# TRANSFORMING EDUCATION WITH VIRTUAL REALITY

*Edited By*
**Reena Malik, Ambuj Sharma, and Prashant Chaudhary**

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# Contents

# Preface

Virtual reality (VR) technology has changed the traditional classroom experience into an exciting interactive one. It has brought about a technological revolution offering a 360-degree view of the world. Now, with VR technology, students can actually learn by living it. They can go on real-time virtual tours while sitting in their classrooms, and can even mix dangerous chemicals without being physically harmed.

It can be agreed that the introduction of virtual reality in education has thoroughly transformed it by providing engaging and immersive ways for students to experience their education and offering visual learning, creative development, etc., to enhance their studies. Moreover, with increasing accessibility, both students and educators can utilize it for effective teaching and learning. By embracing this VR-related technology, teachers can really transform traditional classrooms into lively ones. However, with this, the teacher's role has also shifted to being a facilitator. According to Adobe, "Teachers will be focused on creating conditions for exploring, rather than providing ready-made knowledge."

This book aims to highlight the recent applications of virtual reality in various educational fields through the contributions of researchers, educators and students familiar with the potential opportunities in this field. It has been divided into two parts. Part I discusses the opportunities, challenges and application of modern technology, and Part II focuses on reimagining education with the metaverse.

In Part I, Chapter 1 describes a novel framework for immersive learning in education. Chapter 2 discusses rediscovering tribes through virtual reality and the relevance of new technology in transforming education. Chapter 3 discusses modern technology in the post-pandemic era, which resulted in significant challenges to class management. Chapter 4 imparts information concerning the expanding teaching possibilities afforded by the application of technological products in the education sector. Chapter 5 describes the evolutionary advantages of VR-enabled education and its application. Chapter 6 explores the possibilities along with the apprehensions towards

the use of artificial intelligence in the education sector and arrives at some wonderful insights on the same. Chapter 7 captures the impact of virtual reality on education while explaining the various tools that can be utilized in immersive education.

In Part II, Chapter 8 beautifully describes the role of metaverse as an upcoming trend in the education sector. Chapter 9 shows the relationship between virtual reality and student behavior and the impact and challenges of virtual reality. Chapter 10 discusses VR-enabled tools and techniques, which are the driving force behind their application in the field of education, for an immersive environment that stakeholders can experience. Chapter 11 captures the soul of virtual reality in education by providing a comprehensive view of modern technology with the help of bibliometric and thematic analysis. Chapter 12 discusses virtual reality in the context of vocational education by developing a conceptual framework and roadmap for its adoption in the near future for the benefit of various stakeholders. Chapter 13 talks about the advantages and disadvantages of virtual reality by undertaking a detailed analysis showing a comparison of the strong and weak points of the modern technologies being used in education. Chapter 14 shows the detailed mechanism of virtual reality, and Chapter 15 showcases the importance of virtual reality in modern education, its opportunities and challenges. Chapter 16 focuses on the future of learning and describes it in the context of virtual reality. Chapter 17 describes the relevance of virtual reality in emerging economies with the help of a bibliometric analysis combining past studies, and discusses its future potential. Chapter 18 focuses on the metaverse as a new education avatar showcasing diverse educational experiences. Chapter 19 explains the relevance of emerging digital technologies in upskilling employees in fashion retail to impart an immersive experience for customers. Chapter 20 discusses the role of the metaverse in reimagining teaching learning in the future of education. Chapter 21 proposes a framework for mapping the use of virtual reality especially for students with autistic spectrum disorder (ASD). Finally, Chapter 22 captures the essence of virtual reality by analyzing the literature and state of knowledge.

As virtual reality rapidly enters the mainstream education industry, stakeholders in education platforms are starting to embrace the technology's numerous learning opportunities. There are a variety of special advantages that the use of VR has to offer. By incorporating VR into contemporary education, it provides a new tool for teachers and a new method of connecting with more pupils. It aims to improve, inspire, and stimulate

students' understanding of certain concepts while also enabling them to engage in practical learning. Moreover, VR offers a chance to increase student engagement, allows for empathy, allows undivided imagination, as well as the capacity to visualize learning from different perspectives.

**The Editors**
October 2023

# Part 1

# MODERN TECHNOLOGY IN EDUCATION: OPPORTUNITIES, APPLICATION AND CHALLENGES

# 1

# A Novel Adaptive Framework for Immersive Learning Using VR in Education

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## *Abstract*

Virtual reality, also known as VR, is a simulated 3D environment that allows users to interact and experience an immersive feeling through the virtual world. The existing virtual reality techniques have many complications and calibration issues that make it unfriendly for educational purposes. This chapter proposes a remedial method for the drawbacks and hinderances of the existing techniques using an adaptive learning framework. This approach aims at creating a virtual reality system with changes in the existing software controls. The methodology enhances student learning methods through a virtual reality kit that includes a lightweight head-mounted display (HMD) and a reprogrammable base system that caters to every learner according to their capability. It is important to make sure that the users, be they students or professors, do not use the VR system for a long time. It is not necessary to have full-time learning through virtual reality as only a few concepts in the syllabus require 3D explanations. It should be kept in such a way that technology increases interest in and engagement towards a subject without affecting the minds and health of users.

***Keywords*:** Virtual reality, adaptive learning, immersive classrooms, voice commands, student progressive report, 3D environment, virtual reality kit, student engagement

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## 1.1 Introduction

Virtual reality is an artificial immersive technology with three-dimensional environment which can be explored and experienced by users. The computer-generated environment has graphical scenes and objects that appear to be like real-life scenarios. Virtual reality simulations are of three main types—non-immersive, fully immersive and semi-immersive [14]. Non-immersive virtual technology, which relies on input devices and computer consoles, allows users to remain conscious of their physical environment. Fully immersive virtual reality provides users with the most lifelike simulation experience along with vision and sound. Users need proper VR glasses for the best experience. The head-mounted display (HMD) offers high-resolution content while the display produces a stereoscopic 3D effect and integrates with input tracking to develop an immersive sensation. In semi-immersive VR, users can experience a partially virtual environment that enables them to explore the imaginary world while also allowing them to be aware of their local surroundings. This type of VR is usually employed for education or training that partially resembles real-world mechanics. In addition to that, different people from various locations can come into contact within a single virtual environment with a technique called collaborative virtual reality. Here they can interact with each other by means of microphones, headsets and chatting. Lately, people are getting used to virtual meetings and competitions remotely. The future of virtual meetings has been enhanced by collaborative VR.

The use of information and communication technologies in education can be extremely important in providing instructors, students, and the learning processes with new and innovative forms of support for adaptive learning [7]. Compared to other industries, the area of education adjusts to change more slowly, yet it invariably undergoes transformation to accommodate changes. A very promising use case for virtual reality is the education sector [15]. Virtual reality can expand educational opportunities beyond face-to-face learning to new locations and demographics. It gives access to immersive environments, which can help learners overcome the drawbacks of the current remote and online learning practices. Virtual reality can have an impact on education in more ways than just increasing motivation and participation. With immersive VR, students may move around and interact while also having access to a variety of viewpoints and perspectives on things and scenes. It is proven that virtual reality can offer different immersive learning techniques with a significant amount of student-teacher interaction.

The current virtual reality techniques are functional in service, but do not seem to be cost effective. It is not economical to set up a separate room space for everyone with proper calibration and several external sensors along with an omnidirectional treadmill. One of the major drawbacks of using virtual reality systems is that long-term usage might lead to physical issues in the body like eye strain and dizziness. It is crucial to consider the technology's limits when trying to maintain immersion. Visuals on low resolution displays may appear fuzzy and out of focus. Complex visual settings can result in visual distortions that can cause nausea.

Technology has already involved itself in the education sector in many ways. Almost all schools and colleges provide students with projector-based learning that allows the teacher to use a multimodal form of teaching and to interact with students better [12]. Online learning classes via the internet were a great breakthrough during the COVID-19 global pandemic, which helped to manage and keep up with day-to-day classes. A few institutions over the globe use immersive classrooms that are unique learning spaces where the walls and floors are projected with a 360° scene of the virtual world. This interactive virtual reality experience is free of headsets with multi-sensory effects like touch, smell, and sound. Cave (cave automatic virtual environment) technology, an advanced version of projector-based learning, involves students in a more immersive way. It is a video theater with rear-projection screens where students use 3D glasses to see the graphics created inside.

Virtual reality (VR) technology comes with certain devices like HMDs (head-mounted displays) and haptic sensors, which provide an immersive experience. Visual display of virtual reality technology is done with the help of these head-mounted devices [2]. HMDs have small display optics on one or each eye, integrated into eyeglasses or mounted on a helmet. They are of two types—wired and wireless. To enhance the user experience and provide the sense of touch along with vision, haptic gloves are used, which are wearable gloves that simulate tactile sensations of virtual objects. They are used for kinesthetic communication where the sense of touch is added to the visual interfaces. Some companies are also providing haptic suits along with gloves. There are multi-sensory devices which stimulate other senses and generate tactile feedback. To navigate and control inside the virtual environment, hand-used controllers like touchpads, joysticks or thumbsticks are used.

At the beginning stages of development, VR technology included many external sensors that were connected to a central PC through wires. Additionally, they had to be calibrated each time the VR was activated in

a different space. They then evolved into a wireless mode with the involvement of artificial intelligence. The help of machine learning algorithms has increased the potential of VR technology to a next level. There are posture tracking systems with a set of sensors and controllers that are used to track hands and legs with respect to the head configuration.

In gaming and other sectors, an omnidirectional treadmill (ODT) is used to make the technology more interactive. It is similar to a regular treadmill, but enables the user to locomote in any direction, allowing a 360° movement. They often come along with a few external sensors which help in locating and detecting the user's body position and movement. An adaptive learning approach using VR was proposed in which sensors are used to detect user's emotions and get sensory feedback based on dialogue patterns, body language, facial expressions, and haptic pressure. Sometimes, the system is integrated with wireless joysticks that allow users to navigate and interact in the virtual world.

## 1.2 The Two Perceptive Elements

Immersion in virtual reality refers to the insight of being physically present in a non-physical environment and interacting with the world of imagination and exploration. It is a feeling of involvement of the user in a simulated environment. By simulating human senses like vision, hearing and touch, an immersive experience can be given to the user. Immersion is of three main categories—tactical, narrative and strategic. Interaction is the term used to describe how a person and a virtual scene interact naturally. With the help of input devices, it allows users to feel a sense of being in the real environment [5]. Utilizing the multi-dimensional perception data offered by VR scenes, imagination is the process of acquiring feelings that are both similar to and distinct from those found in the real world.

### 1.2.1 Interactivity

When discussing virtual reality, interactivity refers to the specific connections made between the users and the digital model. It suggests that the user might take part in the information transfer process facilitated by the computer. Therefore, a medium is interactive if it enables the user to modify the form or content of communication. There are various levels of interaction: the lowest allows the user to do nothing more than select information; the intermediate allows the user to add content; and the highest causes the virtual environment to react properly to the user's input. Interactivity

necessitates an integration of technology and architecture to be successfully deployed because a user both provides and receives information [1]. When a user makes changes to virtual items or avatars, the virtual environment is said to be interactive. When a virtual reality experience is interactive, the user can interact with the virtual environment by pressing buttons, moving objects, making gestures, or utilizing other modalities to get input from it. It has been identified that embodiment, which includes movement and gesture, leads to successful learning outcomes.

Interactive learning methods are beneficial because they enable direct control over the current learning. Developers should strive to create a stimulating setting that actively promotes student inquiry and critical thinking. By integrating extraneous information into the virtual world, interactive aspects can help speed up the process of learning. When users can quickly access this data to review their memory or employ prior knowledge to the activity, embedded learning is taking place [3]. Within VR, it is possible to represent some ideas that call for a keen awareness of spatial configuration, or how items on a three-dimensional (3D) plane relate to one another. Regardless of prior skill, learners can practice and enhance spatial abilities since VR surroundings are perceived as 3D. Designers can employ a better grasp of spatiality by thinking about how to assist and challenge students with varying degrees of spatial skills in 3D space.

### 1.2.2 Immersivity

Immersion is the physics of a system; it describes its technological capabilities. The sensory system of a human body uses a variety of modalities, including vision, hearing, touch, smell, taste and force, to collect data about the immediate surroundings. The sensory inputs are reproduced in the brain while perception involves bottom-up interpretation of the sensory data and top-down interpretation of the past knowledge, objectives, and views based on the preexisting conception of the world.

A person typically tends to believe that he "knows" a room after just a short while of entering there. Scanning data through eyes actually reveals that they foveate on a very limited number of important locations in the space, and that the eyes follow recurring patterns between the scanning pathways. The previous model of what a room is helps to determine the essential details. The conceptual system has deduced a complete room model in which the person is situated, despite having "seen" a tiny fraction of what is there to see.

In terms of technology, virtual reality (VR) aims to replace real-world sensory experiences with computer-generated ones that are created from

a statistical database that describes a 3D scene, and its animations and changes are brought on by user input [4]. Only when sensory experiences are effectively substituted, can the brain infer a visual model from the original input of sensory data. The participant's consciousness is altered to perception of the virtual setting rather than the genuine one, despite their certainty that this is not real. The objective is to effectively replace real sensory data.

Vision and hearing are the most common senses, accompanied by touch, smell and force feedback. Taking the conventional VR system into consideration, it is mostly centered on vision and may have additional tactile feedback followed by sound. For most of the applications, vision alone is often effective considering that it is perceptually outscoring for many people. As a result, users of VR commonly find themselves in situations where their visual system sends them through a ride of virtual experience, but all other sense experiences come from the actual physical environment.

Perception involves the entire body. This implies that the body is put to use in a natural way to comprehend. Users turn their heads, move their eyes, lean down, look beneath, gaze over and around while simultaneously reaching out, touching, pushing, and pulling. Due to these constraints, the major technological goal of VR is to reproduce to the greatest extent the feasible perception through such natural sensory dependencies. For instance, while staring very closely at an object in a cave or while wearing an HMD, ultimately, pixels can be seen; or in the majority of current VR systems, if any random virtual object is being touched, it cannot be felt. An immersive VR system is one that enables perception through real-world sensory circumstances. The system's ability to do this completely determines whether one can rotate 360° while viewing a continuous low-latency refresh of the visual field, in line with the gaze direction. With this, systems can be characterized as more immersive or less immersive. Therefore, HMD proves to be more immersive than Cave in this sense because an HMD can depict something that a Cave cannot. In a Cave, users can see their own body when they gaze down at it, whereas while wearing a PHMD with head tracking, they can see a virtual human in place of their own. Movement-induced real-time reset of the sensory perception results in an illusory sense of presence in the artificial environment. One reason why educators think immersive VR will benefit learning is because it has the power to instantly take the user to an enhanced emotional state that can have favorable effects on involvement and attention.

After immersion, feeling of presence is yet another consideration. With immersive VR, the illusion of presence is consistently maintained, giving students the impression that their bodies are actually inside the virtual