equipment and Use of Information and Communication Technologies in Households, focusing on minors. As a result of that survey, it concludes that the use of computers is widespread (91.3% of minors) and even more so, the use of Internet (92.8%). On the other hand, 69.8% of the population aged between 10 to 15 years old have a mobile telephone. This implies that the rate of the use of information and communication technologies by children aged between 10 to 15 years old is, in general, very high and access to technology is at increasingly younger ages [1].

The EDUCAUSE 2019 Horizon Report Preview provides summaries of each of the upcoming edition's trends, challenges, and important developments in educational technology, which were ranked most highly by the expert panel [2]. We can highlight: "*Long-Term Trends: Driving Ed Tech Adoption in Higher Education for Five or More Years, Rethinking How Institutions Work, based on the "new majority learner," who is older, more likely to be balancing work and family with college, and has vastly different needs from those of a traditional-aged student navigating a residential college experience. Institutions of higher education are rethinking how to meet the academic and social needs of all students seeking credentials or degrees. This shift to student-centered learning requires faculty and academic advisors alike to act as guides and facilitators*". With regard to "*Important Developments in Educational Technology for Higher Education Time-to-Adoption Horizon One Year or Less: Mobile Learning and Two to Three Years, Mixed Reality and Artificial Intelligence Based on the foregoing*", we consider that the master classes are not sufficient for current and future students. It is necessary to provide them tools appropriate to the environment in which they are developing.

In this work, we present two mobile applications with the aim to capture the attention of students, motivate and provide them the background to acquire good programming practices. First, an augmented reality mobile application that will allow translating reserved words from structured programming into different programming languages. The second mobile application *Q15 UEx*, through the game the student will have to answer a series of questions in record time. In case of failures, the app is ready to send new questions or links of interest to each student focus on the specific difficulties.

The rest of the paper is organized as follows: Section 2 presents the methodology followed, including a description of the proposed applications for education. Then, Section 3 explains the results expected when making use of the applications. Finally, conclusions and future work.

2 METHODOLOGY

In this section, we explain the technological background on which will be developed the two mobile applications that we propose to improve the learning of programming in first course of *Computer Engineering*, in addition to explaining briefly how it works.

2.1 Background

2.1.1 Augmented reality

Teaching practices in higher education are evolving. Student-centered learning is an approach that increasingly used in education. The redesign of courses and programs to take advantage of digital tools enables instructors to evaluate their teaching practices and use student-centered approaches to facilitate learning.

The modern age of mobile learning sparked by the smartphone and tablet is now over a decade old, and students and teachers today rely on their mobile devices as a vital part of the entire learning experience. The increased use of augmented reality (AR), virtual reality (VR), and mixed reality (MR) has enabled mobile learning to become more active and collaborative. However, creating this quality mobile learning experience takes a lot of effort and, as a result, remains in the early stages of adoption.

The use of augmented reality in education permits combining the real and virtual world enriching the visual experience of the user. Its use is getting very popular in mobile applications in general and in educational ones in particular. The idea is, therefore, to implement a translator of reserved words of structured programming with augmented reality. Dealing such a challenge required to think about two relevant technologies: Unity [3] and Vuforia [4].

Unity is a multiplatform game creation engine, which can be used in combination with Vuforia. Vuforia is a software development platform for mobile devices that allows the creation of augmented reality applications. It uses computer vision technology to recognize and track flat images, 3D objects and text (Fig. 1), allowing developers to position and orient virtual objects (3D models and other media) with real-world images, which will appear when visualized through the camera of a mobile device.

Figure 1. Region of interest in Vuforia text recognition.

2.1.2 Gamification

The term "Gamification" was first coined by Pelling in 2002, to refer to the adaptation of play in education [5]. It is a tool that allows students to have a more dynamic posture in their learning. Trying to change the classic teaching model, the master class, we will introduce the mechanics of the game in the classroom to awaken students' interest in this subject and motivate them to get rewards. The fact that their progress is visible will motivate a competitiveness likely to generate greater interest in the subject. Moreover, the gamification term is taking great relevance in education as a way to motivate students to learn while they enjoy playing games.

Following these trends, and with the software mentioned above, we have implemented two prototypes of mobile applications; we will briefly explain how they work in the next section.

2.2 Description

2.2.1 Translator of reserved words common to the programming languages C, C++, C# and Java.

The reserved words of a programming language are predefined reserved identifiers that have a special meaning and cannot be used as identifiers in programs. As the app "Google Translator" does

with languages, with this application, we propose the translation of reserved words common to different programming languages that we could include as structured. (*if, else, do, while, for,* ...), as well as other reserved words specific to the C/C++ programming language and which are specifically used in the subject of Programming Fundamentals.

This application is based primarily on text recognition (Augmented Reality). If the text is recognized as a reserved word, a general description of the use of this reserved word will be displayed (Fig. 2). Next the student will be able to select the programming language of his choice, within the available ones (C, C++, C# or Java), to show the syntax in the selected language and a short video of use with a basic example.

In addition to recognition of reserved words, three types of games are proposed, one with RA, another to enter the correct answer by keyboard and another to select between several alternatives. With these games, we will get them to practice the different flow control structures (Sequence, Alternative or Selective and Loop), data types and mental execution of small fragments of code.

Finally, to compile all the information of the reserved words, a dictionary has been implemented that will show the definition of the reserved word chosen, the syntax, the examples in the four programming languages and an option that allows to visualize an explanatory video.

This application is based on a server (not hosted in the mobile) that integrates a database, as described below:

The database contains the following information:

- Information about the different reserved words, which can be studied through the application: definition, syntax, programing language, related video, and a basic example.
- Information about the students: all reserved words and games designed to practice basic programming concepts. They will be able to play as many times as they wish to improve their scores.
- Furthermore, we have designed a website where teachers will have access and they can register new examples and videos to display with augmented reality.

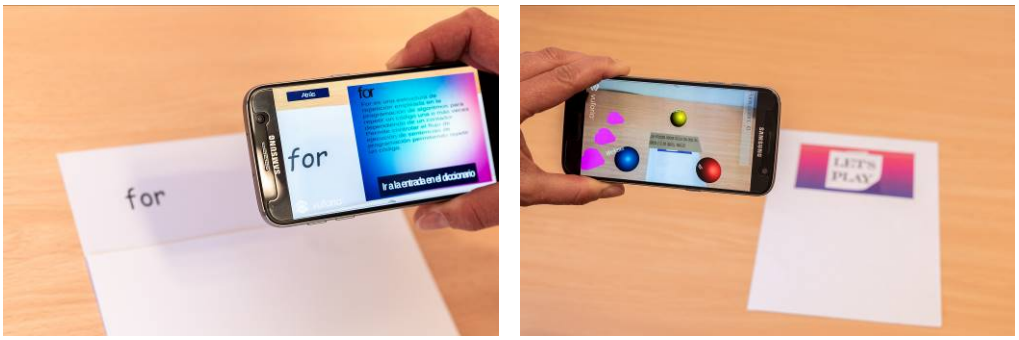

Figure 2. Translate app working example

2.2.2 Q15 UEx

It is a mobile application, in which the student, each week (total 15), will have to answer a several of questions in record time. In case of failures, the app is ready to send new questions or links of interest to each student focus on the specific difficulties. The student will earn rewards each time he or she successfully completes a questionnaire. In the Fig. 3, we can see an example of app working.

Same as the previous application, it is based on a server (not hosted in the mobile) that integrates a database as described below:

The database contains the following information:

- Information about the subject, questions and answers, links and explications about failed questions.
- Information about the students: the tests they can follow, the questions they already answered and in which they failed.

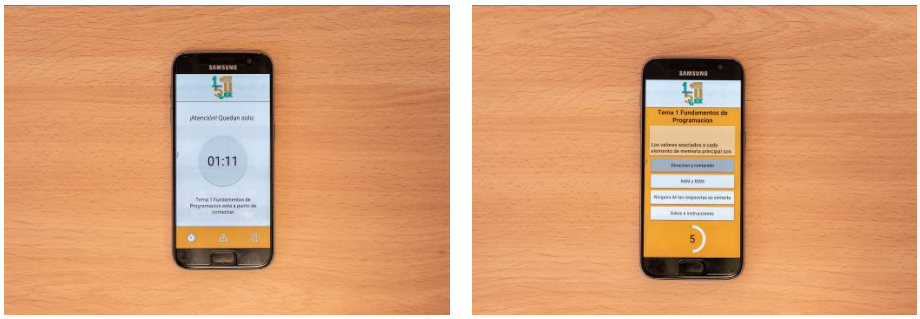

Figure 3. Q15 app working example

3 RESULTS

We have implemented two mobile applications that facilitate the learning of the basic concepts of structured programming. The first of them focused on the knowledge of the reserved words of each programming language and the second, focused on the dynamic evaluation of students, in which the content of the tests is adapted to the specific difficulties of each student. These applications have not yet been validated experimentally by tests conducted with a large number of students. During the following academic year, we will test the apps and we will see if the students perform better results in their final marks, comparing the results of a test group with the results of a reference group.

4 CONCLUSIONS

In this work, we have proposed the use of two mobile applications, one which uses augmented reality to translate the reserved words of a programming language, as well as three games to practice these reserved words and consolidate the acquired knowledge. The second one based on a test as a game in which the student will be able to obtain rewards if he passes each one of the tests proposed by the teacher. In case of failures, reinforce the failed contents with new questions or links of personalized interest for each case. With this, we achieve a twofold purpose, on the one hand, to motivate the student to study while having fun; and on the other, to focus the questions of the game on the specific difficulties that each student presents.

In addition, in the application of reserved words translator, we could extend text recognition by voice recognition and in the test application, improve it with some algorithm of artificial intelligence that can determine automatically the learning itinerary of each student.

In the future, we will test the use of the application in the field of computer science in university education and carry out a study of student satisfaction, as well as the academic results obtained.

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