

# Chapter 3

## Virtual Reality, Augmented Reality, and Mixed Reality in Education: A Brief Overview

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### ABSTRACT

*Virtual reality (VR), augmented reality (AR), and mixed reality (MR) are three different technologies developed in the last decades of the 20th century. They combine hardware and software solutions. They permit the creation of three-dimensional (3D) virtual worlds and virtual objects. This chapter describes how VR, MR, and AR technologies find positive application fields in educational environments. They support different learning styles, offering potential help in teaching and in learning paths.*

### INTRODUCTION

#### Virtual Reality

In the 19<sup>th</sup> century, formal education was based on lectures and recitations. The Swiss pedagogues Johann Heinrich Pestalozzi (1746-1827) was one of the first that studied what is commonly known as “hands-on learning”. He observed that students learn best through physical activity and if they use their senses (Pestalozzi, 1803). Nowadays, modern educational environments find in the new technologies a way to improve the learning paths. For example, VR, AR, and MR can stimulate the senses of the students, involving them in learning activities.

In 1987, Yaakov Garb used the term “virtual reality” as title of a paper. VR is the capability to represent the world with visual symbols (Garb, 1987). Garb’s point of view is far from computer technology. While Garb used the term ‘virtual reality’ as the title of a paper on 1987, the term was used to represent

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the world with visual symbols. It was two years later when Lanier used the term specific to the world of computer technology (Lanier, 1989). He referred the term to the world of computers: VR exists only as an electronic image, without any connection with the real world. As Krueger (1991) stated, “The term therefore typically refers to three-dimensional (3D) realities implemented with stereo viewing goggles and reality gloves” (p. xiii). VR is a technology which involves information technology, computer graphics and electronics, and it gives its users the illusion of being immersed in a computer-generated virtual world with the ability to interact with it. VR has also been defined as an experience in which the users are immersed in a responsive virtual world. This implies users’ dynamic control of viewpoints. (Brooks, 1999).

Burdea and Coiffet (2003) describe VR as a simulation in which computer graphics are used to create a realistic-looking world. The synthetic world is dynamic, responding to the user’s input (gesture, verbal command, etc.). This introduces the real-time interactivity, which is a key feature of this technology, but computer science evolution requires a new definition of VR. More recently, the Encyclopædia Britannica (2019) describes VR as a technology that permits the use of modeling and computer simulation, where a person can interact with a sensory environment or with an artificial three-dimensional visual environment.

In 1997, Rosenblum & Cross define the three primary requirements of a VR system. They are:

- Immersion refers to a realistic feeling that allows users to have exposure to a virtual environment. The perception is created surrounding the user by the VR technologies and by its devices (e.g., data gloves, head mounted display, sound or other sensorial stimuli), that provide an engrossing total environment (Wu et al., 2015). Immersion requires physically involving the user, both by capturing exclusive visual attention and by transparently responding to 3D input, through use of devices such as a head-tracker, 3D mouse, wand, data glove, or fully instrumented body suit;
- Interaction is a kind of action that occurs as two or more objects have an effect upon one another. In VR what is realized through the 3D control devices to investigate and control the virtual environment; and
- Visual realism provides an accurate representation of the virtual world using computer graphics tools.

Immersion is a feature of VR and MR. characterized by different degrees of user involvement.

It is a unique experience that is connected with the real world and the virtuality. Astheimer et al. (1994) define immersion as the feeling of a user, that his virtual environment is real. In a 2004 paper titled *Postmodernism and the Three Types of Immersion*, Adams presented three main categories of immersion: tactical, strategic, and narrative. Tactical immersion gives the users the experience that they are accurately performing actions in the virtual world with convincing feedback. Strategic immersion is associated with mental challenge. Narrative immersion occurs when users become invested in a story, and is similar to what is experienced while reading a book or watching a movie. Björk and Holopainen (2004), divide immersion into three similar categories, but they call them: sensory-motoric immersion, cognitive immersion, and emotional immersion, respectively. In addition, they also add a new category named spatial immersion that occurs when a user feels the simulated world is perceptually convincing (Björk & Holopainen, 2004).

Interaction refers to the natural interaction between the users and the virtual scenes. VR, AR, and MR systems involve interface hardware components. For VR they consist of:

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