EduVirtual - Modern Educational Platform based on Multimedia Technologies

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Abstract—This paper presents an innovative project in the field of education, which applies modern graphic technologies, such as virtual and augmented reality. The project consists of multiple applications, which are using various technologies for different learning purposes. The applications are connected through user profiles and results are sent to a central server where a teacher can see all students' recordings. The goal of the project is to deliver a solution that is easy to use without technical knowledge and is also engaging for students in primary and high schools. This solution should also provide an easy way for teachers to create new educational content and to monitor and analyse students' progress.

Keywords—Educational Platform; Augmented Reality; Virtual Reality; Project Newton

I. INTRODUCTION

Nowadays, younger generations are more interested in information technologies and smart technologies rather than in printed textbooks. This trend increases the demand for software solutions that can cover needs of current students in a way they are used to, which might result in better motivation and concentration in their studies. A good example is virtual reality which offers both, opportunities as well as challenges for the educational sector. This technology is still improving and has achieved interesting results when deployed in education process, but the costs associated with it has been unaffordable for educational institutes [1].

There is a couple of online learning platforms, but any of them do not use AR or VR technologies combining with multi-language study materials. The German Geolinde platform offers content in old and disarranged interface. Its content is focused on Germany, but some chapters contain general information about continents. This platform does not support AR or VR technology, but contains some 360-degree photos [2].

Other platform named Moodle is the most popular e-Learning platform in Europe. It supports hundreds of tools and content types. It is an open-source platform that allows to develop own tools and plugins. Actually, there is not support for AR/VR content and its management.

The National Geographic platform offers various fields of interest. From geography, biology, social studies, up to mathematics. The platform looks very modern and has an easy searching tool. All science areas are very well divided and contain quantity of videos, presentations, images, interactive tasks and various assignments. However, the platform does not support any AR or VR content to improve the learning experience during the lessons.

This paper is organized as follows. Section II describes our proposed educational platform and its components. Section III contains conclusions and goals of future work that can help to enhance current educational processes.

II. EDUVIRTUAL PLATFORM

EduVirtual is an independent e-Learning platform build on modern technologies that help to enhance an interest in knowledge within primary and grammar school. EduVirtual does not replace verified class methodology but gives to teachers a wide spectrum of modern content enriched by VR/AR technology. The content helps a teacher to engage students, raise their interest in studying and makes information presented by texts and images more interesting. EduVirtual is a platform for modern teaching techniques using the most modern technologies. The platform is designed for teachers as an additional tool to engage students, and for student EduVirtual represents a knowledge database full of interactive content helping better to dive into a given subject.

Our proposed learning platform consists of cloud solution that is supported by three applications / components. Two of them are designed for mobile devices utilizing Augmented reality and Virtual reality, and one application designed for PC. All four components share and interchange various data like studying materials, multimedia digital objects, logs from students' activities etc. This interconnection is also used to exchange login session information among applications in the platform, therefore a student needs to log in just once to access all of them. The platform is content and language independent and currently has Slovak, English, Romanian language versions.

This platform was realized as a part of a large-scale EU Horizon 2020 project called Newton [3]. The project focuses on development, integration, deployment and dissemination on innovative technologies applicable in enhanced teaching and learning methodologies. These technologies include virtual and augmented reality [4], multimedia, mulsemedia, interconnected fabrication labs [5], virtual labs [6] and gamification [7].

A. Platform technology

The EduVirtual platform is a slave server for Newton Global Server. EduVirtual can work in two modes: as a slave and as an autonomous solution. These modes are supported by architecture and used technologies. The main role of the Edu-Virtual server is to provide content management for teachers and content delivery for students. The server consists of 8 main modules that offer number of functionalities. Web server provides access to content and builds all dynamic pages. LRS module (Learning Record Store) records all user's activity and results. Core module contains the main logic of the server and processes all rules based on Authorization module, media access, routes, etc. Authorization module can work autonomous or can be a slave database. If EduVirtual is connected to Newton platform, all student's account information and work activities are routed to the platform. If EduVirtual is in the autonomous mode, accounting is handled locally. Media Content module stores all media data that are used for web server or other applications in Apps module. Data Sync module ensure all synchronization and data migration between EduVirtual server and Newton Global Server. API module offers interface for third party integration, communication with endpoint devices or Newton Global Server.

Each student has available four types of approaches for education on two types of devices. Web portal provides an interface for education materials and interactive content based on web technologies. PC application Globe is a complex standalone software that offers 3D studying materials about geography and interface for testing managed from cloud. VR (Virtual reality) application offers 360-degree videos using mobile device and standard VR glasses. Augmented reality is supported by the mobile phone as well, but in this case the mobile phone camera and interactive content from web portal are used. More about these technologies and approaches is described below. The architecture of EduVirtual platform is displayed in Fig. 1.

B. Web Portal

The web portal represents knowledge base and contains various static and interactive studying materials like texts, images, videos or quizzes. All materials are personalized base on logged user and offer unique access into knowledge base. Each student as a platform user can see his/her results and progress on tasks given by the teacher. All students' actions are carefully logged on the portal, so both teacher and student can check a progress on given assignments.
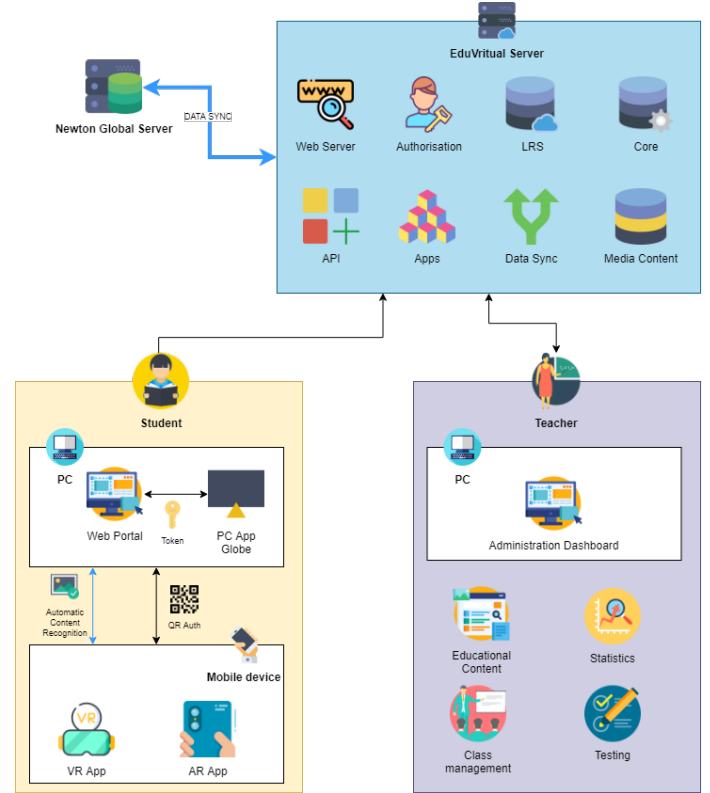

Figure 1. Visual representation of EduVirtual platform architecture

The platform can capture not only page visiting or test results, but it measures a time of visit, page scrolling, clicks on objects, activities from VR and AR applications. All this information is visible for the teacher to make an efficiency statistics of each student, comparing the time spent on learning and analysing results from tests.

All education materials can be categorized for students by language, region, type of school, class subject and grade in school.

The platform cooperates with the mobile application that offers AR/VR interface to enrich the educational content. The platform offers convenient login into all applications and solves the problem with multiple logons. In standard case, a user must type login and password in each application (web site, mobile application, PC application). EduVirtual has a smart login where multiple logins are not needed. The user logs in once and his/her credentials are shared among applications and devices. Based on the logged user, the system generates a temporary QR code on the portal web page that is captured by mobile camera within the mobile application, then the user is automatically logged in in the mobile application. In the case of a PC application, the PC application can communicate directly with browser to acquire credentials.

The web portal provides additional functionality for students to manage their profile information, log in data and account settings. They can also browse through statistics of previously taken tests and courses.
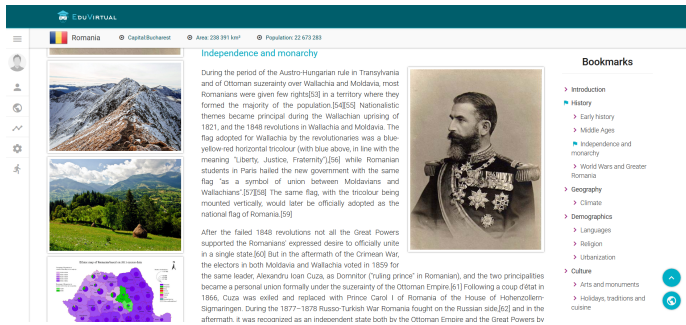
Figure 2. Web portal with studying materials

Figure 3. Vuforia mobile application displaying an augmented Stonehenge model

C. Augmented reality application

Our augmented reality application is designed for mobile devices, such as smartphones and tablets. The application uses a device camera to scan for images from the web portal or other source, that have been previously mapped to augmented models in our database. The application is able to recognize an image on the website and display a corresponding AR content. A student doesn't need to select a content in mobile phone. The content is replayed automatically. Subsequently, the augmented model is displayed in front of the scanned image.

Users can examine a displayed model from various angles and distances based on the movement and position between user's mobile device and scanned image. The augmented models can be static or dynamic containing moving parts and animations.

Models can represent human made objects like monuments, buildings and machines, or natural objects like geysers, waterfalls, interesting rock and geological formations as well as various species of fauna and flora. Fig. 3. shows an example of a 3D model of Stonehenge. Entire application is based on Unity [8] and Vuforia Engine [9].

D. Virtual reality application

Next application, included in EduVirtual platform, is designed for mobile devices, which can support virtual reality, such as newest generation of smart phones. Smart phones can be easily attached to a preassembled cardboard, which is a very cheap solution, but provides full experience of virtual reality.

In this application we present 360-degree videos in such way that the user is located at the camera's place. The user can turn around and explore the place. Since it is a video, surrounding people and objects are moving, which provides a very realistic and immersive experience. Thanks to this application, students can experience lots of interesting places during their learning process, which can be otherwise out of the reach for many schools due to various reasons. The level of experience is determined by quality of mobile device's display and glasses. Higher the quality, better the experience.
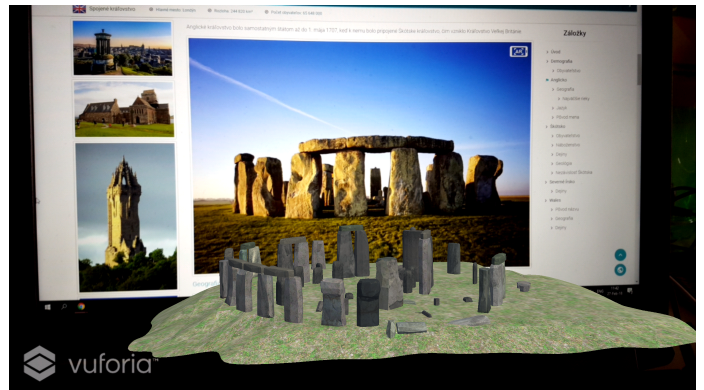
E. Globe application

The Globe is designed and developed as a standard computer application for Windows operating systems. It offers many interesting features, including individual student testing and educating. Students can easily rotate the globe and locate interesting places in a big range of zoom. The 3D approach of the satellite globe visualization is more interesting and slightly more immersive than just searching and looking at classic 2D maps. The Globe has two modes: learning and testing.

In learning mode, a teacher can select specific information and display it on the surface of the globe. Students can move around the globe freely, looking for various information, learning new facts or preparing themselves for exams.

On the other hand, testing mode offers an ability to create custom tests that are categorized under courses. Each test consists of one or more questions. These questions are created by teachers using either existing materials (like school textbooks) or customized digital materials published on the project web portal. There are several types of question forms to choose from:

- Point/polygon question to find a specific point or polygon on a blind map, for example, cities, caves, water springs, mountains, lakes, countries, etc.
- Multiple choice questions with zero, one or more correct answers.
- Single choice questions with only one correct option.
- Yes/No statement questions.

Tests may consist of any number and combination of types of question listed above. A student can move among the questions of a test and fill them in any order. After the student submits the test, an automatic evaluation is executed, and final score as well as correct/incorrect answers are revealed. All results are saved into the database for later analysis.

F. Administration dashboard

The administration dashboard is designed primarily for teachers and administrators in schools. The dashboard contains functionality that can be logically divided into four modules. Educational content module is used to create and edit studying
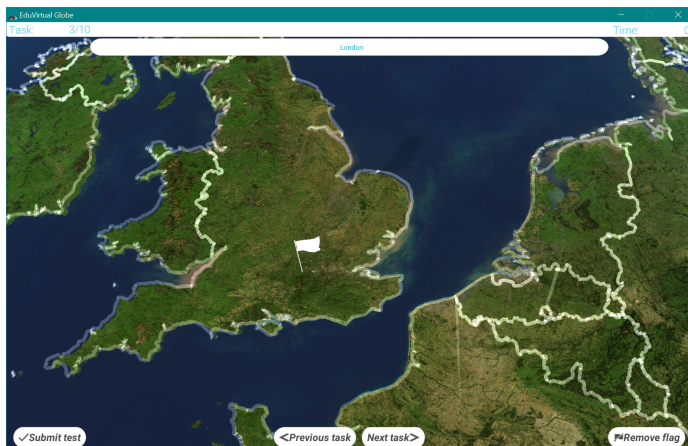
Figure 4. Interactive Globe application used for education and examining students through quizzes and blind maps questions

materials like texts, images, videos, maps and schemes that are displayed in the web portal. Class management module provides functions to manage students' accounts. Teachers can assign students into courses. Testing module contains an interface for teachers to create test questions and tests, setup time limits for tests and assign them to a whole class, certain group, or individual students. The module Statistics displays results from completed tests, logs from students' activities during lessons and additional information about student performance in given courses.

III. Conclusions and Future Work

We created an e-Learning platform which incorporates modern graphic technologies, such as virtual and augmented reality that can help to increase interest in knowledge among students in primary and grammar schools. The platform consists of several modules that share educational content and information about students, their performance in given course and activities during class.

So far, our platform has been deployed and tested at several primary and grammar schools in Slovakia, Ireland and Romania. Irish testing was performed in primary school in Dublin, Romanian testing was applied in primary school in Bucharest. Currently we are processing all outputs from Slovakian testing where within pilot testing was included 27 students from one primary school and 46 students took tree lessons (Slovakia, Czechia, France) in school year 2018/2019.

Future work includes three main directions. The first direction focuses on creating new content and enriching existing one by adding new types of assignments, new geographical data, more detailed models, satellite images of earth, better resolution videos and much more interactive studying materials for students.

The problematic part of the project lies in lack of high-quality digital resources, such as 360-degree videos or augmented reality models of interesting places and objects, which can be very expensive to make a quality content. The quality of user experience is highly dependent on the provided content.

The second direction will focus on employing EduVirtual platform in different school subjects like biology, chemistry, physics or history. There is a potential for applying new ways of transferring information in learning process via interactive and more engaging studying content.

The third direction is to continue of measuring the impact of EduVirtual platform on effectiveness of learning process, students grades and overall students' and teachers' attitude towards the project. This project sets a way of teaching and learning to new, yet unexplored level, so naturally there is room for improvements based on feedback and new ideas.

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