



Exploring Impact of Olfactory Stimuli on User Performance on Mobile Platforms

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Abstract. In today's modern age, it is almost impossible to exist without the Information Communication Technologies that makes our life easier.

In addition to other areas, Information Communication Technologies is also needed in education. There are a number of ways to contribute to the development of the learning process, which we refer to in this article - student centric model, gamification, virtual and augmented reality (using Gear VR), remote and virtual labs. We will also discuss the educational application focused on the basics of geographical knowledge of Slovakia.

Keywords: E-learning · Student centred learning · Gamification · Virtual reality

1 Introduction

In this article we will talk about how modern communications technology affects each and every one of us. The ICT has already been used in many areas, and one of them is education that is inevitable for each of us. The offer is just making mostly important and learning information in a playful form. As regards education, the students can educate themselves anytime and anywhere thanks to the ICT and Internet.

The need for ICT in education is certainly inevitable. The information we need to acquire is more and more, and teachers are not given the opportunity to devote themselves to each student individually as much as they need. It's the one of the benefits ICT, where student can learn a lot of things in a playful way through a simple application.

An example of such an application, where we are creating a blind map of Slovakia, will also be discussed in this article.

Since the development of the learning process on all levels of learning determines the student centric model, gamification, virtual and augmented reality (using Gear VR), remote and virtual labs, student experience measurement, referral system, etc. we will discuss them here in more detail.

2 Virtual, Augmented and Mixed Reality

When we talk about these three types of realities, there are certainly a lot of people who see all these types as one and the virtual reality. But this is a mistake because they are very different from each other. We can further develop and compare them for better understanding (Fig. 1).

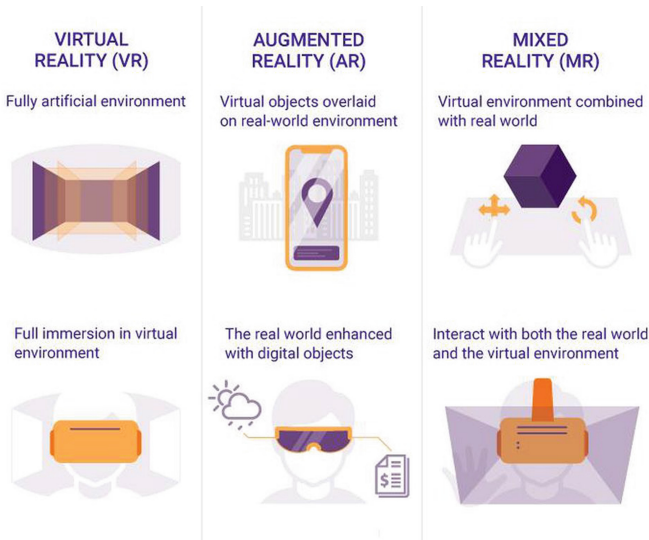


Fig. 1. The difference between Virtual, Augmented and Mixed reality [1]

2.1 Virtual Reality

The concept of virtual reality is well known today. When we hear the VR, we will literally introduce ourselves to escape from reality. But it's just a computer-generated scenario that makes us feel something real. And that is exactly what today's technologies allow us to do, to advance towards to reality maximally, seeing that technology is moving through incredible steps.

Unlike mixed reality, which is more useful, virtual reality has been developed for entertainment purposes.

In order to be fully immersed in a virtual world, a user needs a special headset. Without this headset would be the VR virtually unusable.

We will describe the 2 main VR devices below.

1. Oculus Rift

The Oculus Rift is one such VR system that works as a wearable headset capable of letting the users experience a virtual environment.

The specifications of the Oculus Rift are [2]:

- Head-mounted display
- OLED display technology

- 2160 × 1200 resolution (1800 × 1200 per eye)
- 90 Hz refresh rate
- 110° or greater field of view (nominal)
- Compatible with Microsoft Windows (plans for OS X and Linux compatibility)

The Oculus Rift is designed to give a feeling of presence and provide a lifelike experience with its specialized design and software. It is customizable and adaptable to various uses. One common application is to enhance the gaming experience.

The Oculus Rift comprises an integrated audio VR, thus providing a 3-D audio effect. It also includes rotational and positional tracking accomplished with the help of infrared sensors. Therefore, it can be used while users are sitting, standing or walking around the room.

2. HTC Vive Pro

VIVE Pro is the most capable and fully featured virtual reality system VIVE has ever made. Designed to meet the needs of today's most demanding VR users - from expansive office environments and crowded arcades, to the comfort of your living room. VIVE Pro surpasses the bar-setting experience to realize the most immersive virtual reality experience.

Headset Specifications [3]

- Screen: Dual AMOLED 3.5" diagonal.
- Resolution: 1440 × 1600 pixels per eye (2880 × 1600 pixels combined).
- Refresh Rate: 90 Hz.
- Field Of View: 110°.
- Audio: Hi-Res certified and high impedance headphones (removable).
- Input: Dual integrated microphones.
- Connections: USB-C 3.0, DisplayPort 1.2, Bluetooth.
- Sensors: SteamVR Tracking, G-sensor, gyroscope, proximity, IPD sensor.

2.2 Augmented Reality

In addition to virtual reality, we also know the augmented reality and mixed reality.

As regards to Augmented reality, Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real-world are "augmented" by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory [4, 5].

Enhanced Reality uses existing environments and overlaps virtual objects and information. This type of technology proves to be very useful in our daily lives. For a better understanding of what actually augmented reality means, we can give some examples of devices that use AR.

1. HoloLens

As a standalone headworn computer capable of projecting images that appear to be in the real world, the HoloLens is the first of its kind. With a collection of sensors and



cameras, the HoloLens is constantly scanning the space around the user and updating a 3D mesh of that area in what is referred to as a spatial map.

Another feature of this spatial map is occlusion. So if you have your home mapped correctly, and you bounce a virtual ball off the wall, it can, for example, disappear as it rolls into your kitchen, just as it would in real life [6].

2. Meta 2

The Meta 2 is a tethered, head-mounted device. That means it requires a connection to a traditional PC to function and is designed to be used in a stationary location, with no ability to wander around your real world environment. Crafted around the idea of being a replacement for your 2D screen, Meta 2 plugs into your computer’s video port, with sensor input and image processing being handled by the connected PC’s processors [6] (Table 1).

Table 1. Hololens and Meta 2 comparsion [6]

	 HoloLens	 Meta 2
Standalone Unit?	Yes	No
Screen Resolution	1268x720	2560x1440
Viewing Area	Limited Viewport	Full Area of Glasses
Battery Life	Approximately 3 Hours	N/A
Operating System	Windows 10 (Holographic)	Prioprietary
Work/Life Applications	Yes	Yes
Games	Yes	No
Cost (Dev Kit)	\$3,000	\$949

2.3 Mixed Reality

Another notion associated with virtual reality is a mixed reality. What this type of reality offers us, is essentially a combination of augmented and virtual reality. It includes both physical elements and virtual elements.

Offering the ideal blend of powerful hardware and distinctive features, Samsung’s HMD Odyssey is without a doubt, the best Windows Mixed Reality (WMR) headset on the market today.

The HMD Odyssey has two 3.5-inch AMOLED displays, each with a resolution of 1440 × 1600 pixels. The displays provide a rich and unparalleled visual experience, further enhanced with an immersive 110-degree field of view. The headset also supports 360-degree spatial sound, which is made possible by premium built-in AKG headphones (Fig. 2).



Fig. 2. Samsung HMD Odyssey

3 Student Centred Learning

Learning models were long focused on keeping things standard to make the lives of teachers and institutional administrators simpler. This focus has shifted in recent years to a more student-focused learning model.

One powerful tool within this model is adaptive learning, and research shows its advantages over traditional teaching. It is because of these benefits that teachers, colleges and universities should consider shifting their focus.

This educational method uses computers to cater to each student's unique learning needs. This dynamic process adapts teaching methods based on responses to questions, interactive experiences and tasks.

It's nearly impossible for instructors to focus on each student individually. This makes online learning integral in teaching with these methods. Because of this, eLearning solutions are essential in adaptive learning [8].

This method of student centric method has many real benefits –,blended learning opportunities, students learn faster new things and it's likely to engage students more than a classroom.

4 Gamification

Gamification is the process of taking something that already exists – a website, an enterprise application, an online community – and integrating game mechanics into it to motivate participation, engagement, and loyalty. Gamification takes the data-driven techniques that game designers use to engage players, and applies them to non-game experiences to motivate actions that add value to your business [9] (Table 2).

Table 2. 10 primary game mechanics [10]

Game Dynamics		Competition	Collaboration	Community	Collection	Achievement	Surprise	Progress (emotional)	Exploration
Game Mechanics	Points					●		●	
	Levels	●			●	●		●	
	Missions (individual & team)	●		●		●	●		●
	Badges			●	●	●	●	●	●
	Leaderboards (individual & team)	●	●	●		●			
	Unlocks					●	●		●
	Events Feed	●	●	●				●	●
	Notifications			●				●	
	Quiz	●		●		●		●	
	Progress (visual)					●		●	

5
Virtual and Remote Laboratories

5.1
Virtual Laboratories

These laboratories are very helpful, specially for scientists of Biology, Physics & Chemistry, who are working on their experiments. These types of laboratories allows them to cooperate on same project no matter where they currently are located (Fig. 3).

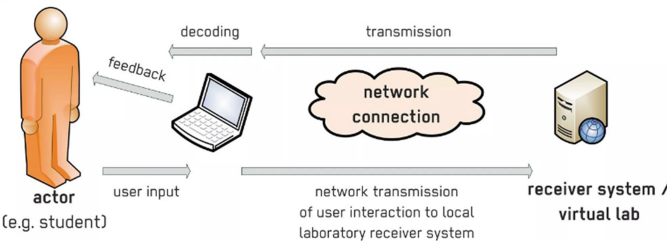


Fig. 3. Virtual laboratory

5.2
Remote Laboratories

Unlike the traditional laboratories, where people have to do everything manually, for example pressing buttons, Remote laboratories allow them to perform it, over the Internet.

Benefits

Convenience - A remote laboratory can be accessed 24 h per day, 7 days a week from any Internet connected location, without requiring staff supervision.

Cost Efficiency - Due to more efficient sharing of resources, educational institutions can satisfy laboratory demand with less equipment.

Alternatively, expensive and bulky equipment can be shared and utilised more effectively.

Enables Distance Education

Courses that traditionally had to be taught on-campus in their entirety may now offer opportunities for distance learning.

Students who work and study part time may also find remote laboratories helpful in balancing their commitments.

Equity

Through the use of automated management systems, all laboratory users can be assigned time limits during busy periods and queued to ensure that everyone has their 'fair share' of time to carry out experiments.

Security

As public access to the laboratory location is not required, remote laboratories are highly immune to wear and tear, theft and vandalism.

Safety - Many experiments can pose fire, electrical, radiation, biological and hazards to personal safety.

Educational institutions may benefit from reduced OH&S compliance costs and reduced insurance premiums [11] (Fig. 4).

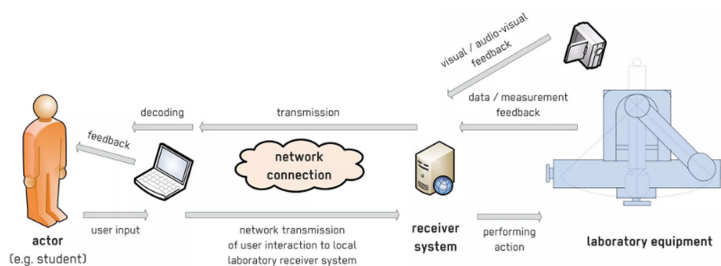


Fig. 4. Remote laboratory

6 Application

Some of the abovementioned principles have been implemented to our application which is practical part of this project. This application's theme is Slovakia and most famous natural and historical tourist places. Its main goal is to help users get to know

geographical position of our biggest towns and most known castles, lakes and caves on the map.

The game engine we have used is UNITY, which is multiplatform and can be used for several types of applications such as mobile games, PC games, web, console games, etc. As programming language, it has been used C# and we have used programming environment Visual Studio Community 2012, which is not default while using UNITY. Platform used for this application is Cardboard because it is supported for all brands of mobile phones which support virtual reality. However, the game can only be played using touchpad or external controller.

The application consists of main menu with short overview what the game is about, what is the goal of the game, who is target audience and how particular games should be played.

The application consists of 3 main parts:

6.1 Learning Mode

This mode consists of 4 maps of Slovakia

- map containing 50 most populous towns of Slovakia
- map containing 20 most known Slovak caves
- map containing 20 most known Slovak castles
- map containing 10 most known Slovak lakes

This scene also includes one display window which shows name of the object (town, cave, etc.) after pointer click on the object.

6.2 Game Mode

- 1st level

The same maps as in the learning mode are present, but there are some differences. This level is more interactive. In the beginning the random object (town, cave, etc.)

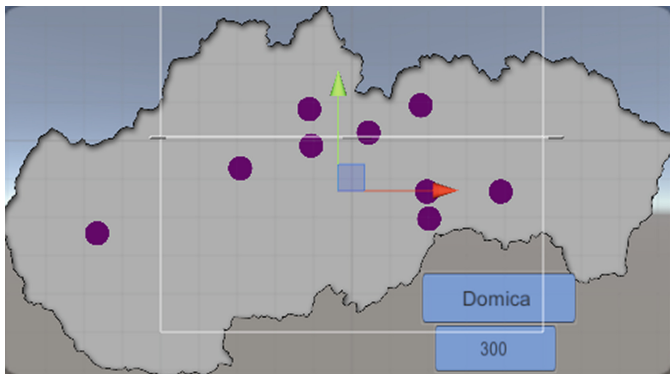


Fig. 5. Scene example

name is displayed on the display window and user is supposed to find the object on the map and choose it. Based on if it is correct user earns or loses some points. There are also short sounds included based on this (Fig. 5).

- 2nd level

This scene uses similar principle as the abovementioned game except for the objects are invisible and therefore user has to identify the position where it should be placed on the map. In order to not decrease user's motivation when he does not identify all (especially the small ones and the less known) cities, castles, etc. correctly, we have decided to divide the towns to five groups (according to the population), the caves, lakes and castles to two groups. The smaller and less known objects will have bigger tolerance of their position on the map.

6.3 Quiz

This theme includes short quiz including mainly basic questions regarding Slovak nature, towns and buildings. There will be some extra not basic but very interesting questions to keep the player's attention. User gets points and badge as reward.

Acknowledgement. Several methods and techniques of using virtual reality in education field are discussed. The main goal of the application is to increase student's motivation. Some of them have been successfully implemented in the application with geographical theme aimed to help students get to know Slovakia a little more.

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