AUGMENTED REALITY AND VIRTUAL REALITY IN SPECIAL EDUCATION

Edited by

V. Ajantha Devi, Williamjeet Singh, Yogesh Kumar

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Preface

In recent years, emerging technologies have been making significant strides in revolutionizing various aspects of education. Among these transformative innovations, augmented reality (AR) and virtual reality (VR) have emerged as game-changers in the realm of special education. The potential of these immersive technologies to enhance learning experiences for students with diverse learning needs and disabilities is both promising and inspiring.

The book *Augmented Reality and Virtual Reality in Special Education* is a comprehensive exploration of how AR and VR are reshaping the landscape of special education, creating new opportunities for personalized learning, inclusivity, and engagement. This book brings together experts, researchers, and educators from diverse fields to shed light on the latest developments, best practices, and cutting-edge applications of AR and VR in special education.

The book *Augmented Reality and Virtual Reality in Special Education* aims to empower educators, researchers, policymakers, and stakeholders in the field of special education to harness the full potential of AR and VR technologies. It aspires to inspire the reader with real-life success stories, research-driven insights, and evidence-based practices that demonstrate how these immersive technologies can lead to a more inclusive, engaging, and transformative educational experience for students with diverse learning needs and disabilities.

Chapter 1: "Digital Learning Environments: Constructing Augmented and Virtual Reality in Educational Applications" discusses the current shift in education towards utilizing digital media, particularly AR and VR, to create realistic and immersive learning environments. The chapter explores the theoretical foundations and benefits of augmented reality-based learning environment (ARLE) experiences in science and mathematics. It also highlights the role of VR in addressing educational applications and the potential of AR and VR to improve remote learning in higher education.

Chapter 2: “Role of AR and VR Technology in Transforming Education” examines the rapid advancement of artificial intelligence and its implications for various fields, including education. The chapter emphasizes the role of AR and VR in enhancing access to education, engaging students, and optimizing learning outcomes. It also discusses the potential of AR and VR to improve teaching methods and reform the educational system.

Chapter 3: “Enhancing Social Skills Development Through Augmented Reality (AR) and Virtual Reality (VR) in Special Education” focuses on the use of AR and VR technologies to address social skills development in individuals with special needs. The chapter presents theoretical frameworks and techniques for incorporating AR and VR in social skills training. Real-world examples and case studies demonstrate the effectiveness of AR and VR in fostering social engagement and self-confidence in individuals with autism spectrum disorder and communication challenges.

Chapter 4: “Immersive Learning’s Promise: The Educational Potential of Augmented and Virtual Reality” delves into the transformative potential of AR and VR in education. The chapter discusses the growing interest in AR and VR adoption worldwide and their impact on learners with disabilities or special needs. It explores how immersive technologies, such as virtual classrooms and simulations, can enhance learning experiences, student participation, creativity, and information retention.

Chapter 5: “Influence of Augmented Reality and Virtual Reality in Special Education in India” specifically examines the benefits of using VR and AR technologies for the treatment of autism in India. The chapter explores how VR can simulate everyday situations for early training scenarios tailored to the needs of children with autism. It also highlights the role of AR in enhancing message delivery and creating inclusive digital campuses in India.

Chapter 6: “Exploring the Untapped Potential of the Metaverse in Special Education: A Comprehensive Analysis of Applications, and AI Integration” introduces the concept of the metaverse and its potential applications in education. The chapter discusses the functions of AI in the metaverse and its possibilities for special education. It also explores various applications of the metaverse, from virtual classrooms to group problem-solving and experiential learning.

Chapter 7: “Fostering and Integrating Augmented Reality/Virtual Reality Experience for Learners with Autism Spectrum Disorders (ASD)” emphasizes the importance of integrating AR and VR technologies in the educational system for children with autism. The chapter discusses the challenges and responsibilities in creating high-quality AR/VR educational content tailored to the needs of these learners.

Chapter 8: “Impact of AR/VR in the Learning Process for Children Affected by Dyslexia” addresses the use of AR and VR technologies to support education for children with dyslexia and other learning difficulties. The chapter discusses the benefits and challenges of implementing AR and VR in teaching and learning, particularly in improving student engagement and learning outcomes.

Chapter 9: “Immersive Experience in the Education of Special Kids Using the Metaverse Platform” explores the use of the metaverse platform to create an immersive learning experience for children with special needs. The chapter highlights how machine learning can be used to customize the experience and accelerate the education of special kids through digital transformation.

Chapter 10: “Privacy and Security Concerns with Augmented Reality/Virtual Reality: A Systematic Review” focuses on the security risks and threats associated with AR and VR devices in educational contexts. The chapter discusses various techniques to mitigate these risks and provides a comparative analysis of reported works in this area.

In conclusion, this book presents a comprehensive examination of the applications, benefits, challenges, and potential of AR and VR in various educational contexts, with a particular focus on learners with special needs. It covers a wide range of topics, including theoretical frameworks, real-world examples, and considerations for privacy and security. The chapters collectively demonstrate the transformative role that AR and VR technologies can play in shaping the future of education.

1

Digital Learning Environments—Constructing Augmented and Virtual Reality in Educational Applications

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Abstract
The current pattern shifts in education, which require students to study real-life scenarios and solve realistic problems utilizing digital media, have created a major challenge. Digital learning environments have transformed the way educational instructions are invented. Such learning atmospheres have evolved to meet various presentation styles, sensory modalities, and reality, with augmented reality (AR) being among the newest innovations where all parts of three dimensions can be brought together. As emerging technologies have grown in popularity, words like virtual reality (VR), AR, and mixed reality (MR) have become commonplace. Virtual reality is a hands-on, integrated learning tool that has a unique role to play in addressing educational applications. The major objective of this work is to design AR-based learning, which is thought to be in the field of science and mathematics in the learning environment, and to provide theoretical foundations for comprehending the benefits and restrictions of AR-based learning environments (ARLE) experiences. The proposed study demonstrates how information from multiple disciplines can be combined with VR to improve remote learning in higher education. In the framework of future technologies, we also discuss internal and external learning environments. The virtual scenario is part of the internal learning environment, whereas the circumstance in the room around the player is part of the external learning environment—the authentic learning experience before, during, and after gameplay. To offer a theoretical basis for future educational backgrounds for VR and AR, we investigate features and communications

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crucial to learning use in educational applications, as well as many learning theories. Several VR/AR learning instances are investigated, as well as analyzed, and various promising areas for additional study are suggested, including a stronger emphasis on convenience, the interaction between real-world and imaginary environments, and recommendations for efficient learning system foundations.

Keywords: Augmented reality, virtual reality, mixed reality, education, augmented reality-based learning environment, higher education, remote learning

1.1 Introduction

In the era of technology and 4th industrial developments, educators think it is important to introduce new learning ideas and shift attitudes to spur creativity across the board. Promoting a curriculum that is driven by problem-solving, exploration, and experiential learning will change education from a normal teacher-centric classroom to a child-centered one. Numerous concepts have emerged in response to the rise of smartphones and other digital devices, together with the most recent advances. Virtual reality (VR), which enables users to incorporate themselves in an environment created by a computer, is one such idea. The definitions of VR, augmented reality (AR), and mixed reality (MR) have entered common discourse, thanks to the rising technology sector. In essence, VR submerges users in an entirely digitized environment, AR superimposes virtual objects in the fixed world, and MR combines virtual elements into the real world and frequently enables human interaction [1].

The COVID-19 pandemic has brought to light the necessity for distance learning to adapt so that it cannot only escape a crisis wave, but also maybe fit the new normal. Governments are becoming more aware of the possibility of cutting-edge technologies like VR and AR to discuss some of the drawbacks of correspondence courses over in-person instruction, including academic misconduct, a decline in socioeconomic aspects of learning, a lack of actual kinesthetic interactions, difficulties preserving students' attention, and the practice of technological boundaries. The deployment of these sophisticated and expensive technologies must be decided upon, not based on technical hype, but rather on results that have been supported by science.

Education research has consistently concentrated on the precise actions a tutor should take to help pupils learn through performance, increase their focus and motivation in class, and develop the necessary skills for this modern period. Students can learn via hearing and seeing, picturing, imagining, acting out, or memorization, according to Felder [1]. In the same way that learning styles differ, so do teaching methods; some instructors emphasize application, some on idea demonstration, and others on understanding. But in a laboratory, learning is dependent on both the training style of the teacher and the student's learning style. Education places a high value on learning experiences, which call for the mental imagery of ideas to better grasp parallels with less mental effort [2].

Rapid advancements in science and technology nowadays impact and alter people's lifestyles. The educational process and educational surroundings cannot remain unaffected by this transformation, aside from people. Comparing technologies utilized in education settings from the past to the present—the journey from the use of a chalkboard to the computer to the Internet—a trend may be noted toward connected phones with artificial intelligence. Education services could not be excluded from the sector since computer and Internet technologies, particularly in recent years, have such a wide range of applications in our daily lives.

Since today's students are classified as members of the Z generation or the digital generation, educators must keep up with technology advancements and employ the best available tools in learning environments. Education-related AR applications are one of these emerging technologies. There are several meanings of the term "AR" that scholars have established, according to an analysis of the literature. These definitions include the following:

The broadest definition of AR is that "it is a realistic setting where digital media items are employed instead of real-world things." It asserts that AR is a descendant of VR. This concept describes AR as an imaginary world that supplements present reality rather than creating it from scratch. In this setting, users may interact harmoniously with both virtual and actual items in AR surroundings. The interacting space between the virtual and physical worlds is created by AR. This is accomplished via AR. When definitions in the literature are compared, it can be said that AR is the process of enhancing the actual environment with digital things.

Applications for AR are being developed quickly every day, and utilization areas across many industries are beginning to expand. Major businesses have begun to prioritize adopting AR to provide their customers with a more embodied and genuine experience. This technology merges the virtual and physical worlds and may be found in a variety of industries, including food, automobiles, cosmetics, and construction. Today, it is crucial for businesses to identify target consumers, follow their behavior, and use technology for sustainable marketing and brand recognition. The most significant factor is that both public and private sector businesses invest in improved technology in more effective ways to sell or promote their services or goods, and they require competent individuals and businesses in this area. Businesses having access to technology may make use of these services, thanks to AR applications.

Although there are various uses for AR apps, the sector of education is the most significant. Over time, educators have become more interested in the novel educational prospects provided by AR technology [3]. The following fresh possibilities and benefits, when assessed, can be achieved [4–6]:

(a) To deliver additional flexible and exciting learning settings for students
(b) To experience a level of ecstasy they have never experienced
(c) To boost students' eagerness also enthusiasm to learn
(d) To encourage students to actively observe their learning processes and to generate hypotheses from these observations
(e) To improve students' academic achievement and assist them in developing social relationships inside the group, linking formal and informal education, and promoting group learning among pupils
(f) The application of AR promotes a sense of liberty, autonomy, and privacy
(g) To foster learning to open new educational options

Wearable technologies catch the eye when AR, which is widely used in the education sector, is evaluated. Smart sensors that can measure the movement of the body are abundant in wearables. Typically, these gadgets seamlessly sync with smartphones via Bluetooth, Wi-Fi, and mobile Internet connections. Sensors are used to link users to portable electronics. Regarding products the user always carries with them, wearable technology offers vital services in a variety of fields, particularly in entertainment, health, employment, information, education, sociability, and security.

1.1.1 Organization of the Chapter

This chapter is systematized in this manner: Section 1.1 introduces the concept of VR/AR applications in education. Section 1.2 characterizes the literature background involving materials and methods to interact between AR and VR. Section 1.3 elaborates the VR/AR adaptability in education. Section 1.4 emphasizes the framework of the ARLE System. The analysis of the digital learning environment in the context of AR and VR is presented in Section 1.5. General discussion and future aspects are concluded in Section 1.6.

1.1.2 Multimedia Principles

Two basic multimedia principles are implemented and investigated in the studies that we present. The spatial contiguity principle, which interacts with geographically connected physical and virtual aspects, and the coherence principle, which interacts with integrated visual and auditory depictions of contextually integrated virtual and physical elements.

1.1.2.1 Study One: Spatial Contiguity Principle

Examining the geographical integration of imaginary and real elements is the aim of the first investigation. The learning materials are entirely visual, and they emphasize how the spatial contiguity concept is applied in AR. The idea can be used to spatially integrate the viewing of both virtual and real-world objects in applications of AR. In the study, a genuine graphical environment is combined with virtual textual content. We wish to determine whether the spatial contiguity principle, specifically this implementation of the concept, has a favorable impact on cognitive parameters such as cognitive burden, task load, and knowledge.

By lowering visual search procedures and the duration of time that the various components must be maintained in working memory for mental fusion, we anticipate that adhering to the geographical contiguity principle through AR reduces superfluous processing, and hence extraneous cognitive burden (H1.1a). The accessible working memory capacity can be utilized for creative processing when information is integrated rather than isolated, increasing the relevant cognitive load (H1.1b).

We also propose that the task load is influenced by the geographical integration of the learning material. We anticipate that as the visualization is integrated, there will be less of a need to store discrete components in working memory for longer periods (H1.2a). Fewer eye movements are required due to the reduced need for visual search processes, which lowers the physical strain (H1.2b). In addition, since integrating the presentation requires fewer simultaneous search and processing steps (H1.2c), we anticipate that the temporal demand will be reduced. We suggest that the integrated presentation makes it simpler to comprehend the material, which results in better performance (H1.2d), as well as lesser work (H1.2e) and dissatisfaction (H1.2f). When information is spatially integrated, we could anticipate enhanced knowledge due to the reduced irrelevant cognitive load, workload-related variables, and the ensuing rise in relevant cognitive load (H1.3). A summary of all of Study One's hypotheses is given in Table 1.1.

Table 1.1 Hypotheses in Study one: spatial contiguity principle.

H1.1a	Lower unnecessary cognitive load results from learning with a unified display of real-world and virtual knowledge as opposed to learning with segregated demonstration.
H1.1b	Comparatively to learning with such a separate demonstration, learning with a unified presentation of real-world and virtual knowledge results in a higher relevant cognitive load.
H1.2a	Less mental effort is required to learn when actual and virtual facts are presented together rather than separately.
H1.2b	Less physical effort is required to learn when actual and virtual information are presented together than when they are presented separately.
H1.2c	Learning with the unified display of real-world and imaginary information was less time-consuming than learning from a separate presentation.
H1.2d	Learning with the unified display of real and imaginary information produces higher performance ratings than training with a separate presentation.
H1.2e	Learning with the unified display of real and imaginary knowledge demands less effort than learning from a separate presentation.
H1.2f	Less dissatisfaction is experienced during learning when actual and virtual facts are presented together rather than separately.
H1.3	Learning with the combined display of real-world and imaginary content results in better information retention than studying with a separate presentation.

1.1.2.2 Study Two: Coherence Principle

Examining the background coherence of imaginary information is the aim of another study. The application of the coherence principle in AR is the main topic of audio-visual instructional material. The idea may be used with both realistic and imaginary, visual and audio aspects in applications of AR. In the study, in addition to actual ambient noises, simulated sounds matched or did not match the subject matter of the added learning material to an application including simulated words, as well as images. In comparison to virtual auditory features, these noises are not directly related to the learning goal.

We propose that adhering to the coherence principle in AR and excluding noises results in decreased unnecessary dispensation and, consequently, in unnecessary cognitive load (H2.1a) due to the fewer items that must be processed. However, because of inspirational properties, matching sounds are anticipated for the rise in germane cognitive load in the limits through which non-matching sounds are unprovoked. For generative processing, functional memory capacities are made available that raise germane cognitive load having no addition in sounds (H2.1b).

Furthermore, we propose that adherence to the coherence principle affects work burden. We predict that when no noises are provided, both demands of psychological (H2.2a) and corporeal (H2.2b) are reduced because there is less sensory information that must be attended to and because fewer sensory organs are explicitly used. Because reduced physical information may be treated in a similar amount of period when new noises are absent (H2.2c), we also anticipate a reduction in temporal demand. We argue that the absence of extra noises increases perceptions of greater presentation (H2.2d) and reduced effort due to the reduced possibility for distraction through additional sensory information (H2.2e).

On the one hand, it is expected that frustration will be reduced when no disturbing sounds are added at all. On the other hand, expectations of frustration will be reduced when matching sounds are added, as opposed to non-resembling sounds whose reason for addition is unclear, which may result in even greater hindrance (H2.2f). When no sounds are added, we could also anticipate increased resulting knowledge due to reduced irrelevant cognitive load, as well as factors related to workload. Although, we could also anticipate that corresponding sounds produce advanced resulting knowledge other than non-matching sounds due to motivating effects and a reduction in frustration (H2.3). Table 1.2 provides a summary of Study Two's hypotheses.

1.2 Materials and Methods—Interaction between AR and VR

This study of the literature provides a thorough and worthy description of usages of VR and AR in the context of social education and serves as a starting point for a conversation and a more in-depth examination of VR/AR in learning. Although VR and AR use many of the same technology, such as tracking sensors and screens, they take two distinct methods to fuse the actual world with the virtual world. Virtual reality is a simulated imaginary