AV and VR as Gamification of Cognitive Tasks

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Abstract. The paper presents a comparative analysis of the functionality of mobile applications of the augmented reality Da Vinci Machines AR, Electricity AR, Bridges AR, Geometry, the collection of VR models VictoryVR Science Curriculum and the digital collection Mozaik. The possibility of using these tools for educational purposes is explored, in particular, to construct cognitive tasks for students during the study of subjects in the natural and mathematical cycle. The indicated shortcomings are stated, didactic requirements for such educational activities are formulated. Among others, attention is focused on the following indicators: hardware, usability, variability of model parameters, interactivity, interdisciplinary use, and the ability to activate certain cognitive actions of students, degree/form of gamification. The educational potential of using interactive models and video is analyzed for both group and individual work with students. Examples of methodical developments are given.

Keywords: learning environment, gamification, virtual reality, augmented reality, synthetic learning environment.

1 Introduction

Appearance of NBIC (nano-, bio-, info- and cognitive) technologies create a new environment for human life and assist the fundamentally new instruments of the techno-evolutionary process. Naturally, it is pedagogy with which scientists associate their hopes with the creation of the concept of combining the humanistic and technological components of the educational process, creating a positive integrated reality, provided convergence of physical and virtual learning environments.

We believe, the positive potential of the information and education environment saturated with digital technologies can be manifested primarily in the growth of cognitive activity of every learning subject. If students learn the information images, in particular real-life phenomena and processes, by experimenting with different digital instruments and technologies (simulation, computer simulation, complemented reality, etc.), this will provide creative activity in the integrated (real and virtual) learning environment.

Trends of modern corporate learningб such as virtual and augmented reality, artificial intelligence, including the use of chat bots, knowledge bases, video content creation, micro curriculum and mobile learning, affect the evolution of tools, forms

and methods of teaching in general education [1].

The modern trends of corporate learning are virtual (VR) and augmented (AR) reality, micro curriculum and mobile learning. They influence the evolution of tools, forms and methods of teaching in general education.

The article deals with the analysis of AR and VR means for the purpose to construct cognitive tasks in learning process.

2 Related Work

The authors reviewed the problems of introducing a synthetic learning environment in the practice of education. Particular attention is paid to a range of issues that are united in the English-language publications as a "synthetic environment", which is considered in two aspects: artificial environment and synthetic one as formed due to the synthesis of the real physical world and the results of simulation and modeling. There are considered issues of trends in usage of game-based learning and modeling as cognitive technologies [2]. The research uses the description of the peculiarities of the organization of students work using a computer modeling system, individual and group work is given, the aspect of motivation of students to study is considered [3].

In modern philosophy, the phenomenon of virtual reality is investigated in a wide range, but most of the concepts relate to the assessment of the impact of virtualization and the human nature. G. Reinhold speaks about virtual reality as a "new world", a new parallel reality. Virtual reality, from his point of view, can be regarded as a magic window that allows you to look into other worlds, whether they are the world of molecules or the world of our fantasies [4]. VR is considered by scientists from the standpoint of engineering psychology of human-machine interfaces, and also became the subject of anthropological and social studies.

Not all 3D visualization systems can be classified as VR. The main features of the following: an image is stereoscopic; an image accords with the coordinates of the visual sensors; a system is equipped with a bidirectional interface (input - coordinates of healthy sensors, output - image); a short time that does not exceed 1/16 second to refresh the image in response to the change of coordinates of the sensors [5].

Gamification as a research trend in education has appeared relatively recently, it is based "on the intersection" of psychology, behavioral economics, management, and game design. To date, the most cited publications are the works of M. Barber, J. McGonigel, D. Clark, Lee Sheldon, K. Verbach. According to Kevin Verbach's book "For the win: How game thinking can revolutionize your business": "Gamification is the use of elements and techniques from video game design in non-game contexts." [6]. Among the various forms of gamification (competition, game without winner and aesthetics) [7], we have focused on creating a general game impression that promotes emotional engagement, the ability to make the task more understandable, to clarify the nature and effectiveness of the phenomenon in action, to enhance the visualization of results, to strengthen the mental development. Our point is to use AV/VR for this.

By exploring some of the aspects of gaming, we propose to distinguish clearly "learning in the form of games" (or game-based learning) and "gaming technology in

learning." We consider awards, badges, scoring points, rating and team work as features of Game-Based Learning. The main weapon of Game-Based Learning is a simulation that can be both digital and non-digital.

The use of the game form is a wide field of pedagogical discussions. The subject of our study is use of gaming techniques, tools and applications with a clearly defined goal of learning and a corresponding pedagogical result, that are characterized by educational and cognitive orientation. Creation of educational situations, acting as a means of encouragement, encouraging students to cognitive activity are in focus of our scientific interests. Successful implementation of VR/AR technologies as learning tools has certain pedagogical backgrounds, including the creation of technically complex content and its methodological support.

3 Research Methodology

We used the theoretical findings of scientists regarding informatization of education (V. Bykov, R. Gurevich, M. Zhaldak, A. Gurzhiy, etc.) and scientific and education principles of formation and use of information learning environments (V. Bykov, Yu. Zhuk, V. Olijnyk, Ye. Polat, etc.). Also, the comparative methods are used to study the phenomenon of virtual reality in concepts of M. McLuhan, M. Castells, A. Toffler and H. Rheingold.

Several theoretical methods are represented in the study: analysis of research problems in scientific publications; study of the experience of using VR and AR in the learning process, methods of comparative analysis, and methods of mathematical statistics for processing quantitative characteristics of phenomena under research.

The theoretical basis of pedagogical research appears to be a system-activity approach in education (L.S. Vygodsky, A.N. Leontiev etc.).

The results of research and practical experience of Ukrainian and foreign teachers and researchers in the field of computer-based training technologies prove the adequacy of the chosen research methods and the relevance of the problem.

4 Results and Discussion

According to the report "Virtual reality and its potential for Europe" [8], education is one of the priority directions of VR technologies application.

Different sources can distinguish types of VR systems, the delimitation of which lies in the plane of methods and modes of their interaction with a user: "*Window to the World*", *Videocameras, Diving systems* creates a sense of presence and Systems of *remote presence* uses connections of remote sensors, located on any object in the real world, with the operator.

In our opinion, although the virtual reality creates the effect of full immersion, the augmented reality will find more use in schoolchildren education. The technology of augmented reality can be considered more democratic, since a user only has to have a smartphone. In contrast, one needs special tools to complete VR course: helmet or virtual reality glasses, and a variety of manipulators that capture the user's hand and gestures and give him more control over the environment.

According to study findings, abuse of VR faces a problem called cognitive overload or information overload at a cognitive level [9]. In response to cognitive overload, cognitive distortions, for example loss of objectivity in selective perception, may occur. Augmented reality introduces only some artificial elements in the field of perception in order to supplement the information about the environment and improve the perception of information. Usage of AR gives a sense of the real location and interaction of objects with the world. In our opinion, this is a positive difference between the augmented reality and the VR.

At Google I/O 2018 in Mountain View, the head of the AR and VR department of Google Clay Bavor made a point that the VR/MR/AR/RR are not distinct and clearly defined. These are "convenient shortcuts for different points of a spectrum".

We have carried out a comparative analysis of functional capabilities, hardware requirements, educational applications of mobile tools of augmented reality (Table 1).

Table 1. Comparison of mobile applications for education using AR and VR

Software	Equipment	Payment	Subjects	Loading
mozaBook, mozaWeb (*)	Tablet, VR-glasses	Paid, free+ Demo	All	AS, GP, MS
GeoGebra Augmented Reality (*)	Smartphone, tablet	free	Maths	AS
A Google Expeditions (*)	VR-glasses	free	Geography	AS, GP
Star Walk, Star Walk2	Smartphone, tablet, VR-glasses	Paid, free& advertising	Astronomy, Environmental Studies	AS, GP, MS Amazon
The Brain AR App	VR-glasses optional	free	Human anatomy	AS, GP
Human body (male) educational VR 3D	Smartphone, VR-glasses optional	free	Human anatomy	GP
Da Vinci Machines AR	Smartphone, tablet	free	Physics	AS, GP
Electricity AR	Smartphone, tablet	free	Physics	AS, GP
Bridges AR	Smartphone, tablet	free	Maths	AS, GP
Geometry - Augmented Reality	Smartphone, tablet	free	Maths	AS, GP
VictoryVR Science Curriculum	Smartphone, tablet	free	Biology,Environ-mental Studies	AS, GP
Geometry AR	Smartphone, tablet	paid	Maths	AS, GP

Note: (*) means Ukrainian version of the tools App Store (AS), Google Play (GP) and Microsoft Store (MS)

Consider some of them in more detail.

The Brain AR App (https://www.harmony.co.uk/project/the-brain-in-3d/) contains mono-object models. It allows to study a human head, ranging from the skin, muscles and skull to inner regions of the brain. The appearance is recommended to be considered in AR mode, the internal structure of the brain can be studied in two modes of VR and AR as well. The program has an intuitive interface, but its use involves explaining from the teacher. The student remains an observer.

Geometry - Augmented Reality (https://itunes.apple.com/us/app/geometry-augmented-reality/id1309016689?mt=8) creates opportunities for active students' action. The set of models is small enough (dot, straight line, triangle, quadrilateral), but a student creates them independently by moving markers in the real world and analyzing a result in the augmented world on the screen. The application is designed for initial assimilation by geometric shapes. Gaming equipment is rational.

Geometry AR is a tool for viewing and exploring geometric figures (https://itunes.apple.com/us/app/geometry-ar/id1329101716?mt=8). This is an application with a similar previous name, but with another functionality. Children can view flat and solid figures by moving, rotating them and examine them from all sides.

Students use a slider or arrow buttons to move around the list of more than 25 figures studied in the course of geometry of the secondary and high school, as well as some algebraic curves (torch, ellipse, parabola, and hyperbole). The program contains reference materials with the possibility of audio text.

The Geographies' Augmented Reality app gives extraordinary opportunities for modeling and analyzing 3D objects, including surfaces created by rotating function graphs around the x-axis. It suit for classes with in-depth study of mathematics (https://itunes.apple.com/us/app/geogebra-augmented-reality/id1276964610).

This is an example of algorithmic models (demonstration of the implementation of a given algorithm) with the ability to make changes to the parameters.

5 Concluding Remarks and Future Work

The educational potential of the use of interactive models and video available through mobile applications is analyzed. The overall game experience with the use of VR / AR technologies promotes emotional involvement of students, availability of educational material, improves visualization of results of the analysis of individual characteristics of the study subject, and activates mental development.

We prefer to use the effects of complemented reality as more accessible and less traumatic for the psyche of a young person.

The task is not to entertain the student, but to find new means, provide modern tools of activity – visual means of complementary reality technology, create educational situations that act as a means of motivation, stimulate students to cognitive activity, prepare students for life and work in the high-tech information society. Thanks to improving the visibility of the educational material and its interactivity, it is possible to conduct previously unreachable practical work.

The analysis of programs focuses on the following indicators: hardware, usability, variability of model parameters, interactivity, interdisciplinary, the ability to activate

certain cognitive actions of students, the degree of gaming.

Problems that require further research in this area are: increasing success of learning, pace of learning the material, apparent expansion of visual capabilities, the development of educational skills, psychophysiological "cost" of cognitive workload under different factors [10], especially in immersive environment.

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