

# Augmented Reality in E-learning

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**Abstract** - Many young people own a mobile device, such as smartphone or tablet and that is the main reason we decided to design and implement educational mobile application StellAR with use of augmented reality technology. This thesis analyses some of the modern trends in education with emphasis on augmented reality and describes StellAR application itself.

**Keywords** - Extended reality, Augmented reality, E-learning, Unity, Vuforia

## I. INTRODUCTION

Technological advancement goes hand in hand with new methods of education. It was proven that these methods increase engagement of students during education process. One example of modern technologies used in education is a so called augmented reality (AR), which in combination with mobile devices represents a very attractive visual teaching aid. We decided to analyze some of the modern trends in education focusing mostly on augmented reality topic. We prepared a concept and programmed StellAR – an educational MAR application. Its aim is to make students learn new things about our solar system in a fun way. StellAR application was properly tested. Test results confirmed that the usage of augmented reality has a great potential in education. Apart from the fact that students reached a relatively high results in the final questionnaire, it is important to underline that they managed to remember mostly information presented visually. As the AR is all about visualizations, we believe, that implementing such applications in the process of education will have positive effect on students - not only on their knowledge, but also on their motivation to study more.

## II. E-LEARNING

### A. What is e-learning?

“E-learning is an approach to teaching and learning, representing all or part of the educational model applied, that is based on the use of electronic media and devices as tools for improving access to training, communication and interaction and that facilitates the adoption of new ways of understanding and developing learning [1].”

Technological improvement seems to affect every single area, including education. So, it's rather expected, that educational system changed as well. There are many modern technologies that can be or are used in educational system, that we will discuss in the following paragraphs.

### B. Gamification in e-learning

Even though education is an inseparable part of our lives, we find learning quite difficult. That is when gamification comes handy.

Gamification is a concept of applying game-design thinking to non-game applications [2]. This essentially means that we can take, for example, educational app and enrich it with rewarding point system, or levelling system. It was proven, that “gamification can drive strong behavioural change especially when combined with scientific principles of repeated retrieval and spaced repetition [2]”.

Gamification is what makes application fun and that's why we decided to apply this concept in our project.

### C. Modern trends in education

For the purpose of this paper, we will present trends such as mobile learning and augmented reality.

- Mobile learning - “The number of educational materials dedicated to mobile devices is growing rapidly. We can find textbooks, applications for foreign language learning, and educational games and programs on the market [3].” Mobile learning has many advantages, e.g. can be used outdoors, offers an easy access to knowledge from anywhere, and a possibility of self-paced learning. On the other hand, “students attention may easily be distracted from educational purposes [3]”.
- Augmented reality - is a technology of adding virtual objects to real scenes. The main benefit of AR is that it “creates realistic models, demonstrating a contextual, three-dimensional nature of the real world to students [4]”. The disadvantage of AR according to the “Book of trends in education”, remains, that “innovation and attractiveness of technology may result in less attention devoted to quality and content, which are of key importance for educational objectives [4].”

Both technologies, mentioned above have their own advantages and challenges. We are positive, that combination of two can bring not only knowledge to students, but also highly motivating entertainment.

## III. AUGMENTED REALITY

Augmented reality falls under extended reality technology, which is an umbrella term for all: augmented reality, virtual reality and mixed reality. What do all these realities have in

common? Mainly, that all are generated by computer, some more than others. For deeper explanation, we use definition by Milgram et al. (2004). “Milgram Reality Virtuality Continuum is a scale ranging from a completely real environment (reality) which we can observe when viewing a real world to a completely virtual environment (virtuality). Within this continuum the space between real environment and virtual environment is called mixed reality (MR). It is straightforward to define MR as an environment where the real world and virtual world are blending together [5].” MR is composed of augmented reality (AR) and augmented virtuality (AV), see figure 1. “AR is a combination of real and virtual object and contains a small amount of virtual data while AV is a concept where elements of reality being added to a virtual environment and contains more digital data [5].”

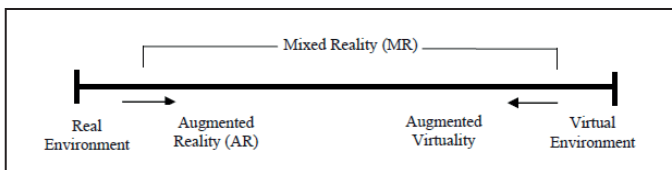


Figure 1. Milgram Reality Virtuality Continuum

There are many definitions of augmented reality. However, the most common one is, that AR is a technology of adding virtual objects to real scenes.

“According to Azuma (1997), Augmented Reality must have three characteristics:

- combining the real and virtual worlds
- having real-time interaction with the user
- is being registered in a 3D space [6]”

Augmented reality can be experienced mainly in two ways. One is by using “see-through“ head-mounted display, which is, by other words, head-mounted display with camera attached on the top, or by a portable device with camera, such as smartphone.



Figure 2. View through Oculus Rift with ZED mini camera attached

Combination of both AR technology and a mobile device is ideal for educational purposes, since it is visual and portable at the same time. This kind of combination is called MAR, mobile augmented reality [5].

### A. Existing educational AR applications

Through the years AR was not only used as a teaching material, but also tested with many other means of learning to prove its relevance in educational system. Applications like Virtuoso (2006), The Frequency 1550 (2009), ARGreenet (2011) or EnredaMadrid (2012), were tested and results were compared to other educational versions of these games like paper or PC version. The results showed that knowledge gained in AR apps were either the same, or higher compared to other versions.

There were many aspects that were tested besides knowledge gain, e.g. learners’ motivation and engagement. It was proven that not only AR versions were more entertaining and fun, but also students felt very engaged and motivated to learn more regarding to the topic of the game.

According to these findings, we decided to design, implement and test new educational application - Stellar, with use of augmented reality technology.

### IV. DESIGN

Our main goal is to contribute to e-learning with brand new learning app, Stellar focused on very visual and interesting topic - solar system. This application will run on smartphone, using augmented reality, which can be used both inside and outside the classroom.

We decided to programme Stellar using Unity editor with platform Vuforia, since it provides us with ground plane detection feature.

Stellar consists of three levels, which are supposed to teach students information about each planet of our solar system, such as planets’ atmosphere, surface, size or distance from the Sun. Apart from these levels, there is also a dynamic solar system model, where student can not only observe planets orbiting around the Sun, but also interact with the whole model’s transformation and motion.

### V. IMPLEMENTATION

Using Unity 2017.3 and Vuforia, we created a teaching MAR application Stellar, which consists of solar system model and three levels:

- add a texture to the planet,
- sort planets by sizes
- put each planet on its’ orbit

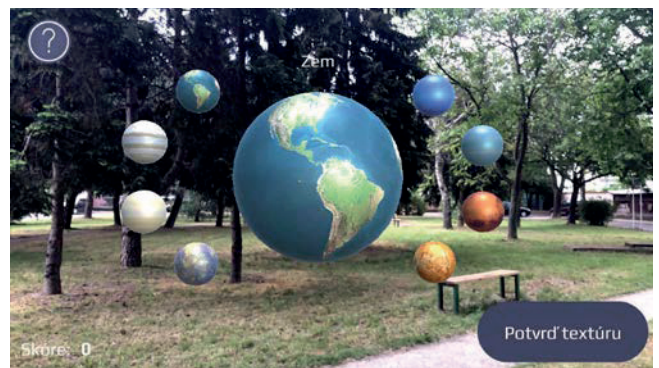


Figure 3. First level of Stellar - Add a texture to the planet

Each level uses ground plane detection, AR camera and object/s to be displayed on plane detection. Our goal was to develop an educational, yet entertaining app. That is why we decided to include some elements of gamification into Stellar, like for example a scoring system, which is supposed to motivate students for better results and make application more fun.

### VI. TESTING STELLAR

Testing took place in elementary school Malokarpatské námestie 1, see figure 4, but also in FIIT faculty in Bratislava. Stellar was properly tested on a sample of fifteen people. Each participant filled in a questionnaire about solar system right before and after testing and a final questionnaire about overall impression from the app.



Figure 4. Testing Stellar in elementary school

Among other things, testing showed that visually presented information was much more easily remembered. Statistics from the last questionnaire indicated, that up to 93.3% of respondents would like their teachers to use such teaching materials as Stellar. Also, 66.7% of respondents were motivated to learn more about solar system, after testing our application.

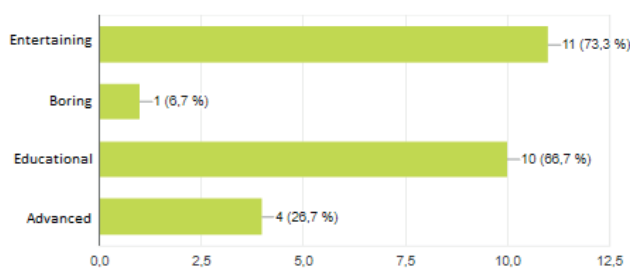


Figure 5. Overall rating of Stellar

In general, participants were very pleased with application, see figure 5. They found it quite intuitive and agile. We were told that a big plus of our educational MAR application was that tasks were easy to understand. Many testers didn't know

that planets were that small compared to the Sun, so they really enjoyed second level of Stellar, where they were supposed to sort planets by size. After completing the task, the Sun shows up behind planets, so that students can see e.g. how small Mercury is compared to the Sun, see figure 6.



Figure 6. Second level of Stellar - sorted planets by size

### VII. CONCLUSION

We believe, that augmented reality is truly one of the best technologies to use while learning, not just because of its great visual potential, but also of its portability in context of mobile devices, such as smartphones or tablets. However, it is important to note, that learning with such a technology is entertaining for just few minutes. We were told by some participants, that holding a device for longer period of time would be quite uncomfortable.

We believe that AR technology should be definitely used in education, but in moderation.

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