Chemistry Learning Through Augmented Reality: ARC

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Abstract- *It has always been a challenge to understand the structures of minute chemical elements and atoms. Students find it difficult to imagine and visualize structures of chemical elements during learning chemistry. It can be very interesting for students to see chemical elements like atoms and molecules in 3-dimensional models from multiple angles. Augmented Reality is one of the most advanced developments in spatial computing technology, and it is extremely effective as a learning tool in chemistry. In this paper, we present an Augmented reality-based learning tool called "ARC" (Augmented reality Chemistry) made with Unity and Vuforia which can easily run on any smartphone and will generate 3-dimensional models of chemical structures like atoms at the place of a visual marker. We believe that integrating immersive technology like augmented reality will enhance Science, technology, engineering, and mathematics (STEM) learning.*

Keywords- Augmented Reality, Chemistry Learning, Inquiry-Based Learning, 3D Molecule, 3D Visualization, 3D Object, Education, Situated Learning, Technology Enhanced Reality, Mobile Learning, Applications in STEM Education, Learning Environments, Mixed Reality, Pedagogy, VR Learning, Spatial Intelligence.

I. INTRODUCTION

Many students around the world find abstract concepts of chemistry like molecules, electrons, and atoms intimidating. These students are also asked to imagine through micro and macro worlds of chemistry, which can be difficult. This issue requires a modification in the learning techniques and materials used in chemistry classes.

The use of augmented reality technology in education allows students to have a more involved, appealing, inspiring, visualizing, and meaningful learning experience.

Augmented Reality is a part of Extended Reality (XR) which has 3 components called Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR).

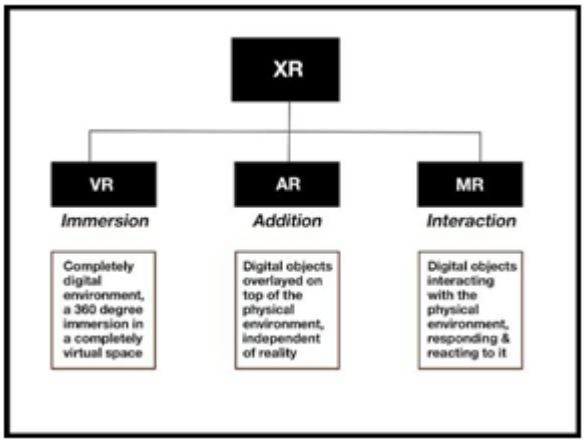

Fig 1: Classification of Extended Reality (XR)

Augmented Reality provides users with a streamlined interface that blends the physical and virtual worlds.

With the explosive development of Augmented Reality, a considerable amount of AR integration into disciplinary teaching has emerged. To create a local Augmented Reality environment, all you need is a computer and a camera. The camera identifies markers within its field of vision and simultaneously exhibits the scene it captures as well as the augmented reality described by the markers on the screen.

Students can interact with digital models that are overlaid upon real-world scenes to get the most realistic and accurate human-computer interaction possible.

II. LITERATURE REVIEW

The effect of Augmented Reality and Virtual Reality on student participation, learning, motivation, abilities, and cognition has been studied in a large number of research papers on the use of AR and VR in education.

In chemistry, spatial skill is essential because students must imagine specific microstructures, but this is a difficult task for a student. So, a large number of computer-

assisted learning methods are used, and several researchers have created real-life scenarios using these tools and evaluated their learning effects on students.

Many research studies have found that Virtual Reality and Augmented Reality based learning technologies have huge potential for pedagogical applications.

III. DESIGN AND DEVELOPMENT OF 'ARC'

Our project's main goal is to improve understanding of the elements of chemistry by using augmented reality technology and to create 3-dimensional models of chemical elements that can interact with the real world and make the learning process more fun and engaging for the students by using their smartphone.

First of all, we created a basic flowchart to get a clear idea about how we want our application to work and perform its functions.

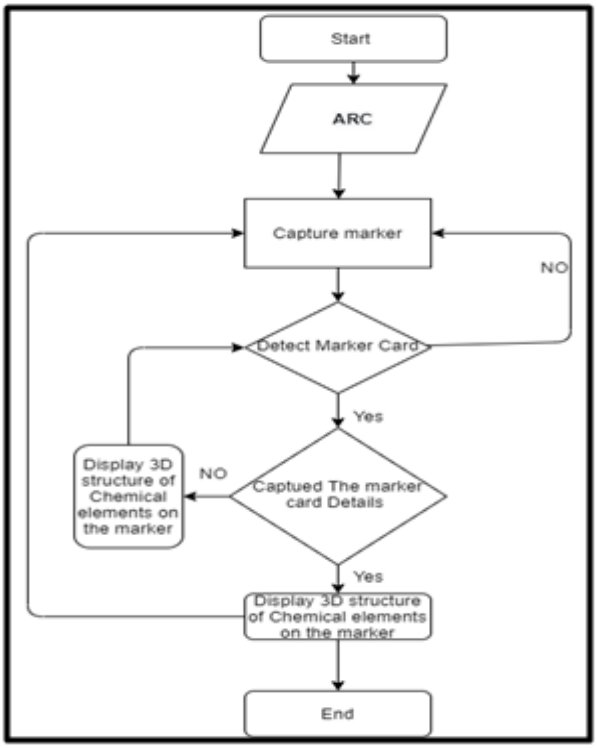

Fig 2: ARC Flowchart

We have used Unity 3D to make models of atoms for our project. Unity 3D is developed by Unity Technologies, it is a cross-platform development software used to Make real-time 3D projects for Games, Animation, Film, Automotive, Transportation, Architecture, Engineering, Manufacturing & Construction.

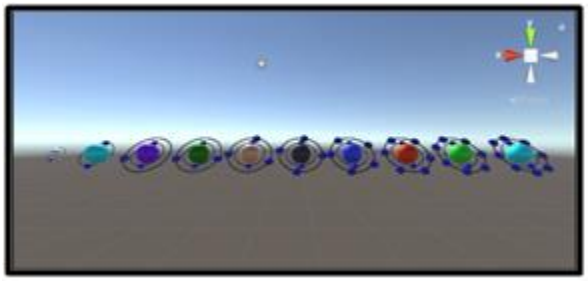

Fig 3: Models of Atoms Made in Unity 3D

We have integrated the Vuforia SDK with Unity 3D, Vuforia is an augmented reality software development kit for mobile devices that enables the creation of augmented reality applications. It uses computer vision technology to recognize and track planar images and 3D objects in real-time.

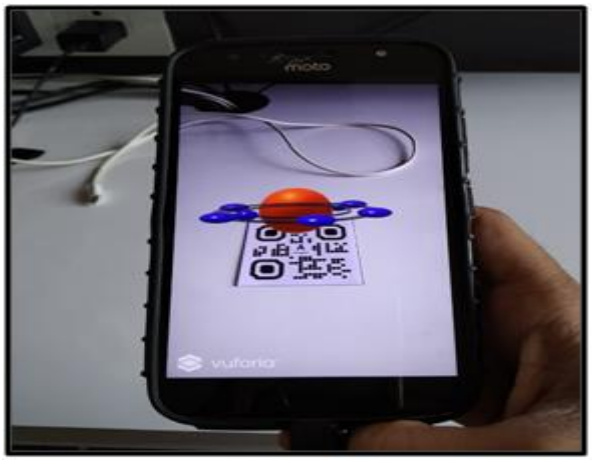

Fig 4: Model of an Oxygen atom of ARC

All the models made in Unity 3D are linked with a unique QR code-based marker and stored in the cloud database of Vuforia SDK. An application which is supported by all android device was build and whenever a user opens the application and scans the unique QR code a model of the atom linked with that particular QR code will appear in front of the user and he can interact and view it from all the angles and can see the electrons orbiting the nucleus of that atom.

Fig 5: QR based Markers

Fig 6: Model of a Carbon atom of ARC

IV. STUDY FINDINGS

We found that using augmented reality is really a fun and interactive way of learning chemistry and it will help students to understand the complex structures and concepts of chemistry. Our study revalidates that using immersive technologies can significantly improve the learning experience and also increases motivation and curiosity among students.
We also like to point out that although our tool works with all smartphones we have noticed better results in terms of maker tracking with a high-end smartphone leading to a better and smooth user experience.

We have also researched wearable augmented reality and virtual reality glasses from companies like Microsoft HoloLens, Magic leap, and Oculus, etc., and 3-dimensional projection technology like holography.

Although the above-mentioned options are quite new and expensive but are able to provide a significantly better outcome when compared with the smartphone-based augmented reality solution and will eventually become mainstream as technology advances and become cheaper.

V. CONCLUSION

Using Augmented Reality can significantly improve the understanding of the complex and abstract concepts of chemistry. We believe that technologies like Augmented Reality, Virtual Reality, Mixed Reality, Hologram, etc will transform and enhance the domain of Education and Training.

VI. ACKNOWLEDGEMENT

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