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USING VIRTUAL REALITY IN SUPPORT STEAM APPROACH FOR GENERAL SCHOOL

Abstract. The article considers the main possibilities of virtual reality tools to support the STEAM approach in general education institutions. The focus is on the benefits of virtual reality for the implementation of STEAM education. The statistics of the law firm Perkins Coie LLP and XR Association «Determining the role of industry in the future of immersive technologies» on the research of the implementation of augmented and virtual realities in 2019. The attitude of teachers of general education institutions of Ukraine to the use of virtual reality in the implementation of the STEAM approach is analyzed. Particular attention is paid to VR applications for the STEAM approach in general school. Some virtual reality applications for general education institutions are offered, such as Google Expeditions, 3D Organon Anatomy, Lecture VR, StarTracker VR-Mobile Sky Map, Nano2d, VR Roller Coaster, Volumetric oscilloscope, Calcflow and others. We concluded that the use of virtual reality opens up many new opportunities in learning and STEAM education that are too complex, time consuming or expensive with traditional approaches. Virtual reality is able not only to provide information about the phenomenon itself, but also to demonstrate it with any degree of detail. A virtual educational environment is a creative environment in which learning is possible with the motivation of students, their emotional uplift and a positive, optimistic mood. A necessary condition for the use of a virtual educational environment is the implementation of a personality-oriented approach and the development and improvement of teaching methods, in particular in the fields of STEAM. Prospects for further research are the design of the STEAM model of oriented educational environment using virtual reality tools.

Key words: virtual reality; STEAM approach; STEAM education; general school; information communication technology.

Introduction. Information Communication Technology (ICT) significantly affect various areas of human life, including education. Teachers and researchers focus on bridging the gap between formal and non-formal education, learning in a real classroom and distance or online. One of the ways to this process is to introduce augmented and virtual reality into the learning process, in particular to support STEAM approach in education.

In general, STEM-oriented education mostly technical competence [1]. However, innovative problem solving requires implementation creative thinking, a holistic approach that combines an artistic component with technical skills [2].

The STEAM approach is transdisciplinary pedagogical approach through which students are given the opportunity, through the use of the project method, and the relationship between exposure to the arts and performance in Science, Technology, Engineering, and Math (STEM) subjects, to independently solve the real problems, that may arise in the teaching tasks set by the teacher, during which the teacher carries out the role of facilitator [3].

Under the quarantine of 2020, introduced to stop the COVID-19 pandemic, distance learning has become an alternative to the traditional in educational institutions of various levels. This situation has significantly affected the ways in which the STEAM approach is implemented in the general school.

A significant problem is in the organizing practical, laboratories, science school expeditions for STEAM education. Therefore, the main task of our study is to replace real learning with virtual reality (VR) as an immersive technology and are the possible approaches in terms of distance learning and quarantine.

Although VR is typically associated with gaming and the overwhelming majority of VR users play such games, the platforms also offer applications VR education programs that are widely available to everyone and in any location.

VR does not change the fact that teaching is a function of the teacher. It can only complement the learning process, not completely replace the teacher. But it provides many tools to demonstrate 3D projections, encourage remote learners, use interactive whiteboards, organize hands-on activities, and more.

The research objective of this work was to investigate the use of VR in support of STEAM teaching.

The purpose of the article is to analyze the use of virtual reality in support of STEAM approach for general and to identify the basic requirements for supporting implementation and development of STEAM education in Ukraine. To achieve the purpose of our study 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 VR for STEAM approach in general school; synthesis and generalization to formulate the main points of the study; interpretation of the research results.

Results. The vast majority – 86 % – of respondents (the survey was completed by 200 respondents) to the 2019 Augmented and Virtual Reality Survey Report agreed that by 2025, VR and AR technologies will be as ubiquitous as mobile devices (Fig. 1) [4, p.6].

It is also important to note the respondents' answers to the questions: «In which industries do you believe XR is most applicable at this time?» (Fig. 2) [4, p.13].

The answers in Diagram on figure 2 indicate that the most popular XR are for games (61%), medicine (41%) and education (41%).

It is probably no surprise that gaming is once again seen as most promising area of development. But respondents provided a fairly diversified look at promise in other industries, especially with regard to healthcare and medical devices, education, manufacturing and automotive (23%), movies and television (21%), and military defense (15%).

Fig. 1. Diagram respondents' answers to the statement: «By 2025, AR/VR/MR/XR will be as ubiquitous as mobile devices in the consumer market»

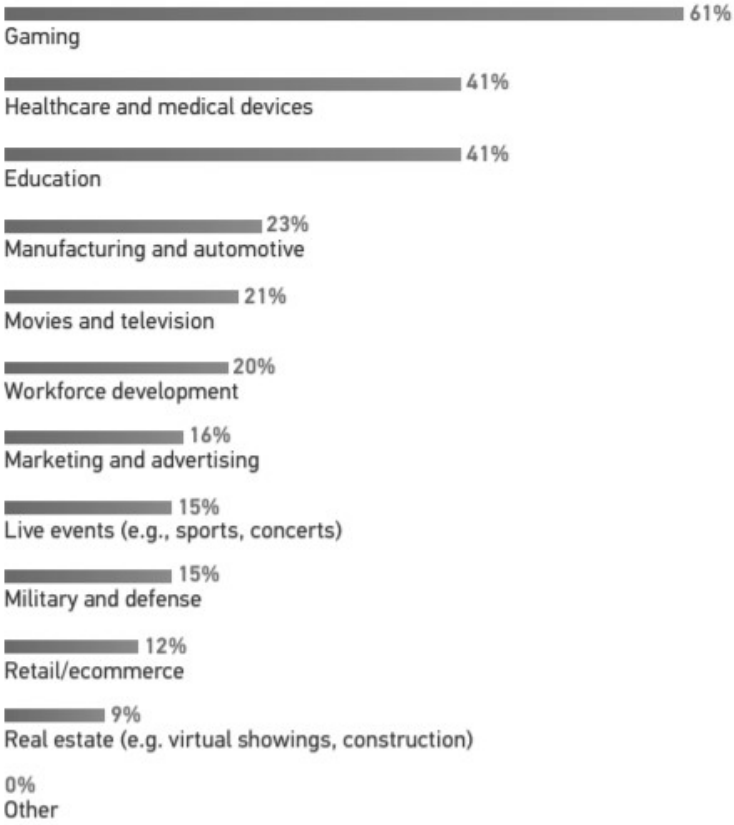

Fig. 2. Diagram respondents' answers to the questions: «In which industries do you believe XR is most applicable at this time?»

We conducted the surveys in 2020, distributed in online format among 24 teachers from a Primary Education school and 90 teachers from Secondary General Education three schools (Levels I-III N1 in Brovary, Semipolkivskyi Secondary School of the 1st-3rd Grade and Specialized school № 181 named after Ivan Kudrya (Ukraine), the data were collected and a statistical study was carried out among all the teachers surveyed.

The questions of the questionnaire concerned the attitude of teachers to the use of virtual reality for the implementation of the STEAM approach in teaching.

Therefore, the teachers' responses have computed and the percentage represented by each sentence represented in each of the educational centers has calculated and thus be able to make a comparison of the results in each of the educational environments (Table 1).

According to the survey results on teachers' understanding VR to be provided for supporting the STEAM approach in general school teaching process, the teachers are not highly interested in using VR in STEAM education. At the same time, the results were found out to show certain teachers' interest in the using VR in STEAM education. Despite not very high percentage of positive results, 72 teachers, who participated in the questionnaire, reported on their readiness to use VR technology in their lessons. This data gave us the impetus to create, organize and conduct a training project with using VR.

Discussion. Researchers [5; 6; 7] identify the following main benefits of using VR technology in education, in particular for supporting the STEAM

Table 1.

The results of teachers' survey on their attitudes and understanding virtual reality for STEAM education (2020).

	Strongly disagree (%)	Disagree (%)	Neither agree nor disagree (%)	Agree (%)	Strongly agree (%)
I have a clear understanding of what virtual reality is and how I can it integrated with STEAM education in my class	18,0	37,0	12,0	29,0	4,2
I have heard colleagues talking about virtual reality for STEAM education	13,0	24,0	19,0	36,0	7,4
I have talked with colleagues about virtual reality for STEAM education	18,0	35,0	14,0	33,0	0,0
I can employ teaching approaches with virtual reality that foster integrated STEAM education	18,0	43,6	25,5	12,7	0,0
Total (N= 114)					

approach in general school etc.:

- Visibility: using 3D graphics, you can show in detail any model, for example, the chemical processes up to the atomic level;
- Security: you can immerse the user in any of the activities, such as heart surgery, high-speed train control, spacecraft, etc. without endangering life;
- Focusing: the virtual world, which surrounds the viewer on all sides in all 360 degrees, will allow you to fully focus on the material and not be distracted by external stimuli;
- Involvement: VR allows you to change scenarios, influence the course of the experiment or solve the problem in a game and understandable form, for example, during a virtual lesson you can see the world through the eyes of a historical character or go on a journey;
- Virtual lessons: providing a sense of presence and participation in the virtual world.

We offer the following examples of VR applications for STEAM approach in general school in the table 2.

Table 2.

Examples of VR applications for STEAM approach in general school

VR	Subjects	Short description
Google Expeditions	history, language, astronomy, physics, geography, biology	expeditions explore history, science, the arts, and the natural world
3D Organon Anatomy	language, anatomy, biology	the multi-user and cross-platform module allows educators to deliver 3D anatomy sessions where students can interact via voice and text chat and will be able to follow the anatomy instruction in real time
Lecture VR	history, language, astronomy, physics, geography, biology	allows to recreate any historic lecture from the past or record any current live lecture
StarTracker VR-Mobile Sky Map	physics, astronomy	maps 3D Star Field into a sphere surface
Nano2d	language, chemistry, biology	the virtual environment for studying two-dimensional materials, serving as an educational and research tool for advanced materials science
VR Roller Coaster	physics	illustrates potential and kinetic energy
inMind2	language, anatomy, biology, chemistry	is an action VR game with a decision-making strategy and neuroscience of the human brain
HandWaver	math, art	is a gesture-based virtual mathematical making environment where learners at all levels can use their hands to act on mathematical figures directly, without mediating their intuitions through equations, keyboards, or mouse movements
Volumetric oscilloscope	math, art, physics	is an audio-responsive oscilloscope in a cubic format, the X and Y axes being left and right channels, and the Z axis being temporal
Calcflow	math, art, physics	is for create double integral of a sinusoidal graph in 3D, own parametrized function and vector field

It should be noted that teachers should use these VR applications according to the topics of the lessons, the goals of the educational projects, the wishes of the students and other impact factors.

Conclusions. The use of virtual reality opens up many new opportunities in learning and STEAM education that are too complex, time consuming or expensive with traditional approaches. Virtual reality

is able not only to provide information about the phenomenon itself, but also to demonstrate it with any degree of detail. A virtual educational environment is a creative environment in which learning is possible with the motivation of students, their emotional uplift and a positive, optimistic mood. A necessary condition for the use of a virtual educational environment is the implementation of a personality-oriented approach and the development and improvement of teaching methods, in particular in the fields of STEAM. Prospects for further research are the design of the STEAM model of oriented educational environment using virtual reality tools.

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ВИКОРИСТАННЯ ВІРТУАЛЬНОЇ РЕАЛЬНОСТІ ДЛЯ ПІДТРИМКИ STEAM ПІДХОДУ В ЗАКЛАДАХ ЗАГАЛЬНОЇ ОСВІТИ

Анотація. У статті розглядаються основні можливості засобів віртуальної реальності для підтримки STEAM підходу в закладах загальної освіти. Зосереджується увага на перевагах віртуальної реальності для впровадження STEAM освіти. Надаються статистичні дані юридичної фірми Perkins Coie LLP та XR Association «Визначення ролі промисловості в майбутньому імерсивних технологій» про дослідження щодо впровадження доповненої і віртуальної реальностей у 2019 році. Проаналізовано ставлення вчителів закладів загальної освіти України щодо використання віртуальної реальності при впровадженні STEAM підходу. Особливо звертається увага на додатки VR для підходу STEAM в загальній школі. Запропоновані деякі додатки віртуальної реальності для закладів загальної освіти, як Google Expeditions, 3D Organon Anatomy, Lecture VR, StarTracker VR-Mobile Sky Map, Nano2d, VR Roller Coaster, Volumetric oscilloscope, Calcflow та інші. Зроблено висновок, що використання віртуальної реальності відкриває багато нових можливостей у навчанні та STEAM-освіті, які є занадто складними, трудомісткими або дорогими за традиційних підходів. Віртуальна реальність здатна не тільки надати інформацію про саме явище, але і продемонструвати його з будь-яким ступенем деталізації. Віртуальне освітнє середовище − це творче середовище, в якому навчання можливе з мотивацією учнів, їх емоційним піднесенням та позитивним, оптимістичним настроєм. Необхідною умовою використання віртуального освітнього середовища є впровадження особистісно орієнтованого підходу, розробка та вдосконалення методів навчання, зокрема у сферах STEAM. Виокремлено основні переваги використання технології VR в освіті, зокрема для підтримки підходу STEAM у загальній школі, як наочність, що можете детально показати будь-яку модель, наприклад, хімічні процеси до атомного рівня; безпека, що можете занурити користувача в будь-яку діяльність, наприклад, на операції на серці, керування швидкісними поїздами, космічні кораблі тощо, не загрожуючи життю; фокусування уваги, що надає можливість зосередити увагу учня на матеріалі і не відволікатися на зовнішні подразники та інше.

Ключові слова: віртуальна реальність; STEAM підхід; STEAM освіта; загальна школа; інформаційні комунікаційні технології.