Brief Review

Virtual Reality in Education and Its Impact on Adolescent Learning and Mental Health

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ABSTRACT

This study examines the role of Virtual Reality (VR) in education and explores its impact on adolescent learning and mental health. It specifically aims to evaluate the educational benefits of immersive environments, such as increased cognitive engagement, active learning, and the development of empathy, while also highlighting potential psychological and social risks associated with excessive or unsupervised use during adolescence. This narrative literature review analyzes peer-reviewed articles, theoretical papers, and review studies, focusing on cognitive engagement, learning motivation, social-emotional development, and potential risks, including cybersickness and technology overuse. The findings indicate that VR can enhance learning by increasing participation, motivation, and understanding of complex concepts. Additionally, immersive simulations appear to support the development of empathy and social skills and may benefit adolescents with social anxiety or autism. However, risks such as cybersickness, cognitive overload, and technology dependence are also identified, particularly when VR is used excessively or without appropriate supervision. Overall, Virtual Reality emerges as a promising educational tool that can enhance both cognitive and psychosocial aspects of adolescent development when implemented within well-structured pedagogical frameworks. Nevertheless, careful design, supervision, and ethical considerations are essential to minimize potential risks and ensure that immersive technologies contribute positively to adolescent learning and wellbeing.

KEY WORDS: virtual reality, adolescents, education, mental health, immersive learning

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Introduction

Virtual Reality (VR) technologies have increasingly attracted attention within the field of education due to their capacity to create immersive and interactive learning environments. The integration of VR into educational practice aligns with several established theoretical frameworks in cognitive and developmental psychology. Constructivist learning theories suggest that knowledge is actively constructed through interaction with the environment rather than passively received from instructors. Foundational theorists such as Piaget emphasized that learning occurs through active exploration and cognitive restructuring as individuals encounter new experiences and adapt their existing mental schemas (1). Similarly, Vygotsky highlighted the importance of social interaction and guided learning processes in the development of higher cognitive functions (2).VR environments closely align with these theoretical perspectives because they allow learners to actively interact with simulated contexts. Within immersive environments, students can experiment, make errors, and repeat tasks in a safe digital setting that encourages experiential learning (3). Such experiences enable learners to engage with complex phenomena that might otherwise be inaccessible due to cost, safety concerns, or logistical constraints. For example, simulations can recreate laboratory experiments, historical environments, or medical training scenarios that would be difficult to replicate in traditional classrooms.Vygotsky's concept of the Zone of Proximal Development (ZPD) further supports the use of collaborative virtual environments in educational contexts (2). The ZPD refers to the range of tasks that learners can accomplish with guidance from more knowledgeable peers or instructors. In multi-user virtual environments (MUVEs), learners can collaborate with peers, instructors, or intelligent tutoring systems that provide scaffolding and real-time feedback, thereby facilitating skill acquisition and conceptual understanding (4). Situated cognition theory further emphasizes that learning is most effective when knowledge is embedded within authentic and meaningful contexts (5). VR simulations can recreate realistic professional or social situations in which learners must apply theoretical knowledge to practical challenges. For instance, virtual simulations of historical settings or professional environments allow students to engage with complex scenarios in ways that promote deeper comprehension and knowledge transfer. From the perspective of multimedia learning theory, immersive technologies must also be designed carefully to avoid excessive cognitive load (6,7). According to Mayer's principles of multimedia learning, educational materials should be

structured in ways that optimize cognitive processing by balancing visual, auditory, and interactive elements (7). While immersive technologies can enhance engagement, poorly designed VR environments may overwhelm learners with excessive sensory information. Consequently, effective instructional design plays a crucial role in ensuring that immersive environments support rather than hinder learning processes.

Virtual Reality and Adolescents' Developmental Needs

Adolescence represents a developmental stage characterized by profound biological, cognitive, and psychosocial transformations. Neurodevelopmental research indicates that the prefrontal cortex, which is responsible for executive functions such as planning, impulse control, and decision-making, continues to mature into early adulthood (8,17). During this period, adolescents often exhibit increased sensation-seeking behavior and heightened emotional responsiveness due to the ongoing development of neural systems associated with reward processing and emotional regulation. Immersive technologies such as VR may align with adolescents' developmental needs for exploration, experimentation, and experiential learning. By providing simulated environments that encourage interaction and discovery, VR addresses developmental needs for exploration and autonomy while maintaining a controlled educational framework (9). Adolescents may benefit from immersive experiences that allow them to explore complex concepts in ways that traditional instructional methods cannot easily replicate. Research suggests that virtual environments may also contribute to psychosocial development by offering opportunities to practice social interactions and emotional regulation. Simulated social scenarios, for example, have been used to support interventions for individuals experiencing social anxiety or difficulties with interpersonal communication. Such environments allow users to practice social behaviors within safe and controlled settings, potentially reducing anxiety and improving emotional regulation (10). Additionally, immersive environments may enhance motivation by promoting active participation and learner autonomy. Adolescents often respond positively to interactive learning experiences that provide opportunities for decision-making and problem-solving. Educational research has demonstrated that VR-based learning environments can increase student engagement and motivation compared with traditional instructional methods (11). Despite these potential benefits, concerns have been raised regarding the possible negative effects of prolonged or poorly supervised VR use among adolescents. Immersive environments may produce symptoms consistent with behavioral addiction or problematic technology use,

particularly when individuals become highly engaged in reward-based digital environments (24). These risks are especially relevant during adolescence, a developmental stage associated with increased vulnerability to impulsive behavior and reward-seeking. Another commonly reported concern involves cybersickness, a condition characterized by symptoms such as nausea, dizziness, headaches, and visual discomfort during or after VR exposure (12,22,23). Cybersickness occurs when discrepancies between visual and vestibular sensory inputs create sensory conflict within the brain. Although technological improvements have reduced these effects in recent years, they remain a significant consideration when implementing VR in educational contexts. Moreover, immersive multisensory environments may contribute to cognitive overload if they present excessive or poorly structured information. Adolescents with learning difficulties may be particularly susceptible to such challenges, as complex visual and interactive elements may overwhelm cognitive processing capacity (13). In some cases, highly immersive environments may also reduce the perceived boundary between real and virtual experiences. For vulnerable individuals, particularly those with emotional or developmental difficulties, intense engagement with virtual environments may influence perceptions of identity and social relationships (14). Consequently, careful supervision and structured implementation are essential to ensure that VR technologies support healthy developmental processes. Encouragingly, research has also demonstrated positive outcomes of VR interventions for adolescents with developmental conditions such as autism spectrum disorder. Virtual environments have been used successfully to support social skills training, attention development, and understanding of social cues among adolescents on the autism spectrum (15).

Potential Positive Effects of Educational Virtual Reality

One of the most widely recognized benefits of VR in education is its ability to support active learning. Immersive environments encourage students to interact directly with learning materials rather than passively receiving information. According to the ICAP framework of cognitive engagement, active and interactive learning activities are associated with deeper conceptual understanding and improved learning outcomes (18). VR is particularly valuable for teaching complex or abstract concepts that require spatial reasoning or visualization. For example, immersive simulations can enable students to explore molecular structures, astronomical systems, or anatomical models in three-dimensional space, thereby facilitating comprehension of concepts that may be difficult to understand through static images or textual descriptions (19). Another important benefit involves emotional engagement and empathy development. Perspective-taking experiences in VR have been shown to foster empathy by allowing individuals to experience situations from another person's viewpoint. Research comparing traditional perspective-taking exercises with immersive VR simulations has demonstrated that VR can produce stronger and longer-lasting empathic responses (21). Such experiences may contribute positively to adolescents' social development and moral reasoning. Educational environments that align with adolescents' developmental needs can also enhance engagement and academic motivation. According to stage–environment fit theory, adolescents perform best when educational contexts provide opportunities for autonomy, social interaction, and meaningful participation (20). Immersive technologies may support such conditions by enabling collaborative learning experiences and interactive exploration. Repeated successful performance in virtual environments may also strengthen adolescents' sense of self-efficacy. When learners are able to practice skills in simulated contexts and gradually improve their performance, they may develop greater confidence in their abilities. This process can contribute to resilience and persistence when According to the DSM-V manual of the American Psychiatric Association, and as noted by confronting academic challenges (10,21). VR may additionally support inclusive educational practices. For adolescents with attention difficulties or autism spectrum conditions, immersive environments can provide structured and predictable contexts in which to rehearse social interactions or practice academic tasks (15). Such environments may reduce anxiety associated with real-world social situations while providing opportunities for skill development.

Potential Risks and Negative Effects

Despite its educational potential, VR use among adolescents also presents several risks that require careful consideration. The most commonly reported adverse effect associated with VR exposure is cybersickness. Symptoms such as nausea, dizziness, visual fatigue, and disorientation have been documented across a variety of VR applications (22,23). These effects are particularly relevant in educational contexts where students may use head-mounted displays for extended periods. Another potential concern involves technology-related dependence. Immersive environments often incorporate reward systems and interactive feedback that may reinforce continued engagement. For

adolescents who are already vulnerable to excessive digital media use, such mechanisms may contribute to problematic use behaviors (24). In addition, immersive technologies may reduce the perceived boundary between real and virtual experiences. Adolescents who spend excessive time in virtual environments may substitute digital interactions for real-world social relationships, potentially increasing social isolation (14). This risk may be particularly pronounced among individuals who already experience difficulties with peer relationships. Exposure to emotionally intense or distressing virtual scenarios may also place psychological strain on adolescents. Because VR environments create a strong sense of presence and realism, emotionally charged simulations may evoke strong psychological responses (14). Consequently, educational applications should be carefully designed to avoid unnecessary psychological stress. To mitigate these risks, educators and institutions must implement clear guidelines regarding appropriate usage duration, supervision, and content selection. Structured pedagogical integration and monitoring are essential to ensure that VR technologies are used responsibly and effectively in educational settings (16).

Ethical and Deontological Considerations

The implementation of VR in education also raises important ethical considerations. VR should be understood as a non-neutral educational intervention with potential cognitive, emotional, and social implications (14). Decisions regarding the design and implementation of immersive technologies must therefore take into account both educational benefits and potential developmental risks. One major ethical issue concerns data privacy and surveillance. Many immersive systems collect behavioral, physiological, or biometric data in order to enhance user interaction or personalize learning experiences. The collection and storage of such sensitive data raise concerns regarding privacy protection and informed consent, particularly when adolescents are involved. Another ethical consideration involves the psychological effects of immersive role-play experiences. Intense identification with virtual roles may influence adolescents' perceptions of identity and social relationships. Although such experiences may be beneficial in educational contexts, they must be carefully moderated to avoid unintended psychological consequences (8,14). Equitable access to immersive technologies also represents a significant ethical concern. Schools and educational institutions vary widely in their technological resources, and unequal access to VR technologies may exacerbate existing educational and social inequities. Ensuring equitable distribution of technological resources is therefore essential for responsible implementation.

Limitations

This review has several limitations that should be acknowledged. First, the present study follows a narrative review approach and does not employ a systematic search strategy or predefined inclusion and exclusion criteria. As a result, the selection of studies may reflect subjective interpretation and may not represent the full scope of the available literature. Second, potential publication bias may exist because studies reporting positive outcomes of VR-based interventions may be more likely to be published than studies reporting negative or inconclusive findings. Consequently, the literature reviewed in this paper may overrepresent favorable results regarding VR applications in education. Third, the review primarily includes studies published in English-language journals. This limitation may reduce representation of research conducted in other linguistic or regional contexts. Future research should aim to incorporate broader international perspectives, including studies conducted in diverse cultural and educational settings. Finally, VR technology is evolving rapidly, and new empirical findings continue to emerge. As a result, some conclusions presented in this review may require revision as additional research becomes available.

Conclusion

Virtual Reality has created new opportunities for enhancing adolescent learning and psychosocial development. Immersive environments allow students to engage actively with complex concepts, practice skills in realistic simulations, and develop empathy through perspective-taking experiences. When implemented within structured pedagogical frameworks, VR technologies can support active learning, motivation, and social development among adolescents (1–7,18,19). At the same time, potential risks such as cybersickness, cognitive overload, and problematic technology use must be carefully monitored (12,22–24). Adolescence represents a sensitive developmental stage characterized by ongoing neurological and psychosocial maturation, and immersive technologies may exert particularly strong influences during this period (8,17).For these reasons, VR requires critical, ethically informed application to ensure that technological innovation aligns with developmental protection and educational responsibility. With appropriate instructional design, supervision, and ethical awareness, VR has the potential to become a valuable tool for supporting both educational achievement and adolescent wellbeing.

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