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POSSIBILITIES OF USING VIRTUAL REALITY IN TEACHING CHEMISTRY: A 3D LABORATORY EXPERIENCE IN BLENDER

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Abstract
The integration of Virtual Reality (VR) technology into the educational process has fundamentally transformed traditional teaching methodologies, especially in experimental sciences such as chemistry. This study examines the development and implementation of a 3D laboratory created using Blender software, allowing chemical reactions to be conducted in a safe environment. Furthermore, it provides opportunities to save resources. The results indicate that VR technology increases students' engagement, conceptual understanding, and motivation by offering experience-based learning in a virtual environment.

Keywords: Blender, 3D laboratory model, VR chemistry.

Introduction

In recent years, large-scale integration of modern technologies into education has led to significant changes in traditional teaching methodologies. One of the most promising directions in this process is the use of Virtual Reality (VR) technologies. VR provides students with immersive learning experiences and actively engages them in the learning process.

Chemistry, being an experimental science, requires laboratory activities to reinforce theoretical knowledge through practical work. However, establishing fully-equipped chemistry laboratories in schools and educational institutions presents a number of challenges. High financial costs, safety issues, and limited technical capabilities can complicate the process. Under such conditions, VR-based laboratory simulations serve as an effective alternative, offering students a safe, interactive, and resource-efficient environment for conducting experiments. Traditional chemistry teaching primarily relies on textbooks and theoretical explanations, which often fail to stimulate student engagement, make visualization of molecular processes difficult, and lower motivation. For this reason, VR

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simulations based on high-quality 3D models play an important role by enabling interactive execution of chemical reactions. In this regard, the Oculus Quest 3 produced by Meta stands out as an effective technological solution. The aim of this study is to design a 3D chemistry laboratory using Blender software and integrate it into a virtual reality environment to increase the effectiveness of chemistry education. This approach allows students to safely perform experiments, connect theory with practice, and gain deeper understanding while reducing reliance on physical laboratory resources.

Literature Review

Although VR has been researched in education for decades, its large-scale implementation remains limited due to technological and organizational barriers. Systematic reviews show that researchers mainly focus on motivational effects of VR, relying on constructivist pedagogy, collaboration, and gamification approaches [1]. VR education is based on three principles: immersion, interactivity, and user participation. While non-immersive VR is more accessible, immersive VR has faced implementation challenges due to cost and technical complexity. However, commercial VR devices like Oculus Rift have recently expanded its use in higher education [2].

VR allows interaction with virtual environments through multiple sensory channels, making it a powerful educational tool. Despite its advantages, VR also presents challenges such as technological limitations and accessibility issues [3]. Researchers emphasize the need to align VR environments with pedagogical principles to ensure effective learning [4]. Recent technological advancements have reduced the cost of VR systems, making them more accessible for educational institutions. For example, a study comparing VR-based astronomy learning with mobile-based learning found that VR provided higher engagement and active learning [5]. Moreover, the development of AR and VR technologies has supported innovative models aligned with 21st-century learning needs [6].

Methodology

This study utilized various digital tools, software, and devices to create and implement a VR-based chemistry laboratory environment. The primary tool used

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for 3D modeling was Blender due to its flexibility and high-quality rendering capabilities. The 3D lab included:

• Laboratory glassware — beakers, test tubes, Bunsen burner, pipettes, volumetric flasks, etc.

• Experimental simulations — chemical reactions, molecular interactions, and physical changes.

• Realistic visual effects — lighting, textures, and dynamic animations. Models were optimized for VR to ensure smooth real-time interaction. Meta Quest VR headsets were used for immersive exploration, offering high-resolution displays, hand-tracking controllers, and wireless movement.

Results and Discussion

A 3D chemistry laboratory and equipment were created using Blender [7]. Realistic physics and high-resolution rendering provided immersion and interaction. Blender's integration with VR platforms allowed seamless implementation. These findings align with previous research highlighting VR as a valuable alternative when physical laboratory access is limited [8].

Conclusion

This study highlights the significant potential of VR in enhancing chemistry education. Creating a VR-based chemistry lab using Blender demonstrates the possibility of building realistic, interactive environments for safe and efficient learning. The developed 3D lab was imported into Gravity Sketch and tested with VR headsets, enabling students to navigate and interact with laboratory tools. VR-based labs bridge the gap between theory and practice, offering an innovative model for STEM education.

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