

Virtual Reality in Online Education

Tomáš Sklárš¹, Gregor Rozinaj²

¹ FIIT Slovak Technical University, Ilkovičova 2, 812 19, Bratislava

² FEI Slovak Technical University, Ilkovičova 3, 812 19, Bratislava

tomassklars@gmail.com

Abstract - Student centric model is playing a crucial role in the quest for finding good solutions to the use of emerging technologies in the process of education. Therefore we find it crucial to, first, thoroughly grasp the idea behind this model and how it was created, then search for the ways to apply the student-centered-model-principles to the development of software solutions in the education department. Later we take a closer look at some current modern applications developed for education and we try to confront them with the principles we discovered in the first part of our study. In the next stage we come up with our own idea of how to apply the concepts covered in analysis in our own VR application for education. We work on the development of a product which enables students to virtually visit different places in Slovakia and gives them the ability to display and read extra information about that place. We also include a game in a form of multiple-choice quiz that allows students to test their knowledge of places within the scope of the game. In the end we show results of our testing of the final product. **Keywords** – Student-centric model; Virtual reality; Education; Geography classes.

I. INTRODUCTION

In our work we chose to explore the possibilities of using modern technologies within the realm of education. We analyzed the existing solutions for the usage of modern technologies in education and chose to design, develop, test, and evaluate an application that would be a useful addon to the standard geography education. In this application, students are able to virtually visit different places in Slovakia in order to explore them without the need of travelling, which is supposed to increase the availability of this sort of content to most of the students. We also chose to include a game mode that enables students to test their knowledge of the material covered in this application.

II. ANALYSIS

In the first place, we analyzed the student-centered-model of education and identified key features of this model. These features can be summarized based on a research [5] as:

- Student takes active role in his learning, instead of passive acceptance of new information
- Emphasis on a deeper understanding of the presented material
- Student is allowed to do more things on his own, take more responsibility, but needs to be accountable
- Students need and respect their teachers and vice-versa

- Both students and teacher reflect on the learning process, give and get valuable feedback

Later on we analyzed the current state of usage of modern technologies in online education. We came to the conclusion that there are three technologies/approaches that are the most prevalent and relevant in the integration of technology to education. These approaches include virtual reality, augmented reality, and gamification.

Virtual reality gives students a completely immersive experience in which he can be transported to a completely different place. It allows him to travel to different place or spectate/ participate in different events.

Augmented reality, on the other hand, allows for enhancing the real environment surrounding the subject with extra objects, which can either explain some principles or offer interaction. In our opinion, the best usage of this approach is in story-telling, which can be more suitable for classes like history or philosophy, where stories play a more vital part.

Gamification is the act of creating a game-like educative experience. Often, this happens by adding achievements or levels to the educational environment like website or application. This is best used as a mean to keep student's motivation high by comparison with others or by displaying their progress on their journey to knowledge, as expressed by Dichev [2]. Barata [1] documented an attempt to incorporate gamification into the educational process, where gamification improved the average grade of students. However, it was accompanied by some problems he described:

- The need for week-to-week work made students feel like the requirements are higher;
- Certain students did not enjoy being compared to others and disliked the inability to hide their scores and progress;
- The requirements were set up in a way that encouraged persistence over the quality of the work;
- The fact that one cannot travel back in time in real world, in a contrast to the game world, made it more difficult for students who did not grasp the concept at the beginning of the semester.

We have learnt that in order for virtual reality application to be effective in the learning process, it needs features that would enable students to actively participate in education, not just a

360-degree video/animation. Mihalikova [4] offered 3 degrees of Virtual Reality:

1. Passive- student is just a spectator watching a video, animation, or picture. This is less engaging yet extremely affordable, as one only needs a low-end smartphone and cardboard in order to make it work.
2. Active- student is allowed to engage with the environment in a way that he might actively change a perspective of what he sees, yet he cannot alter the simulation that is going on around him. This is still rather simple to implement on cheaper devices, yet it offers some extra perks when compared to the passive one.
3. Interactive- student can interact with application, alter input parameters and watch what difference it makes. This is also the one that is the most difficult one to use in school environment, as it requires dedicated devices such as Oculus Rift.

In the ideal universe, student would be able to tweak some input parameters and witness the transformation caused by this change. When not-applicable, there should be at least some other other form of engagement between the application and student, that is enabled by the application.

We also learnt that games are a significant addition that sparks more interest in student's minds and therefore makes learning more appealing even to the ones that don't particularly enjoy traditional approaches to education. We would prefer avoiding comparison with others as it might disrupt learning patterns of some of the students and the lack of privacy might make them less comfortable.

III. DESIGN

A. Product Specification

In this section we will take a closer look at the product specification of this product- particularly at Functional and Non-Functional characteristics of the product, while also keeping an eye on what is not included.

1) Functional Characteristics

We decided to develop a:

- Virtual reality application;
- Available for Android devices;
- Controlled by Gaze without the need of additional input devices
- That helps with learning and teaching Geography;
- By displaying 360-degree panoramas of different places in Slovakia;
- Allows students to display extra information about different sights and places they see;
- Includes a game that helps them get a feedback on how they did in their studies.

2) Non-Functional Characteristics

The non-functional characteristics of this product that we took into account are:

- This product needs the internet connection as it uses Google Street View API to retrieve images from Google Street View in order for them to be displayed as panoramas.
- This application needs to be easily scalable so that the teacher can add new places he wants to show the students.
- Own set of images and panoramas is not included, it is however possible to replace Google Street View images for own images in order to remove the need of an internet access.

B. Explanation of the Product Specification and design choices

Based on the findings from the analysis we chose to design a virtual reality application that allows students to view 360-degree panoramas from places all over Slovakia. We, however, did not intend to create just a simple picture viewer, as we would be just reinventing a wheel- Google has allowed this kind of functionality for a few years, already.

Rather than that, we made a decision to include possibilities to add extra information about displayed places and sights, as it enables students to take more responsibility for their learning. It is our attempt to make the application interactive, as walking around in the VR is usually not very appealing to the subject- it causes nausea and motion sickness, as our brains are confused by the imbalance of movement perceived by eyes (walking) and rest of the body that remains perfectly stationary.

The game part is also very important, as we decided to include a playable mode that gives students a mean to evaluate how well they know places included in the application and makes their decisions progressively more difficult. We decided to omit the possibility to compare with other students directly, as it would create an environment that might turn out to be too competitive and not private enough, as we learnt in the process of analyzing the gamification.

On the other hand, we did not intend for this application to be a standalone product that would leave the teacher out. The influence of a teacher is still important as this application just opens the door for more creativity in classes. To achieve that, we made a decision to make the application as available to students as possible- the control by gaze without the need for additional devices and choosing the content of the app to be simple enough so that a simple Android smartphone can display it. Another choice we made was to prepare the application for further extensions, as we wanted it to be customizable for the needs of the course.

In this phase we put together a few activity diagrams that we were supposed to follow. An example of such diagram can be seen in Figure 1. It shows how we had planned the whole activity to look like prior to the implementation and we can conclude that we were rather close to the final look.

We have not been so close to reality when creating the first low-fidelity prototypes. In that stage, we planned only for a simple menu with a few buttons to be put on the middle of the screen, as we were preferring ease of use for the students.

Other than that, we have also prepared some of the test scenarios in this phase, so that we would be able to properly assess the quality of the application as well as user experience.

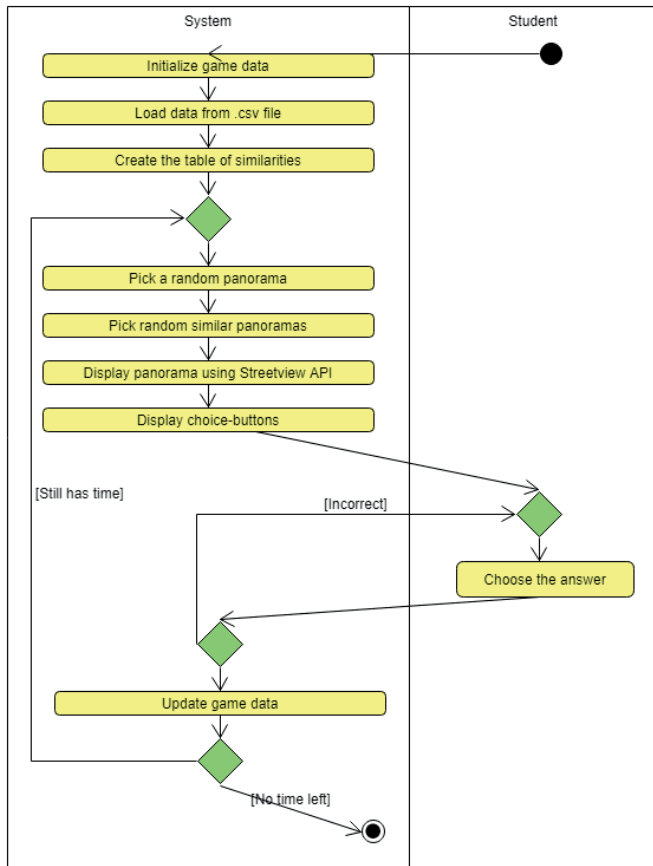


Figure 1 Activity diagram for the Game mode.

IV. IMPLEMENTATION

We implemented this application in Unity 2017.4 as an Android app for Google Cardboard and wrote scripts using the C# programming language. That’s how we planned to make this software available to as many students as possible- almost every student owns a smartphone [3] and almost no school in Slovakia has access to dedicated virtual reality classrooms. Therefore, smartphones using Android OS were the natural choice for our project. Out of the two most widely spread approaches to VR on Android devices we chose the Cardboard platform over Daydream as it is significantly more available- all one needs is an Android 4.4 or higher.

In order to minimize the requirements for gear, we chose to implement a Gaze-based controls and simple yet intuitive user interface. We used Google VR SDK for Unity as a base for those controls. The scenes use pictures from Google Street View API retrieved by an asset called Street View API

Wrapper from Unity Asset Store and turned into a material that covers a sphere around the camera.

We, however, chose to allow students to learn more and included objects student can activate in order to display extra information about specific sights. This can be done via the gaze-based controls as well. The extra information comes from local visitor sites.

When it comes to implementation in Unity, it is important to emphasize that time spent working on the project is split between creating scenes with objects and scripting. Another part of this project was also collecting data- both images and descriptions for the places included in the project.

A. Main Business Logic and Controls

Google VR SDK for Unity supports the controls of our VR app really well. We cast rays using `gvrReticlePointer`, and detect collisions of those ray with objects added to the scene. We use 2 kinds of scripts to manage this interaction- both of them are Unity’s `MonoBehaviour` class scripts:

One of these scripts, `GazeClick.cs` belongs to the `gvrReticlePointer` object. When rays cast from `gvrReticlePointer` collide with an object, the countdown to 2 seconds begins. If one gazes at the same spot for those 2 seconds an action is triggered.

The other script category consists of 3 scripts: `SphereClick.cs`, `ChangeScene.cs`, and `UiPanelSwitch.cs`. Those scripts differ only in the action they perform when they are triggered. One of these scripts belongs to every clickable object in the scene. Just like the `GazeClick.cs` it also traces, whether rays collide with this particular object and when `GazeClick.cs` gets to 2 seconds, these scripts perform their specific action:

- `SphereClick.cs` sets one of the Panels visible/invisible
- `ChangeScene.cs` loads a new scene
- `UiPanelSwitch.cs` swaps two visible panels

We made a choice to have these two kinds of scripts separated, so that we would not have to do the countdowns in separate scripts, but to have one script that would be responsible for time- tracking only and other ones that would be responsible for their specific tasks.

We also decided to display only one panorama per scene and have a separate scene for each panorama, as we tried to keep the code as simple as possible. This way one can add new scenes without the need to significantly alter the code- this is possible thanks to prefabs we put together and by doing so fulfilled one of the needs for this project- now it is really easy to teach even non-programmers to fill the map with more towns and cities.



Figure 2 Map of Slovakia that allows students to choose their destination.

B. Game mode

The game is basically a multiple-choice quiz that tests student's knowledge of places included in the app. They gain score time bonus for each correct answer and can play as long as they have some time left. The game is getting progressively more difficult as the offered choices are of places that are more and more similar. It is guaranteed by a system of tags that are assigned to each place- the more common tags, the harder.

The game is implemented in the way it was designed in Figure 1 with the exception that the game checks whether there is time left periodically and not only after the right answer is submitted.

The whole game is being managed by GameManagerScript.cs. It starts by initializing the game data such as score, time left, level and difficulty. Then it reads data from the csv file- this allows for super easy extension as you can add more places to this game by tweaking this csv file. This file consists of a name of the location, latitude, longitude, and 6 booleans representing different features of places such as: "is the picture from indoors or outdoors?"

Afterwards, we create 2 tables that store the amount of similar tags between each pair of panoramas and the amount of similar panoramas the panorama has for each level.

Then one panorama that has at least one other similar panorama on the same level, is picked, as well as three of the similar panoramas. This panorama is displayed and student can choose one of the answers that are provided based on the similarities between panoramas.

V. TESTING

We tested the game as well as the rest of our app on 10 middle and high school students and the conclusion was that the app would increase their interest in the studied subject. Here we offer a brief overview of their answers:

- The app was easy to use: 4,4/6.
- Displaying additional information was easy: 5,3/6.
- The game mode would motivate me to study: 4,2/6.
- I felt nausea during the use of the app: 3/6.
- This app would be a welcome addition to our classes: 5,8/6.

VI. CONCLUSION

In this paper, we showed our software solution that would make teaching Geography classes easier and more engaging for students. We started by analyzing the possibilities, we designed and proposed a solution, and we implemented and tested it. Students enjoyed using this software and therefore we can conclude that we succeeded.

There definitely is a space for improvements- the amount of data in the app can be increased to make it more useful and the pictures can be replaced by own panoramas that would not require internet connection. However, the point of our work was not to collect data, but to develop an app and that is what we managed to do.

VII. ACKNOWLEDGEMENTS

This project was realized under the Horizon 2020 project NEWTON.

VIII. REFERENCES

- [1] BARATA, Gabriel, Sandra GAMA, Joaquim JORGE a Daniel GONÇALVES. 2013. So Fun It Hurts: Gamifying an Engineering Course. In: Foundations of Augmented Cognition. Berlin, Heidelberg: Springer Berlin Heidelberg, s. 639-648. Lecture Notes in Computer Science. DOI: 10.1007/978-3-642-39454-6_68. ISBN 978-3-642-39453-9. Available from: http://link.springer.com/10.1007/978-3-642-39454-6_68
- [2] DICHEV, Christo a Darina DICHEVA. 2017. Gamifying education: what is known, what is believed and what remains uncertain. International Journal of Educational Technology in Higher Education. 14(1), -. DOI: 10.1186/s41239-017-0042-5. ISSN 2365-9440. Available from: <http://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-017-0042-5>
- [3] DZURIČKO, Slavo. 2018. Školáci používajú mobily už od veku 6 rokov, na strednej majú smartfón takmer všetci. Mój Android [online]. 14.8.2018 [cit. 2019-05-02]. Available from: <https://www.mojandroid.sk/deti-zakladna-skola-slsp-prieskum/>
- [4] MIHÁLIKOVÁ, Jana a Ondrej LÍŠKA. 2006. Využitie virtuálnej reality vo vzdelávacom procese. 83-85. Transfér Inovácií 9/2006 [cit. 2017-12-5]. Available from: <http://www.sjf.tuke.sk/transferinovacii/pages/archiv/transfer/9-2006/pdf/83-85.pdf>
- [5] O'NEILL, Geraldine a Tim MCMAHON. Student-centered learning: What does it mean for students and lecturers? AISHE [online]. [cit. 2017-12-5]. Available from: http://www.aishe.org/readings/2005-1/oneill-mcmahon-Tues_19th_Oct_SCL.html