Tomorrow's Classroom: Virtual Reality Chemistry Lab

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Keywords

Virtual Reality; User experience; eLearning; Game Development; Natural Language Processing; Artificial Intelligence; guidance

ACM Reference Format:
Alina Duca and Adrian Iftene. 2025. Tomorrow's Classroom: Virtual Reality Chemistry Lab. *ACM/IMS J. Data Sci.* 37, 4, Article 111 (August 2025), 2 pages. https://doi.org/XXXXXXX.XXXXXXX

1 Abstract

In the context of immersive technologies, the introduction of Virtual Reality (VR) in education opens up new perspectives for learning and teaching, allowing students to explore and interact with intuitively teaching materials and providing innovative ways to experience and understand complex concepts such as chemical reactions, the anatomy of the human body, the evolution of biological species, outer space, geological processes or historical events. This application shows how advanced technologies like VR can revolutionize the way students discover and understand information, allowing them to explore theoretical concepts visually and interactively. Through VR, theoretical notions become tangible and applicable, facilitating experiential learning that stimulates students' curiosity and active engagement. By creating a virtual laboratory, participants can directly experience the effects and dynamics of various chemical reactions without the risks associated with handling real substances. This approach not only increases student engagement and curiosity but also improves information retention and a deep understanding of chemical processes. Also, our solution shows how, by incorporating Artificial Intelligence algorithms in virtual environments, we can take the field of eLearning to a higher level.

2 Introduction

VR has made remarkable progress in multiple fields, revolutionizing the education [9], medical [1], gaming [7] [2] and entertainment [5] sectors. By using VR, chemistry becomes more immersive, allowing students to conduct chemical experiments in a safe, controlled, isolated and harmless environment. Introducing elements such as educational games or incorporating voice-controlled chatbots into eLearning VR applications adds a new level of digital interaction, improving personalization and accessibility. These innovations make learning more engaging and effective, facilitating a deeper understanding and application of chemical concepts for diverse user groups. The use of VR in chemistry teaching enables interactive exploration and real-time visualization of complex chemical reactions, thus providing a deeper and more intuitive understanding of abstract concepts that are difficult to illustrate by traditional methods.

This application proposes a laboratory where users can carry out chemical experiments, being guided by a robot through both written and verbal instructions, this functionality can be found within the application under the name of Learn to make reactions, this being one of the three main functionalities of the application. Also, our solution aims to incorporate advanced speech recognition and natural language processing (NLP) technologies, by incorporating a chatbot, this functionality being called Lab Assistant. One last functionality that must be mentioned here is the evaluation one, Test your knowledge, where users can test their acquired knowledge: both theoretical notions (from the robot's explanations and from what they can see during the reactions), as well as practical ones, here being able to test if they have understood the stages of making the reactions. Our approach not only improves personalization over traditional VR applications, but also leverages the immersive environment of VR to facilitate deeper and more meaningful user engagement in the learning process. Our contribution includes the creation of a VR application incorporating a realistic and immersive chemistry laboratory and an advanced conversational agent, demonstrating their ability to effectively optimize the delivery of educational content and respond to users' curiosities and concerns, whether related to theoretical notions, either by the context of the application. Preliminary feedback confirms the effectiveness of our system in meeting diverse user requirements, laying the foundations for a more integrated and accessible digital future. The paper will detail the development of the system, its innovative architecture and key findings from preliminary user interaction.

3 Results

To the question "How hard was it for you to do the chemical reactions?" 10% of the answers were neutral, 20% of the participants made the reactions easily, and 70% very easily, and to the question "How would you describe your experience with Learn to make reactions part?" all the answers fall into the "Very good" category. Also, all respondents stated at the end of the test that they were able to learn at least one chemical reaction among those performed

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ACM 2831-3194/2025/8-ART111
https://doi.org/XXXXXXX.XXXXXXX

and that they could more easily identify the substances they saw and used while using the application.

To the question "How would you describe your experience with Test your knowledge part?" all the answers fall into the "Very good" category.

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4 Conclusion

The development of this application started from the identification of some problems in the teaching and learning of chemistry in schools, among which are the lack of attractiveness of the field among students, the small number of practical chemistry hours, the risk caused by the handling of dangerous substances and the dependence on the existence of a laboratory or a suitable environment. As new elements, the application proposes the integration of a chatbot to answer users' questions, as well as the guidance part that facilitates the learning process of a chemical reaction or the evaluation part.

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