EFFICIENCY AND ADVANTAGES OF TEACHING CHEMISTRY BASED ON 3D TECHNOLOGIES (FOR ENGINEERING STUDENTS)

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Abstract. *In the article, teaching based on 3D technologies, Augment reality-Augment reality (AR), Virtual reality Virtual reality (VR), Mixed reality Mixed reality (MR), programs focused on effectiveness in teaching chemistry.*

Keywords: *virtual education, Augment reality (AR), Virtual reality Virtual reality (VR), Mixed reality Mixed reality (MR), 3D virtual environment, virtual reality.*

In October 2019, the concept of developing the higher education system of the Republic of Uzbekistan until 2030 was adopted in our country. This document was based on tasks such as the development of integration of science, education and production in order to accelerate intellectual development, train competitive personnel, effectively organize scientific and innovative activities, and strengthen international cooperation. The content of the concept reflects the priorities of the reform of the higher education system of our country. In it, expansion of the coverage level and improvement of the quality of education in higher educational institutions, introduction of digital technologies and educational platforms, involvement of young people in scientific activities, formation of innovative structures, commercialization of scientific research results, achievement of international recognition and many other specific directions are defined. All this serves to raise the educational process to a new level of quality [1].

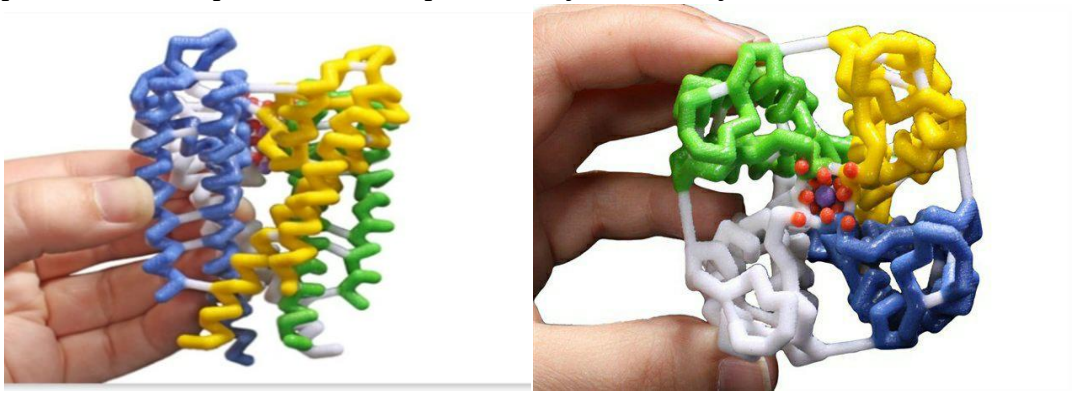
The encouraging speech of our President Shavkat Mirziyoyev at the solemn ceremony dedicated to the Day of Teachers and Trainers is proof of this. As the head of our state noted, we set ourselves the main goal of creating a new renaissance in Uzbekistan, i.e. the foundations of the third renaissance, through large-scale democratic changes, including educational reforms[2].

In chemistry teaching, molecules are traditionally represented in 3D programs and drawn in 2D on paper or whiteboard, i.e. on the screen. However, the conceptual transition from 2D to 3D (i.e., spatial ability) is essential for understanding chemistry. This is a process that interests many university students and they should practice it by visualizing atoms, molecules and reaction mechanisms. We want to study how university students perceive the use of 3D technologies and Virtual reality (VR), Augment reality (AR) technology in chemistry education and the impact on the quality of knowledge they receive. More specifically, we want to highlight in more detail what opportunities and difficulties students face when using AR technology in order to strengthen the transition from 2D view of molecules to 3D structure described by AR glasses [3].

In chemistry lessons, when students do not have the opportunity to see chemical reactions, ongoing processes, and laboratory activities, 3D printers can be used to make models of chemical production enterprises, to see and imagine chemical processes [4]. In addition to viewing these processes virtually, they can also perform them interactively. The main thing is that in the conditions where working with explosives is dangerous, these virtual laboratories can be very useful [5]. The good thing is that the knowledge the students get and their understanding of the subject will be significantly wider [6].

Picture-1. In this figure (a) chemical apparatus for interaction with the monitor or

Displays 3D models and users can watch a video of organic chemical theories before the experiment; (b) displays user instructions or chemical reaction schemes that users can read before testing; (c) shows how to mix the chemical into a flask containing a stirrer and (d) shows how to start the reaction by turning on the stir button and the heating button [7]. *3D printers* are three-dimensional printing equipment technology. We can print any item or object on paper, and with the help of modern 3D printers, we can produce any item in any size [8].

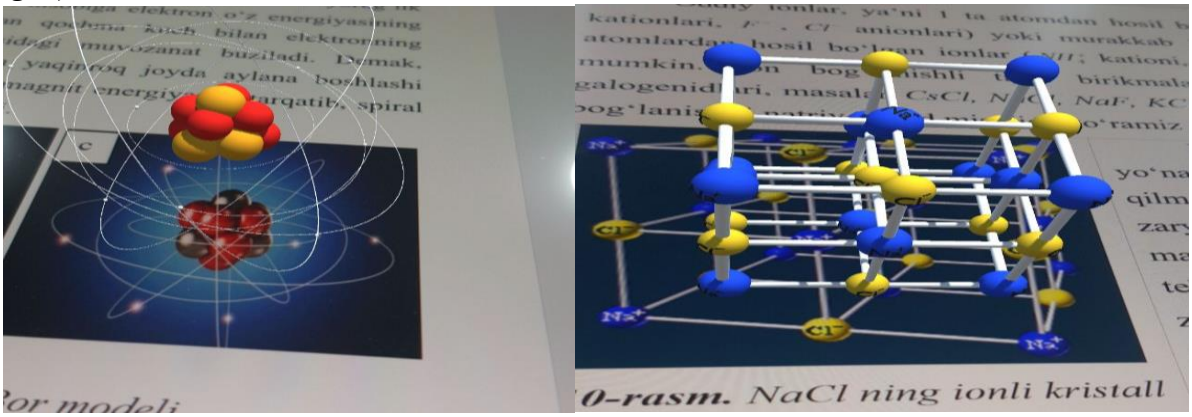


Picture-2. Models of proteins developed using 3D printers

It can be difficult and time-consuming for technical students to step outside of traditional teaching methods to learn how to use and use "new" technologies, but these technologies we will consider the advantages of using [3] [9].

- Increasing students' interest in science
- Use of modern pedagogical and information technologies
- Improving the quality of education students receive
- Training of qualified personnel in line with global requirements

Augmented reality (AR for short) is the creation of additional information about the environment by inputting information in the form of various sensors on the plane. This technology can give us the opportunity to scan the surrounding 3D objects and identify the surrounding objects. There is some plane around you [10]. With the help of augmented reality technology or specially developed programs, you can place a 3D object on the same plane as in real life [11], (Fig. 3).

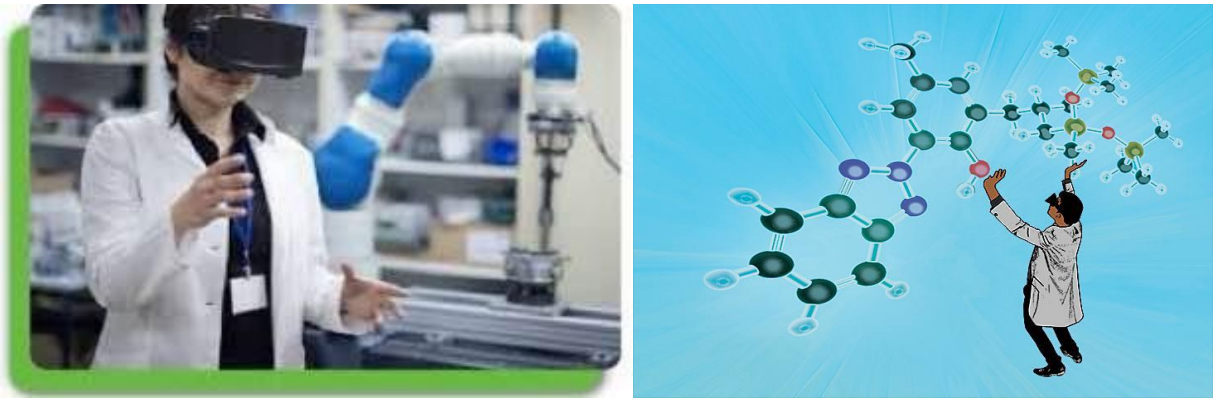


Picture-3. Interactive electronic textbook created on the basis of 3D software and AR technologies

Various digital and advanced technologies are used in higher education in order to increase the activity and interest of students in cognitive thinking and affective education, and this idea not only increases the effectiveness of the knowledge gained in classes, but also brings many conveniences [12]. [13].

Virtual reality (VR, English: virtual reality, VR, artificial reality) is a world created by technical means, transmitted to a person through his senses: sight, hearing, touch, etc. Virtual reality simulates both impact and reaction. Perform virtual reality and computer simulation of real-time reactions for a robust set of reality experiences. [14].

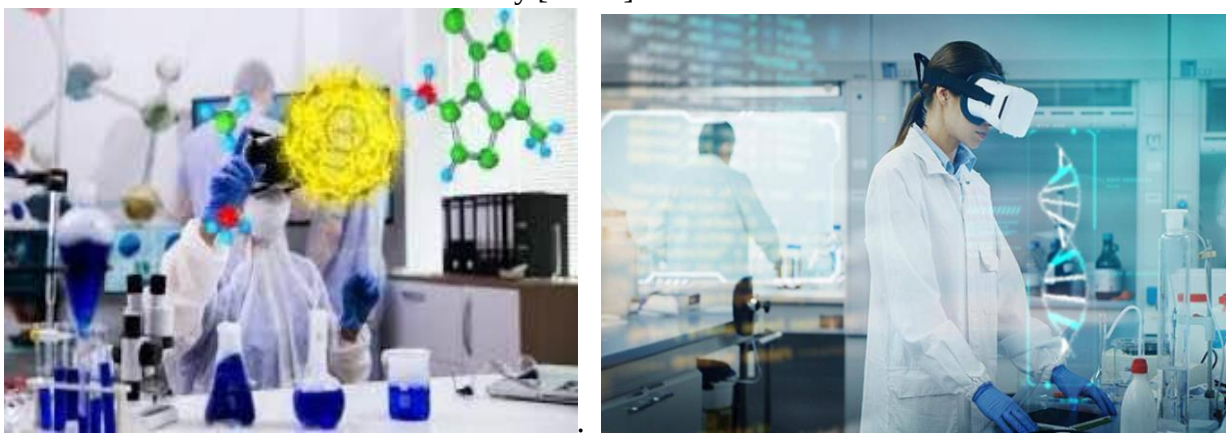
The power of virtual objects is kept close to the security of an object similar to the reality of material reality. In addition to effectively helping chemical processes in the study of reactions, virtual world users can often use them for other purposes as well [15].



Picture-4. Interactive approach to chemistry lessons based on 3D software and VR technologies

MR (Mixed Reality) is a further development of VR and AR to enhance the realism of the user experience. It can be said: MR = VR + AR = virtual world + digital information + real world. It is also a combination of virtual and reality. The digital information developed by MR technology can also use the real world as a carrier, and it is three-dimensional and more realistic. The difference between MR and AR is that in the world of MR, the virtual objects presented in the real world are not displaced as the player's position changes. Their positions are actually relatively stable. In the developed MR world, users cannot distinguish which is a virtual object and which is a real object[16].

Using 3D projections and simulations in all areas of education, including chemistry, students can interact with virtual objects and manipulate them to learn in detail [17]. If university students use Mixed Reality (mixed reality) to study chemistry, it even allows teachers to teach and communicate with their students remotely [18-19].



Picture-4. Chemistry lessons based on MR technologies and programs

Virtual educational technologies and distance learning technologies in education solve such tasks as developing individualized educational methods, forming and improving the student's knowledge, and determining the level of acquired knowledge. The use of distance learning

technologies in the educational process has a strong impact on the positive changes in the content, forms and methods of education [20-21].

Therefore, the education system is being consistently developed in order to educate young people to be knowledgeable and competent, to train experts in line with world development. The initial reforms in the field of higher education focused primarily on increasing coverage, improving the financial condition of institutes and universities, and providing financial support to professors and teachers.

The use of 3D virtual software in chemistry has more potential benefits for improving the quality of education and student engagement.

Therefore, the interaction in the virtual world increases the students' engagement in the online class, as well as the students' sense of connection and understanding with the chemical processes taking place.

Students are more likely to engage in discussions in the virtual world than in a face-to-face class. The most important benefit of using the virtual world is the opportunity to use more discussion situations, instant messages or e-mail than traditional face-to-face classes.

The virtual world offers many interesting opportunities for students who want to explore new educational tools and resources in teaching. From our experience creating a virtual chemistry classroom, we know that 3D graphics are a powerful tool for visualizing and understanding complex and abstract information.

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