EMOTIONAL MANAGEMENT IN ADHD: THE CONTRIBUTION OF ARTIFICIAL INTELLIGENCE AND VIRTUAL REALITY IN EDUCATIONAL CONTEXTS

LA GESTIONE DELLE EMOZIONI NELL'ADHD: IL CONTRIBUTO DELL'INTELLIGENZA ARTIFICIALE E DELLA REALTÀ VIRTUALE NEI CONTESTI EDUCATIVI

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ABSTRACT

This essay explores the transformative potential of Virtual Reality and Artificial Intelligence in educational innovation. Through immersive, interactive, and personalised learning experiences, they are revolutionising traditional educational models. In particular, the use of such technologies to address challenges related to emotional regulation in children with ADHD is analysed, emphasising the importance of creating inclusive and effective learning environments.

Questo saggio esplora il potenziale trasformativo della Realtà Virtuale e dell'Intelligenza Artificiale nel campo dell'innovazione educativa. Attraverso esperienze di apprendimento immersive, interattive e personalizzate, stanno rivoluzionando i modelli educativi tradizionali. In particolare, si analizza l'utilizzo di tali tecnologie per affrontare le sfide legate alla regolazione emotiva nei bambini con ADHD, sottolineando l'importanza di creare ambienti inclusivi ed efficaci per l'apprendimento

Introduction

Virtual Reality (VR) and artificial intelligence (AI) represent two innovative technologies that are reshaping numerous sectors, including education(Bersaglieri, 2022; Kowalicka, 2022; Panciroli et al., 2020). The first definition of VR goes back to Bryson, in 1998, who stated that "*Virtual Reality is the use of computer technology to create the effect of an interactive three-dimensional world in which objects have a sense of spatial presence*"(Bryson, 2013). VR enables users to immerse themselves in simulated environments, interacting with virtual objects and characters in a natural and immersive manner.(Rubio-Tamayo et al., 2017) Meanwhile, AI, often likened to the human mind for its capacity to learn, process information, and make decisions in a human-like fashion, plays a pivotal role in enhancing VR experiences(Petrović, 2018). By analysing user behavioural data within VR environments, AI can adapt the virtual surroundings based on individual preferences and habits, offering a more personalized and engaging experience.

The combination of VR and AI, due to their characteristics and strengths, is effectively revolutionising sectors of different nature, creating innovative opportunities and significantly improving user experience in a variety of fields.

In the healthcare sector, VR is being used to simulate complex medical procedures, allowing healthcare workers to gain hands-on experience in a safe and controlled environment, and at the same time, AI supports diagnostics by analysing large amounts of clinical and imaging data to detect patterns and correlations that are difficult for humans to detect. This combination enables more accurate and timely diagnoses, greatly improving patient care(T. D. Parsons et al., 2017; Pillai & Mathew, 2019).

In the entertainment industry, in video games first and foremost, VR offers immersive and immersive experiences, transporting users into detailed virtual worlds(Pallavicini et al., 2019; Zyda, 2005). At the same time, AI personalises the user experience, suggesting content and interactions tailored to individual preferences. From a play and entertainment perspective, such modalities not only increase user engagement, but also make users an integral part of narratives and experiences, creating unique emotional and participatory bonds.

The military exploits VR for the simulation of training and operational scenarios, allowing armed forces to test strategies and capabilities in highly realistic virtual environments(Gluck et al., 2020). Simultaneously, AI provides support in analysing intelligence data, identifying patterns and anomalies to improve the effectiveness of military operations and troop safety.

Furthermore, another sector that is beginning to take advantage of VR and AI is the automotive industry, as VR is crucial in the design and simulation of vehicles, and in the testing of prototypes before realisation, while AI powers advanced driver assistance systems, ensuring safer and more efficient driving through the analysis of road data and the prediction of vehicle behaviour(Firu et al., 2021; Jain & Kulkarni, 2022).

And last but not least, in the field of education, the integration of VR and AI offers a new educational paradigm in which students can learn in an active and personalised way. In recent years, the integration of VR and AI has spread significantly in educational contexts, leading to transformative changes in teaching and learning methodologies(Au & Lee, 2017; Miao et al., 2021).

These new approaches in pedagogical settings have led to a number of positive effects that go beyond simply improving learning processes and school knowledge. They contribute to promoting an increase in student motivation, fostering the development of stronger social relationships and, consequently, promoting the inclusion and psychological well-being of children(Hugh-Jones et al., 2023). The interactive and personalised nature offered by VR and AI, even during learning experiences, stimulates students' curiosity and interest, increasing their intrinsic motivation to learn. They feel actively involved in the learning process, as they are encouraged to explore, experiment, and interact with content in a more direct and engaging way than with traditional methods. They also foster collaboration and interaction among students, creating opportunities for the development of social relationships. Through collaborative learning experiences and the sharing of knowledge and skills, students learn to work together, communicate effectively, and develop a sense of belonging to the educational community.

Because of this, these approaches have also been shown to have a significant impact in disability and learning disorders, including children with Specific Learning Disorders, Autism Spectrum Disorders and ADHD(Barua et al., 2022). Indeed, the immersive and personalised nature of the learning experiences offered by VR and AI is adapted to the different needs and learning styles of these students.

This paper embarks on an in-depth exploration through a comprehensive literature review to delve into the synergistic advantages arising from the integration of VR and AI within educational environments. The primary focus lies in their potential to not only augment academic learning but also to significantly improve the social well-being of children, particularly those grappling with Attention Deficit Hyperactivity Disorder (ADHD). Leveraging the immersive experiences facilitated by

VR and the personalized learning pathways facilitated by AI, educators strive to fortify students' emotional intelligence. This entails furnishing them with an array of tools and resources tailored to navigate daily challenges and to access learning opportunities with heightened efficacy and inclusivity. By delving into the intricacies of these technological advancements, this study aims to illuminate the transformative capacity of VR and AI in cultivating holistic development and fostering educational equity for all students.

1. VR and Artificial Intelligence in Educational Context

In the educational landscape, the integration of technology has become an inevitable way forward(Vesisenaho et al., 2019). Indeed, technology now invades every aspect of our daily lives, transforming the way we work, communicate, and learn. However, its introduction is not just a passive phenomenon, but an active development that offers us the opportunity to completely redefine the educational process. The advent of information technology and the Internet has accelerated the number of educational applications and electronic learning content.

Among the many technological strategies adopted by new pedagogical approaches, VR and AI have found fertile ground and are already finding consistent application, leading to changes in traditional educational practices.

These technological approaches have introduced new ways of learning that are more immersive and engaging, allowing students to interact directly with learning materials in three-dimensional environments. It has also made learning more accessible, allowing students to explore complex concepts in a more intuitive and personalised way. VR applying the principles of constructivism, which envisages active learning by the learner, has also provided new opportunities for experience-based learning, allowing students to acquire skills through hands-on experiences in different domains.

Scientific research has already been set in motion to study the benefits and possible risks related to the introduction of these technologies in school contexts, to assess their effectiveness, efficiency, from different points of view.

Kavanagh et al. (2017) carried out a literature review on the use of VR in education, highlighting numerous benefits(Kavanagh et al., 2017). Among these benefits are enhanced learning, increased time devoted to school tasks, heightened motivation to acquire new knowledge, and greater enjoyment in the learning process.

Black et al. (2017), underscored the profound impact of VR on history education. These technologies provide the opportunity for virtual journeys through historical epochs, enabling students to fully immerse themselves in the historical context. This immersive experience renders tangible and practical what would otherwise remain mere theoretical or mnemonic concepts(Black, 2017). This approach has been effectively implemented in numerous projects, such as at the archaeological site of Pompeii, allowing students to observe and study the Pompeian civilisation prior to the eruption of Vesuvius in 79 A.D(Jacobson & Vadnal, 2005).

Besides the academic, learning and training aspects of students, there are numerous studies that have instead investigated the effect of VR and Artificial Intelligence from a psychological, emotional, and social perspective. In fact, some of them have shown that the use of VR in the classroom leads to an improvement in motivation, enjoyment and self-efficacy compared to conventional training methods(Chittaro & Buttussi, 2015). In addition, Hugh-Jones and colleagues, demonstrated how structured programmes based on innovative technologies such as VR can be useful as prevention tools for mental well-being in adolescent students(Hugh-Jones et al., 2023). In particular, this study, through a qualitative analysis carried out in some schools in the United Kingdom, and a feed-back from the teachers, showed in the majority of cases, an increased participation and motivation and a reduced stress on the part of the students who agreed to participate in the study. Furthermore, this study also reported benefits for students with autism and ADHD, finding, in particular, greater calm and concentration after 15 to 30 minutes of activity through VR.

2. Attention deficit hyperactivity disorder (ADHD)

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterised by inattention, impulsivity and hyperactivity, occurring during childhood onset(Scahill & Schwab-Stone, 2000). Diagnosing ADHD requires a nuanced and comprehensive approach. Clinicians need to manage the intricate interplay between ADHD symptoms and features related to other neurodevelopmental disorders such as ASD, recognising how these may intertwine or manifest differently in each individual(Minino, 2022). Differential diagnosis is crucial to ensure accurate identification and tailored interventions.

Interventions for individuals with ADHD are characterised by behavioural interventions such as cognitive-behavioural therapy (CBT) and social skills training, which can help improve executive dysfunction, sensory sensitivities and social

communication deficits, thereby improving adaptive functioning and reducing ADHD symptoms.

In addition to traditional therapies, it is essential to consider the implementation of other methodologies aimed at supporting and improving the day-to-day conditions of children with ADHD. The emotional difficulties that these children often encounter, resulting from their reduced ability to manage emotions and situations, can have a negative impact on their social interactions and inclusion in school and relational contexts.

The adoption of innovative teaching methodologies in educational contexts plays a crucial role in supporting individuals with ADHD in their schooling. Therefore, it is of great interest to explore the application of innovative methodologies that can provide targeted resources and tools to address the challenges related to these difficulties, thus promoting an inclusive learning environment, and fostering students' social and relational well-being.

3. Beneficial Effect of VR in Children with ADHD

As we have already pointed out in the previous sections, VR offers a wide range of benefits for children of developmental age, from purely academic to psychological. The scientific interest that has developed towards these new technologies in the educational sphere has taken many paths, one of which, that of the benefits in situations of disability or neurodevelopmental disorders, and in particular, in children with ADHD.

Through the use of immersive and interactive technologies, VR provides an immersive learning environment, with reduced likelihood of distractive events, which can greatly increase the prospects of success for children with ADHD(Alqithami et al., 2019). Indeed, as previously pointed out, one of the most significant aspects of VR is its ability to provide a realistic simulation of situations and environments, immersion in a protected context. This allows children to learn in a motivating context, and also to experience and practise social and emotional skills in a controlled environment (Romero-Ayuso et al., 2021).

Indeed, VR is described in some studies as an 'Embodied Technology', according to the predictive coding hypothesis. This theory claims that VR is able to generate simulations of the body within the virtual world, allowing users to explore and manipulate their surroundings. This process improves self-regulation and learning

through the representation of predictions of internal and external sensory stimuli. These features are particularly pertinent for individuals with ADHD, as VR's ability to generate realistic simulations and provide a protected environment aligns well with their specific needs.

Furthermore, VR offers a highly customised learning mode, adaptable to the specific needs of each child. Through the use of motion tracking technologies and real-time feedback, VR can adapt the level of challenge and type of activity according to each child's individual abilities and progress, thus promoting more effective and rewarding learning. The case study conducted by Parsons et al. (2007) showed that the adaptability of VR to the individual needs of children with ADHD led to increased motivation and engagement in learning.

The case study conducted by Rizzo et al. (2009) explored the effectiveness of VR in improving attention and concentration in children with ADHD through the use of educational games and interactive activities. The results showed that children exposed to VR exhibited a significant increase in attention and concentration during learning activities compared to the control group.

It is crucial to emphasise that despite the many benefits of immersive and personalised technologies for children with ADHD, it is crucial to carefully consider the potential risks. Some studies have emphasised the importance of using such tools in presential contexts. In particular, there is ample evidence that virtual classroom adherence may even impair the attention span of children with ADHD, compared to a control group(Adams et al., 2009; Neguț et al., 2017).

4. **Emotional management development through VR and AI in children with ADHD**

In the context of scientific research, the potential of emerging technologies, in particular VR and AI, and their combination, especially with regard to children with ADHD, becomes evident. We have highlighted the numerous benefits that these technologies offer, both in terms of learning and improving motivation and attention. Another crucial aspect to consider is the impact these systems can have on the management and regulation of emotions in children with ADHD, an aspect that is often compromised in individuals with this disorder(S. Parsons & Mitchell, 2002). It is important to emphasise that emotion management and emotional intelligence are crucial to foster social inclusion and promote a children's social and relational well-being. Indeed, the ability to regulate emotions can significantly

influence a child's interaction with the world around him and his relationships with others.

Indeed, the immersive nature of VR provides children with ADHD a rich and engaging platform to immerse themselves in, fostering exploration and practice of emotion regulation techniques within safe and controlled virtual environments. Simultaneously, the integration of AI plays a pivotal role in customising interventions to meet the unique needs and preferences of each child, thereby optimising the efficacy and impact of the intervention.

A recent study by Drigas and Mitsea (2020) has shown that the use of digital games and VR can be extremely effective in strengthening the metacognitive and emotional skills of these children (Drigas & Mitsea, 2020). In particular, this review article highlights the significant potential of VR games in improving the metacognitive, social and emotional skills of people with special needs. Through a comprehensive analysis, it emphasises how customised educational applications of VR offer a playful, safe, controlled and motivating training environment.

Another systematic review by Wang et al. in 2021 revealed that the majority of the papers included in the study reported positive results on the effectiveness of VR in improving children's social skills(Wang et al., 2021). This includes the ability to interact socially, develop empathy, gain perspective, and recognise emotions in others. The immersive environments and realistic characters of VR seem to stimulate children's curiosity and promote interactivity, providing an immersive environment for therapy.

Through interactive and immersive scenarios, children develop the ability to identify and manage intense emotions and impulsivity while improving emotional awareness and self-regulation skills. The adoption of VR as an educational tool proves particularly valuable for children with ADHD, as it offers an engaging and highly personalised learning experience, adapting to their specific needs and challenges.

It should be noted that some studies have highlighted an improvement in social skills with Augmented Reality (AR) as well(Doulou & Drigas, 2022; Ocay et al., 2018). AR is a technology that creates an interactive experience by overlaying digital elements onto the real world. As VR, its interactive nature can encourage learning through practical and engaging experiences, helping children with ADHD develop social and cognitive skills in a fun and stimulating way. However, unlike VR, it provides the opportunity to display instructions or feedback directly in the real context, without modifying or altering the environment being experienced.

Conclusion

In conclusion, the integration of VR and AI technologies in education provides a rich landscape of opportunities and potential. It is clear from our analysis that these innovations are radically redefining the way we learn and teach, bringing with them several clear advantages.

Our investigations revealed that the use of VR and AI in schools and educational institutions can significantly enhance student learning, increase motivation, foster greater participation and engagement during learning activities.

Furthermore, it is important to recognise the crucial role these technologies can play in the context of disabilities, particularly in addressing challenges related to ADHD. Indeed, immersive technologies such as VR provide a safe and controlled environment in which children with ADHD can not only a practise emotional regulation strategies but also improve cognitive and social skills.

However, it is essential not to underestimate the possible critical issues associated with the use of these technologies. These include, for example, the potential misuse, or abuse, of digital platforms, a particularly relevant concern among young people. In addition, the significant cost required for widespread implementation in educational settings is a major obstacle. Furthermore, the lack of comprehensive training programmes for educators is a barrier to universal adoption.

To address these challenges and maximise the benefits of VR and AI technologies in improving the learning outcomes and well-being of students, particularly those with ADHD, clear objectives and practical strategies for the future are therefore essential. This involves the development of educational policies and initiatives to ensure the responsible and safe use of VR and AI in schools. Furthermore, concerted efforts are needed to advance research and innovation to create accessible and effective solutions for diverse student populations.

Only through collaboration and a comprehensive approach can the transformative potential of VR and AI technologies in education be fully exploited, thereby fostering a more inclusive and sustainable learning environment for all.

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