

# Augmented Reality (AR) and Virtual Reality (VR) Based Learning System

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## Abstract

Augmented reality (AR) and virtual reality (VR) technologies have transformed digital experiences by offering immersive and interactive environments and simulations that boost engagement and learning. Over the past twelve years, these technologies have significantly impacted education, offering novel approaches to teaching and training. Despite their potential, AR and VR are still in the emerging stages and require substantial customization and investment to meet the growing educational demand. Their applications are rapidly expanding in the architecture, engineering, and construction (AEC) industry, driven by advancements in equipment and technology. This has led to a surge in their use for creating realistic, immersive environments that facilitate better understanding and visualization of complex concepts. The growing interest among researchers in integrating AR and VR into education and training programs aims to provide students and trainees with enriched learning experiences that are not only interactive but also highly engaging and visually stimulating. By leveraging these technologies, educators can offer more dynamic and effective instructional methods, catering to diverse learning needs and preferences. As AR and VR continue to evolve, their role in education and various industries is expected to expand, further transforming how knowledge and skills are imparted and acquired.

**Keywords:** Augmented reality, e-learning, Android application, technological developments, artificial intelligence

## INTRODUCTION

Virtual reality (VR) and augmented reality (AR) are two of the most cutting-edge technological developments available today, and they have enormous potential for enhancing the educational system. VR and AR have become increasingly popular in education in recent years, offering many ways to exploit technology-enhanced learning. Students can better engage with complex subjects beyond lectures and textbooks when exposed to immersive digital experiences using AR and VR, which also allows lecturers to tailor information to each student's unique learning style. These tools not only make learning more immersive but also give teachers the chance to run simulations and go on virtual field excursions without having to worry about the logistics of actual travel. Furthermore, by bridging the gap between traditional classroom training and real-world experiences, the application can help learners' professional development in measurable ways.

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Nowadays, companies use AR to enhance worker safety through virtual training simulations and by showing how the equipment will function before it is constructed. On the other hand, VR is a groundbreaking technological development that has fundamentally altered the way people interact with

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and experience digital environments. Through the combination of state-of-the-art motion sensors, display technology such as VR allows users to fully immerse themselves in incredibly lifelike representations of actual or imagined environments. Although AR and VR may seem similar, they are distinct technologies with different functions. VR immerses users in a wholly virtual environment, delivering an interactive experience through headsets or glasses. By contrast, AR enhances the real world by overlaying digital objects on it, adding extra information, or improving its functionality.

Students remember 20% of what they hear, 30% of what they see, and up to 90% of what they perform through action or simulation. Our Motivation is to develop an application that will help students and learners to easily study/understand concepts using 3D simulations.

### **LITERATURE SURVEY**

AR applications and projects are widespread in many fields [5]. VR has been found to offer a more immersive experience than mobile devices, as it creates a sense of presence and realism. It was also found that VR increased the involvement of students as they felt more engaged and motivated to learn. Moreover, they found that VR facilitated active learning as it enabled students to interact with the environment and discover new information.

AR/VR applications function through instructions and measurements with the help of computer-aided modeling (CAD), thus using augmented reality on their mobile phones to visualize and design a specific area that cannot be physically visited [2, 6, 7]. Several games such as Pokémon Go use AR/VR with the help of tools such as Unity, Blender, and Vuforia. Analysis of the results using descriptive and inferential statistics is a good way to understand progress and make changes as needed. Research has suggested that respondents are satisfied with the application and have a high level of usability.

AR can be a powerful tool for astronomy education as it can provide a realistic, immersive, and interactive representation of the solar system that can stimulate students' interest and engagement in learning [3, 8]. Frameworks such as VITON also use this technology to integrate with existing businesses to increase sales and expenses.

Many have also emphasized the potential of the AR environment to adjust furniture properties, create personalized arrangements, and integrate artificial intelligence (AI) for enhanced user experience. It has been emphasized that AR applications can be integrated with AI to enhance user imagination and provide an animated experience in real time [1].

There have been suggestions for future research and development of AR educational applications such as exploring different platforms, subjects, pedagogies, and evaluation methods [4]. VR may have an impact on society and culture in terms of ethical, legal, psychological, and social issues. It also acknowledges some challenges and limitations of AR, such as technical issues, costs, accessibility, compatibility, and ethical concerns [8].

### **PROPOSED SYSTEM**

The use of AR in e-learning has been growing rapidly in recent years as it offers many benefits for learners and educators [9]. AR technology merges digital information and virtual objects with a real-world environment, enriching the learning experience by creating interactive and immersive educational settings. AR can also enable hands-on learning, remote collaboration, contextual learning, and real-time feedback [10].

In this project, we suggest developing an e-learning AR application for hands-on and immersive learning for four subjects: physics, chemistry, mathematics, and biology. This application is a web-based platform that enables users to register and log in to their credentials. After logging in, users can choose one of the four subjects and access two options: AR effect and QR code [10].

The AR effect option allows users to view and interact with 3D models of various concepts and phenomena related to a chosen subject. The QR code option allows users to scan QR codes from their mobile camera and open the AR mode. Users can then scan a particular picture related to the chosen subject and see a 3D view of the picture from different angles. This project aims to create an engaging and innovative e-learning AR application that can improve learners' understanding and retention of subject matter. The application also offers learners an engaging and interactive method to explore and study various topics in physics, chemistry, and biology [11, 12].

## ARCHITECTURE

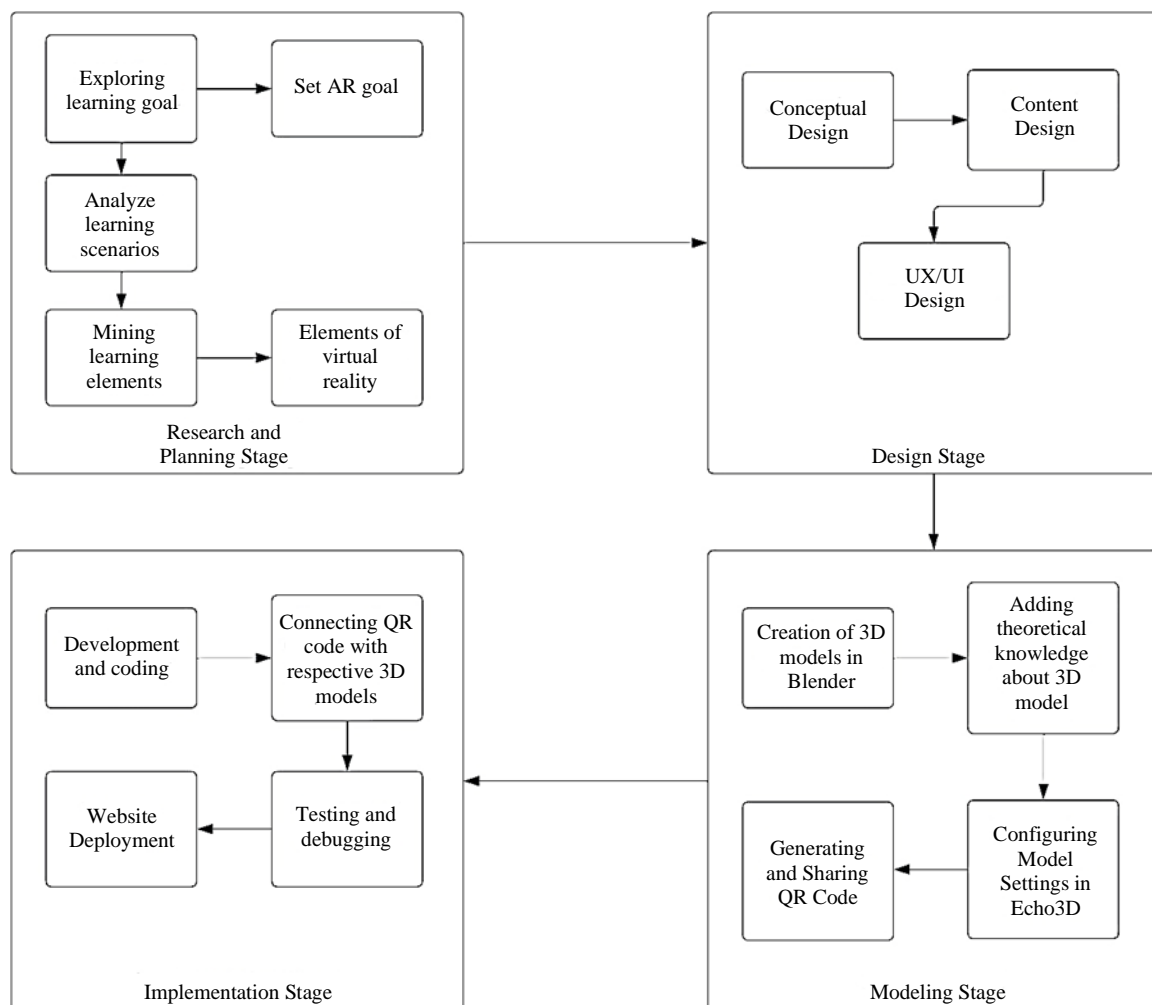
This section describes the architecture of the proposed AR Tool. AR systems present new opportunities in science and engineering education. A rising community is devoted to creating instruments that facilitate the creation of visual or audio content of virtual scenery and items that mimic virtual aspects and systems Figure 1.

### Research and Planning Stage

This involves setting learning goals, analyzing scenarios, mining learning elements, setting AR goals, and identifying VR components to be integrated.

### Design Stage

This stage includes conceptual design, content design, and UX/UI design to create an engaging and intuitive AR application.



**Figure 1.** Workflow.

### Implementation Stage

This stage involves writing code, connecting QR codes with 3D models, testing and debugging the application, and deploying the website for user access.

### Modeling Stage

Involves creating 3D models in Blender, generating and sharing QR codes, adding theoretical knowledge, and configuring model settings in Echo3D for optimal AR performance. Each stage is crucial for systematically transforming educational goals into an interactive AR experience.

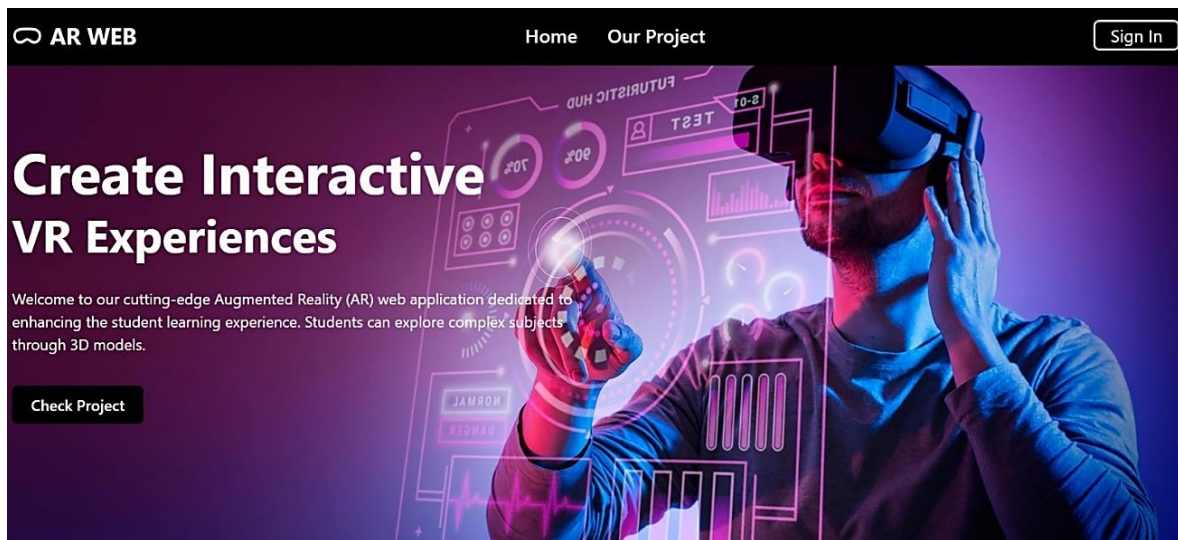
### Algorithm for Model Creation

1. Launch Blender and you will find a default scene featuring a cube, light, and a camera. Familiarize oneself with the interface: 3D viewports, tools, and menu options.
2. The default cube is removed by selecting it and pressing 'X' or 'Delete' on the keyboard. To add a new object, open the 'Add' menu (Shift + A) in the 3D viewport and select a primitive shape, such as a cube, sphere, cylinder, or another mesh object.
3. To manipulate the object, move (G), rotate (R), and scale (S) tools were used. Press the respective key and then move the mouse or type a value to modify the object's position, rotation, or size. Toggles between object mode and edit mode to adjust the object's vertices, edges, and faces. Use the 'Sculpt Mode' to dynamically mold or sculpt the object. The 'Edit Mode' is selected to modify the mesh directly by moving the vertices, edges, and faces.
4. Creating and applying materials to an object. Color, glossiness, and other properties can be modified. Textures are added for more realistic or detailed appearances.
5. Set up a scene for rendering by configuring the camera and the lighting. Go to the 'Render' tab to choose the rendering settings and output format (image or video). Several other options are available for exploration.
6. Save your work regularly. Go to 'File' and 'Save' to save your work. When you are ready to export, choose 'File.'
7. Export and select the desired format (for example, .fbx, .obj, .stl) for use in other applications and 3D printing.

### Algorithm for Model Viewing in AR

1. Save your Blender model in glb (glTF binary) format, which is compatible with many AR platforms.
2. Go to the Echo3D website and sign your account. If you do not have an account, register and create one before signing in. Either start a new project or choose an existing one and then upload the glb file to Echo3D.
3. Configure the model settings, such as the scale, rotation, and initial position, within the Echo3D platform.
4. The Echo3D interface is used to generate a QR code associated with the uploaded 3D model.
5. Download the QR code generated from Echo3D. This QR code enables users to access the AR experience.
6. Share QR codes through various means, such as embedding them in educational materials, printing them, or displaying them digitally.
7. Users scan QR codes using their mobile devices with an AR-capable application or an Echo3D viewer. The application loads the AR experience, allowing users to view the 3D model overlaid in the real world.
8. Users can interact with a 3D model, manipulate it, and explore its details in the AR environment provided by Echo3D.
9. Optionally, explore sharing options within Echo3D to enable collaborative viewing experiences or to share the AR model link directly.

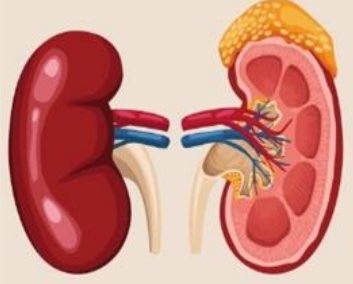

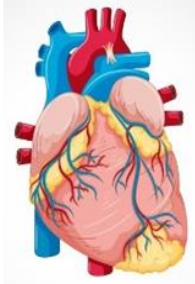



With the increasing number of applications associated with the AR/VR domain, the processes of viewing and creation can be achieved in many distinct ways and can be approached as needed by the programmer.



**Figure 2.** The main page of an educational platform.

**Biology**

Our project provides a unique opportunity to visualize complex biological concepts with stunning 3D imagery.

 <p><b>Kidney</b> The kidney is a vital organ responsible for filtering waste products and excess fluids from the blood to form urine</p> 	 <p><b>Heart</b> The heart is a muscular organ responsible for pumping blood throughout the body, It consists of four chambers two atria and two ventricles</p> 	 <p><b>DNA</b> DNA is composed of two polynucleotide chains that coil around each other to form a double helix Each strand of DNA consists of a long chain of nucleotides.</p> 
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**Figure 3.** Options for AR experiences.

## RESULTS AND ANALYSIS

As illustrated in Figure 2, the main page of an educational platform offers VR experiences and acts as a central hub for accessing various interactive and immersive learning materials.

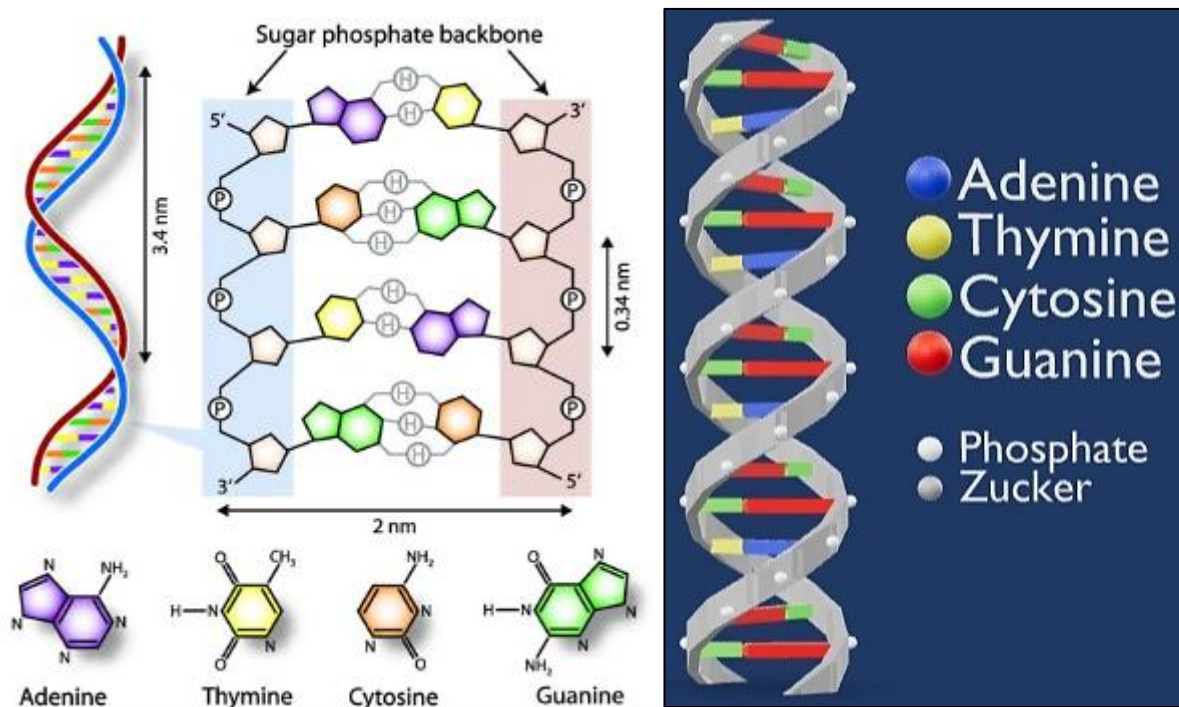
As illustrated in Figure 3, the educational platform offers VR experience by providing interactive and immersive learning materials for various biological concepts.

As illustrated in Figure 4, the DNA double helix with detailed labeling provides a clear and concise representation of the genetic structures and their functions.

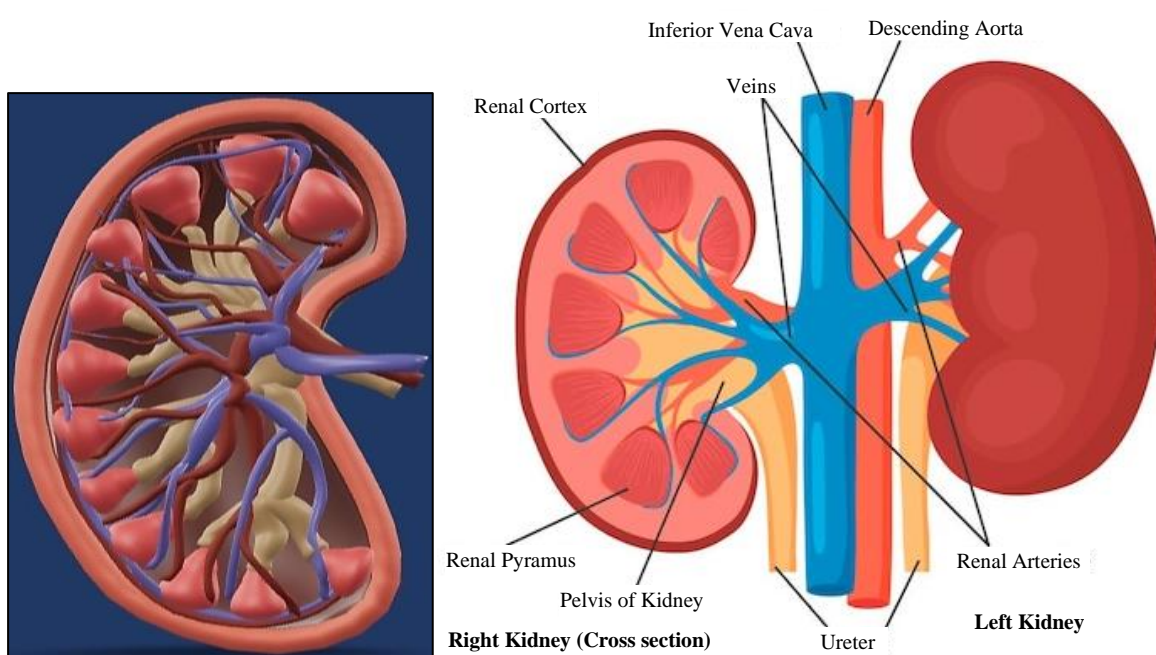
The kidney intersection in Figure 5 presents an interactive 3D model of the kidney, complete with labeled parts for additional information. It is designed to provide an engaging learning experience that

enhances the understanding of kidney anatomy and function. The outcome is an enriched educational tool that leverages AR technology for deeper anatomical studies.

With the inclusion of AR and VR technologies, the educational platform shown in our project represents an important breakthrough in the digital learning field. Through the use of dynamic 3D models covering various fields such as chemistry, physics, and biology, the platform provides students with an interactive means of learning and understanding complex scientific ideas. Kidney and DNA models are excellent illustrations of how complex biological structures can be portrayed, offering an understandable and educational view into the tiny world.



**Figure 4.** DNA representation.



**Figure 5.** Kidney intersection.

This method accommodates various learning styles and increases interactivity in the classroom, which may improve recall of material and student participation. The platform's attractive design makes it easy to navigate a wide range of educational materials, inspiring students to go deeper into their studies. This creative application of technology in the classroom opens the door to a more dynamic and immersive learning environment, establishing the foundation for a revolution in science education.

## CONCLUSION

The e-learning AR application is a web-based platform that aims to provide immersive and practical learning for students in various disciplines such as physics, chemistry, mathematics, and biology. The application lets users register and log in, select a subject, and choose between two options: AR effect and QR code.

The AR effect option displays digital information and virtual objects on the screen, whereas the QR code option enables users to scan code and view a 3D model of a picture in AR mode using their mobile camera. The application enhances the learning experience by engaging students with interactive and contextual content that can be viewed from various perspectives. Vuforia and Blender software were used for the development.

Finally, innovative e-learning tools include AR and VR. Nonetheless, substantial work remains in this area concerning both technological and application development as well as training. We propose creating an Android application and creating materials for engineering domains in our near future effort.

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