THE BENEFITS OF USING IMMERSIVE TECHNOLOGIES AT GENERAL SCHOOL

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Abstract
The article is devoted to the problem and benefits of the use immersive technologies at general school. Immersive technologies are an important tools for future improving the educational process, and important to study their impact on the mental and physical condition of young people, which will depend on the effectiveness of the use of virtual reality in education at various levels. The purpose of the article is to analyze the use of immersive technologies for school learning and to identify the basic benefits of using immersive technologies at general school. We made a comparative description of traditional earning and learning using immersive technologies. WE can highlight the main advantages of immersive technologies: providing the ability to change the relative size of the pre-investigated objects, which leads to the visualization of objects of the micro and macro world; creation of models of the phenomena or processes which cannot be directly and clearly registered by bodies of senses of the person; visualization of abstract models and production of objects that have no form in the real world; focusing students on the study of specific objects without distraction to external stimuli, which gives them the opportunity to focus fully on the material.
Keywords
Immersive technologies, augmented reality, virtual reality, mixed reality, general school

1. Introduction

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The development of information and communication technologies, e-learning, the emergence of a new generation of students and other factors are led to a change in the paradigm of education, etc. Thus, teachers should seek the necessary tools to organize the learning process to ensure the formation of key competencies in students and increase their motivation to learn. In the conditions of the pandemic caused by COVID - 19, the technology of mobile learning as a kind of distance learning with the use of mobile phones, smartphones, e-books acquire special significance. In distance learning, the teaching of theoretical material is sufficiently well implemented by simple means of audio or video broadcasts, placement of text materials or presentations. A significant problem is in the organizing practical, laboratories, science school trips & tours, etc. Therefore, the main task of our study is to replace real learning with virtual (VR) and augmented reality (AR) as an immersive technologies (IT) and are the possible approaches in terms of distance learning and quarantine. In a recent survey of faculty, 81 percent of respondents said that VR, AR, and Mixed reality (MR) will be key educational technologies over the next decade [1], [2].

Effectively integrating these technologies into the curriculum requires careful planning and numerous resources; in addition to adopting and incorporating the technology itself, institutions must

consider related efforts, including faculty development, instructional design, learning space integration, infrastructure assessments, and governance, policy, ethics, and access equity.

2. Theoretical Backgrounds

Immersive technologies (IT) are methods and devices that create an effect of identification with immersive media through sensory stimuli that use simulation and displays for humans' immersive into virtual worlds which may not always be available in real life [3]. Such technologies are combination of real environment and digital technology via using interactive activities, and are the integration of virtual content with the physical environment, allowing the user to naturally interact with mixed reality, which includes two main types of reality, both AR and VR. P. Milgram, H. Takemura, A. Utsumi, and F. Kishino (1994) proposed a "Reality Virtuality Continuum", and introduced "Mixed Reality" (MR) as combinations of AR & VR technologies (Fig. 1) [4]. In their model MR represents all simulated environments in which the real world and virtual world are juxtaposed. MR applications can be provide users with immersive experiences that have both real and virtual content. Its include Virtual reality, Augmented reality, Augmented virtuality (AV).
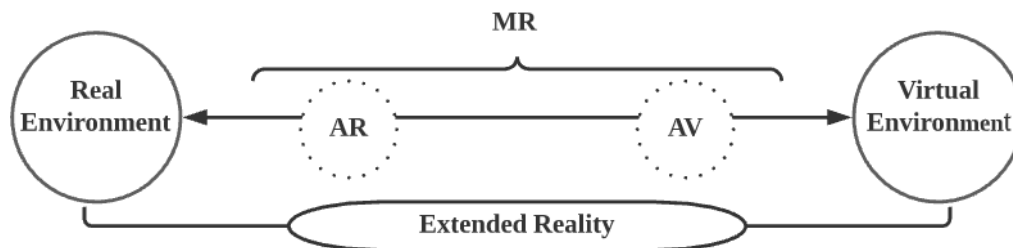

Figure 1: Reality Virtuality Continuum (P. Milgram, H. Takemura, A. Utsumi, and F. Kishino, 1994)

Virtual reality is a term describing a computer simulated environment in which the user is placed in such a way that they feel immersed by it. This requires the simulation to stimulate the user's senses in such a way that the user focuses on the simulation instead of their surroundings, making the experience feel realistic. The sensory stimulation is primarily comprised of visually presented information, while auditory and haptic training simulations are also common. There also exist systems that can stimulate other parts of the nervous system, such as the somatosensory system and the olfactory system [5].

AR – superimposed images are integrated through the use of Information and Communication Technologies (ICT) via mobile devices such as the camera of a computer or a mobile device (laptop, tablet, or mobile phone) [6]. AR is characterized by the inclusion of digital information (images, video and audio) in real space, tries to combine the real world with the virtual environment, allows users to interact with both physical and digital objects. AV is, in contrast to augmented reality, an environment which is largely virtual, and real elements augment it (Mihelj, et al., 2014). An example is a virtual world into which a real person's physical appearance is added. In our opinion, the main Immersive technologies for school are VR, AR and MR (Fig. 2).

Virtual reality (VR) and augmented reality (AR) are two closely related technologies that have some differences and represent a new direction in the development of digital technologies. VR creates the likeness of the real world through technical means. The effects created by projection penetrate the human brain and cause sensations as close as possible to real ones. VR is defined as a new concept of using computers and the human-machine interface to create the effect of a three-dimensional environment in which the user interacts with virtual objects interactively, while creating a strong sense of three-dimensional presence.

VR is characterized by the following factors [6, 7]:
- presence (the illusion of being directly in another place, the world);
- immersion (sensory organs process information received from objects and events of the virtual environment);
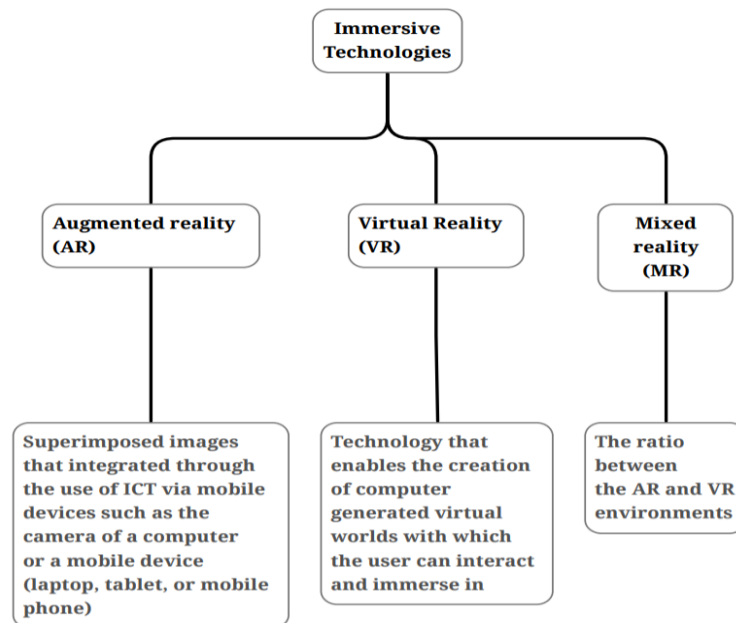- involvement (all thought processes are focused on virtual interaction).

Figure 2: Types of Immersive technologies (the author`s concept)

The Table 1 "Comparative characteristics of traditional learning and learning using immersive technologies" shows the differences between the traditional learning and learning using immersive technologies by such indicators as teachers' role, students' role, type of information communication, teaching methods, teaching material.

Table 1

Comparative characteristics of traditional learning and learning using immersive technologies

Important issues for to organize and support training	Traditional education	Learning using immersive technologies
Teachers' role	The teacher acts as a provider of information, determines all aspects of the learning process	The teacher acts as a diagnostician, consultant
Students' role	Focus on the teacher's activities of the who passes knowledge to a group of students	Assimilation and generation of information in active work with educational material via the use of VR and AR tools
Type of information communication	Led by teacher	Sense organs involved in the process of perception – seeing, hearing
Teaching methods	Lectures, conversations, reproductive activity	Methods that are associated with the performance of practical tasks by students (problem, activity, practice-oriented, competence)
Teaching material	Paper and electronic textbooks, computers, electronic educational resources	VR applications for the simulation of real environments, VR accessories (for example, helmets with controllers, which can support the VR with collaborative infrastructure; AR glasses, that are to superpose synthetic

information on a transparent glass and require an external pad consisting in an Android device used to execute and to control its AR apps)

The role of IT in education can be determined by such criteria as: gaining experience, social role, simulation in the learning process, importance in life and learning, acquisition of knowledge and self-knowledge, namely:

- gaining experience takes into account the fact that the IT environment is considered part of pedagogy, and the student's personal experience is an important basis for a possible change in his personality and development and consolidation of new skills and abilities;
- the social role of IT takes into account the fact that in interactive entertainment the student takes on a role governed by a set of rules, the individual experience of students is different, even if they have the same roles;
- importance in life and study, taking into account that the scenario of IT is a unique social activity necessary for the development of the student and his socialization;
- simulation in the learning process - is the creation of a model that represents real life (problem) and is able to respond to the behavior of students and organizers of the scenario; during the simulation, participants may encounter situations that are not common or do not occur in real life;
- acquisition of knowledge and self-knowledge takes into account that IT and activities in such an environment are based on entertaining learning and allow teachers to get to know their students better, allow the teacher to form an opinion about student behavior;
- students will not be distracted by external stimuli, IT provides an opportunity them to fully focus on the learning material.

We must take into account when using IT, especially when using its in schools teaching, the negative impact possibility on human health.

Scientists (Brooks, et al., 2010) define the so-called simulator disease, or cyberdisease, as a common disease when using virtual reality equipment, especially main displays:

"The sickness is caused when the user is moving their head, and the images displayed in the HMD is not responding quickly enough. This causes a delay between the user's actual movement and the user's perceived vision of the movement, the change in viewpoint in the HMD. The differences are confusing the user's brain, trying to handle multiple different impressions, thus causing sickness" [8].

Despite these challenges, which will be explored in the IT use of school learning, these technologies are important for the future development and improvement of education.

The purpose of the article is to analyze the use of immersive technologies for school learning and to identify the basic benefits of using immersive technologies at general school.

3. Research Methods

To achieve the purpose of our study and also to clarify the problem of using immersive technologies at general school we were used the following methods: systematic and comparative analysis of pedagogical, psychological, philosophical, sociological works, methodological and specialized literature; analysis of the pedagogical experience of using the immersive technologies in general school; synthesis and generalization to formulate the main points of the study; interviews and questionnaires of teachers about their attitude of the use immersive technologies at general school (the surveys distributed in online format among 94 teachers from Secondary General Education three schools (Levels I-III N1 in Brovary (Ukraine), at Semipolkivskyi Secondary School of the 1st-3rd Grade (Ukraine) and Specialized school of foreign languages 181 in Kyiv (Ukraine), the data were collected and a statistical study was carried out among all the teachers surveyed); interpretation of the research results.

4. Results and Discussion

We looked at the sites that offer the most popular IT and studies, which analyzes the role of virtual and augmented reality in education [8, 9, 10]. We summarized and highlighted the examples IT for any schools' subjects after that, proposing them in the table 2 "The generalization examples IT for any schools' subjects", namely: MoleculE VR and inCell VR (Cardboard) for Biology; The Brain AR App, EducationXR and The Body VR for Anatomy; Nano2d and Mel Chemistry VR for Chemistry; HandWaver, VR Math and GeoGebra 3D with AR for Mathematics; Virtual iSCool and ClassVR Physics for Physics; Google Arts and Culture (Virtual museum) and ARKit for Art; Skyscrapers AR and Google Expeditions for Geography; Music Room VR and AR Piano Tutor for Musical art.

Table 2
The generalization examples IT for any schools' subjects

Subject	Examples of IT	Comments
Biology	MoleculE VR	is an educational virtual reality app about how biological cells communicate
	inCell VR (Cardboard)	is a game for cell study
Anatomy	The Brain AR App	Is an animated model, audio descriptions for parts of the human' brain
	EducationXR	is an extended reality (XR) platform used to deliver the most immersive education content possible for native mobile, tablet, desktop and virtual reality applications. This application provides users with the ability to connect together with other users in one singular experience regardless of location and hardware.
	The Body VR	is an educational virtual reality experience that takes the user inside the human body, provides an opportunity to travel through the blood and discover how blood cells work to spread oxygen throughout the body
Chemistry	Nano2d	the virtual environmentinte for studying two-dimensional materials, serving as an educational and research tool for advanced materials science
	Mel Chemistry VR	is a collection of Chemistry VR lessons, which are aligned with the school chemistry curriculum, covering all of its main topics
Mathematics	HandWaver	is a gesture-based virtual mathematical making environment, where users can construct uni-, two-, and three-dimensional mathematical objects through iterations of gesture-based operators
	VR Math	is an app that helps students to understand and educators to teach 3D Geometry
	GeoGebra 3D with AR	is an application for representing and studying various geometric shapes
Physics	Virtual iSCool	basic thermodynamics: Specific and Molar Properties, Ideal Gas and Cubic Equations of

		State
	ClassVR Physics	is an open platform, supporting Virtual, Augmented and Mixed Reality curriculum content, as well as allowing students and teachers to create, upload and share their own content, creating a collaborative community of global educational resources
Art	Google Arts and Culture (Virtual museum)	provides an opportunity to visit museums around the world, examine paintings and other works of art in detail, listen to their history, etc.
	ARKit	is creating visual effects for films, that is performed on a mobile device in real time
Geography	Skyscrapers AR	is a form of augmented reality application that offers users to stay close to the famous skyscrapers of the world, walk around the building and view it in details from all sides, figuring out the features of the architectural creation
	Google Expeditions	is an immersive learning and teaching tool that lets you go on VR trips or explore AR objects, explore historical landmarks, and etc.
Musical art	Music Room VR	is designed as a professional musical instruments, integrated with Bitwig 8-Track, the leading expressive audio workstation
	AR Piano Tutor	recognises the piano including the notes of its keyboard and determines the three-dimensional position and orientation of the piano in a 3D space (this is done with a precision of up to 1 centimetre)

We asked the teachers (94 secondary school teachers), as experts, see the proposed IT (Google Expeditions, MERGE Cube, Robotics in VR, Virtual museum, Nano2d, Virtual iSCool, ClassVR Physics, inCell VR) and answer the questionnaire that about using IT in class or e-learning (Table 3, fig. 3).

The survey was designed where the pros and cons of Immersive technologies could be visualized, and in such a way that each teacher responded with a degree of satisfaction, classified in five blocks from lowest to highest satisfaction in:
• Strongly disagree (SD);
• I do not agree (D);
• Agree (A);
• Totally agree (TA) (this block is not shown in Table 3 because none of the teachers marked it).

Table 3
The results of teachers' survey on their attitudes about using IT in class or e-learning

I will to use in my class	strongly disagree (%)	disagree (%)	agree (%)	totally agree (%)	Important teachers' comments
Google Expeditions	8,4	32,8	58,8	-	used to explain new topics, very motivating students to learn
MERGE Cube	11,2	26,7	62,1	-	the tool is more popular with students from 7 to 11 years

	SD	D	A	TA	Comments
Robotics in VR	28,4	37,5	34,1	-	difficult to use because it is necessary to have accessories as VR helmets with two controllers or VR glasses are some models
Virtual museum	17,4	17,2	65,4	-	used to explain new topics, very motivating students to learn
Nano2d	-	12	88	-	students can to investigate immersive hundreds of two-dimensional materials of their atomic structures, electronic band structures (both 2D and 3D), as well as phonon spectrum and vibrational modes
Virtual iSCool	-	67,3	32,7	-	it is interesting tool, but needs more detailed instructions and guidelines
ClassVR Physics	-	56,7	43,3	-	it is interesting tool, but needs more detailed instructions and guidelines
inCell VR	-	23,7	76,3	-	an interesting game that motivates students to deepen their knowledge of cells

The results of teachers' survey on their attitudes about using IT in class or e-learning (%)

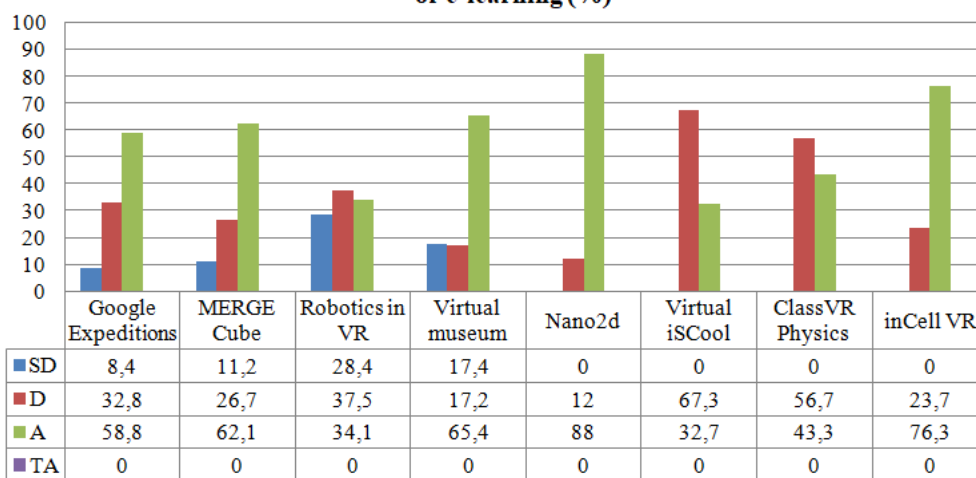|	Google Expeditions	MERGE Cube	Robotics in VR	Virtual museum	Nano2d	Virtual iSCool	ClassVR Physics	inCell VR
SD	8,4	11,2	28,4	17,4	0	0	0	0
D	32,8	26,7	37,5	17,2	12	67,3	56,7	23,7
A	58,8	62,1	34,1	65,4	88	32,7	43,3	76,3
TA	0	0	0	0	0	0	0	0

Figure 3: Diagram of the results of teachers' survey on their attitudes about using IT in class or e-learning)

According to the results of the survey of teachers about using IT in class or e-learning, the most understandable and used are such IT: Nano2d, inCell VR,Virtual museum, Google Expeditions, MERGE Cube. WE can highlight the main advantages of IT:

- providing the ability to change the relative size of the pre-investigated objects, which leads to the visualization of objects of the micro and macro world;
- creation of models of the phenomena or processes which cannot be directly and clearly registered by bodies of senses of the person;
- visualization of abstract models and production of objects that have no form in the real world;
- focusing students on the study of specific objects without distraction to external stimuli, which gives them the opportunity to focus fully on the material.

5. Conclusions and prospects for further research

Immersive technologies can be used as a supplement, but not as a complete independent training course. They should be used in the study of the most complex topics of various subjects and for training of professional skills in various activities. These tools significantly improve the learning process and students' perception of scientific material, expand their opportunities for research, laboratory work, etc. Each of the Immersive technologies needs specific instructions and guidelines for their implementation in school and in a particular subject.

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