

Abstract

Virtual Reality (VR) introduces new opportunities in education by providing an interactive and intuitive way to understand complex concepts like chemical reactions and human anatomy. By creating a safe virtual laboratory, users can directly experience chemical processes, enhancing engagement and knowledge retention. Integrating Artificial Intelligence algorithms in VR further elevates eLearning by offering personalized support and a more immersive learning experience.

Technologies Used

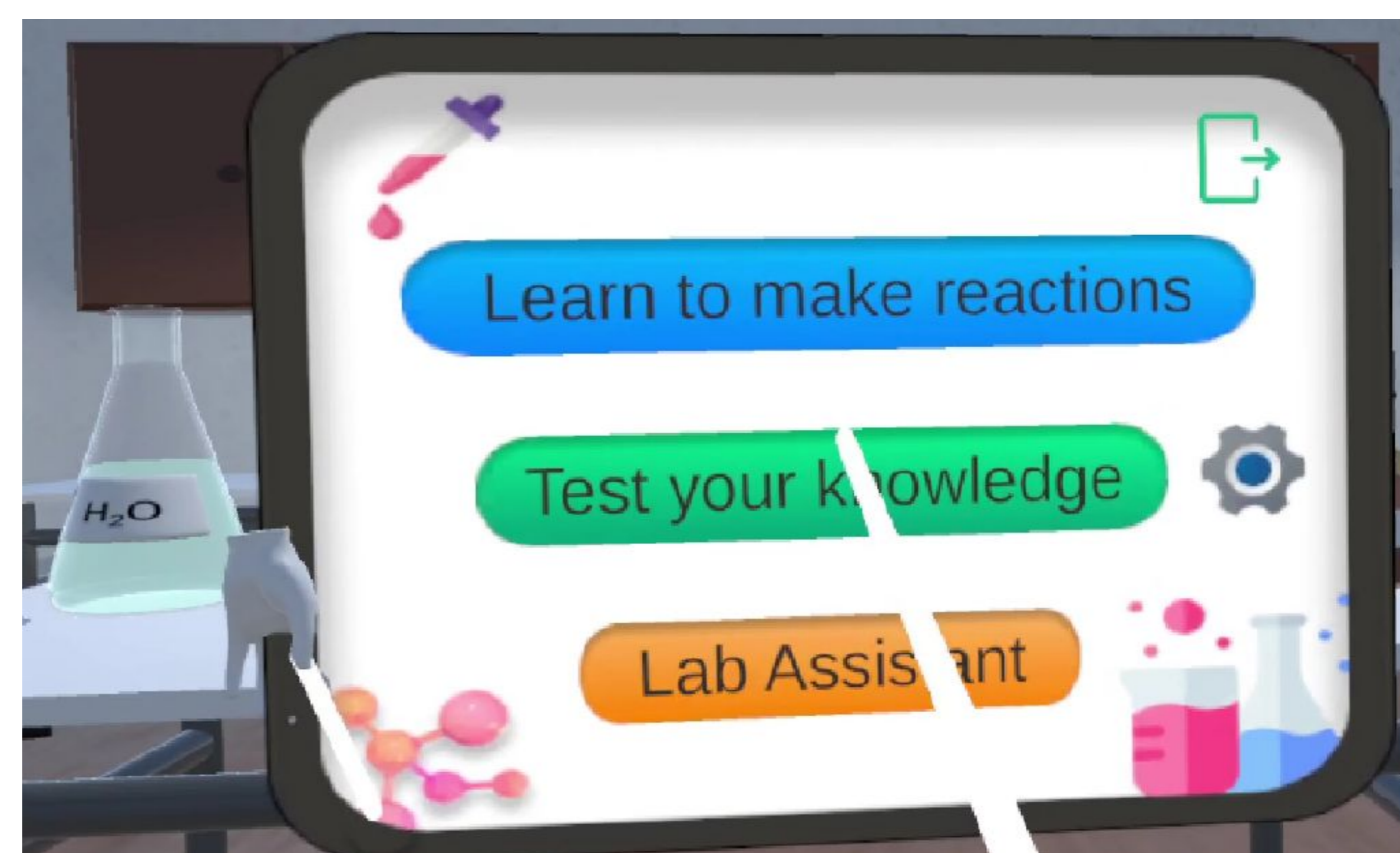
The application was developed using the Unity game engine¹, known for its cross-platform capabilities, 3D/AR/VR support, and C# scripting. Key Unity packages included XR Plugin Management, XR Interaction Toolkit, OpenXR, Inworld.AI, and Shader Graph.

Blender² was used to design 3D models and animations, while the Meta Quest 2³ VR headset served as the primary platform for deployment, offering an accessible and immersive standalone VR experience.

Architecture

The application includes three core features:

1. Learn to Make Reactions – Users are guided by a robot, via written and verbal instructions, to perform chemical reactions such as combination, decomposition, substitution, and neutralization. The experiment is selected from a virtual book on the laboratory desk. Once selected, the required substances and tools appear, and the robot guides the user through each step. Feedback is



'Main Menu' Scene



'Learn to make reactions' Scene

provided through animations (e.g., color changes, gas release, explosions) and voice prompts.

2. Test Your Knowledge – This section allows users to assess their understanding through timed (60-second) theoretical and practical tasks. Users can choose which type of task to attempt. Correct and incorrect answers are visually indicated, and if time runs out, the system moves to the next task. Users can revisit the learning section to review missed concepts.

3. Lab Assistant – A virtual assistant, built with Inworld.AI⁴, answers user questions about chemistry and the app itself. It uses advanced NLP techniques (e.g., BERT⁵, entity recognition, sentiment analysis) to deliver accurate, context-aware responses via both text and speech.

References

1. <https://unity.com/>
2. <https://www.blender.org/>
3. https://www.meta.com/quest/products/quest-2/?srsltid=AfmBOopKCBFe30UdesCUGyzYdF2-YbygEwwoy7YaC2pL_q6vMDGnuaLn
4. <https://inworld.ai/>
5. https://huggingface.co/docs/transformers/model_doc/bert

