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Editorial: Metaverse in education: opportunities and challenges

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Editorial on the Research Topic
Metaverse in education: opportunities and challenges

The emergence of the Metaverse marks a transformative era in the field of education where learning transcends traditional classroom boundaries and enters immersive virtual environments. This digital transformation of learning and teaching pedagogies offers unparalleled opportunities for engaging, interactive and personalized educational experiences that enable learners to explore complex and practical concepts in visually stimulating ways. However, there remain significant challenges in terms of accessibility, equity, scalability, and technical advancement. With the Metaverse reshaping education, the academic community needs to address its challenges to unlock its full potential for enhanced learning. As part of this Research Topic, the following is a summary of the contributions made by fellow academics to highlight the applications, potential and associated challenges toward a fully functional educational metaverse.

Mirault et al. introduced an innovative study leveraging Virtual Reality (VR) to assess reading fluency in primary school children. The study utilized a VR adaptation of the lexical decision task to intricately record children's eye movements. It then assessed the external validity of VR metrics, including lexical decision reaction time and accuracy, gaze durations, and refixation probabilities, by comparing them with the traditional gold standard for reading fluency, the One-Minute Reading test. Findings revealed strong correlations between VR assessments and traditional fluency metrics, suggesting that VR-based assessment serves as a valid child-friendly alternative for assessing children's reading behavior.

Li J. T. S. et al. evaluated the use of augmented reality (AR) to teach post-stroke and COPD management to third-year pharmacy students in Hong Kong. Despite the use of AR modules for immersive learning, feedback from 54 students showed no improvement in knowledge or counseling confidence, with technical issues (e.g., setup complexity, network dependency, and battery drain) detracting from the experience. The authors suggest that the significant time and expense involved in creating AR content requires careful topic selection to ensure its cost-effectiveness, particularly when traditional methods could be just as effective.

Tang et al. proposed a design for immersive VR to train biomedical science undergraduates in animal handling. The authors developed a virtual animal handling simulator (ViSi) and reported that students participating in ViSi positively assessed their involvement in the virtual environment and their concentration on the assigned task. The authors noted that the impact of immersive VR technology integrated into skills training is promising, although there are a few technical problems to be resolved.

In their study of 360° Desktop Virtual Reality (DVR), Albus and Seufert found that using signals to highlight key information significantly increased recall and comprehension while reducing extraneous cognitive load, or unnecessary mental effort, among learners. However, they observed no difference in germane cognitive load, which is the effort related to the learning process itself, between the signaled and non-signaled groups. This indicates that signaling in DVR environments may enhance learning efficiency by improving memory performance and minimizing cognitive overload.

In this review article by Reyes et al., the authors explored the relationship between the Metaverse and complex thinking through a systematic review of the literature by analyzing 234 publications. Their study reveals that the extensive exploration of the Metaverse began in 2022, the timeline that aligns well with the advancements in the design of algorithms and virtual reality technology. This massive interest from the academic community underscores the importance of the Metaverse in fostering pedagogies centered around complex thinking that encompasses scientific, critical, systemic and innovative thinking. The research highlights how the Metaverse, when viewed through this lens, opens new horizons of research avenues to harness the Metaverse's full potential for the future academic landscape.

This review article by Mikhailenko et al. delved into the use of eye-tracking in immersive virtual reality for education, suggesting a transformative approach to educational methodologies. The review not only talks about the technicalities of eye-tracking but also covers its multifaceted applications across disciplines. The narrative is built around the integration of eye-tracking with virtual reality, with the potential to revolutionize the educational landscape through personalized and engaging learning strategies. The merging of eye-tracking and virtual reality can enable innovative learning and assessment approaches through a better understanding of student engagement and cognitive processes. The authors advocate for further research to maximize the benefits of eye-tracking in the virtual reality environment, which could unlock new dimensions of personalized learning experiences.

Li Z. et al. performed a comprehensive bibliometric analysis of virtual reality in anatomy education. The review, which covered publications from 1999 to 2022, revealed a substantial increase in research on the use of virtual reality in anatomy education, indicating a growing interest within the academic community. Learning human anatomy is challenging for medical students due to the lack of specimens for experimental teaching and the unclear observation of fine specimen structures. However, virtual reality can overcome such challenges by providing active learning environments and improving observational clarity. The article advocates for collaborative efforts across countries to further advance virtual reality-based anatomy education while highlighting the challenges associated with the technology costs and training requirements.

Myburgh reflected on the creation of virtual reality experiences for biology students. He highlighted how, during COVID-19, while academics around the globe tried to keep educational processes going, it was challenging to provide adequate learning support for subjects like biology that rely heavily on practical laboratory training. The author, therefore, emphasized the need for virtual laboratories with immersive learning environments to overcome such challenges in the context of remote teaching. The article presents an overview of the available resources that can be used by faculty for remote teaching; however, the creation of a set of free and open-source virtual laboratories is proposed to address the global demand for a more accessible, hands-on biology education.

The study by Mukasheva et al. evaluated a virtual reality (VR)–based workshop to support deeper learning of sorting algorithms. The concepts of bubble sorting and selection sorting were integrated into a VR sorting application developed by the authors. The authors concluded that the level of visualization and student interaction in the VR environment had a significant positive impact on students' understanding of the abstract concepts and processes required to develop the sorting algorithms.

Sahin et al. studied the impacts of an intervention with a teenager with autism spectrum disorder (ASD) facilitated by a smart glasses-based social communication module. The module used sensors in the smart glasses to monitor the social interactions of the adolescents and to prompt the child to use socially accepted behaviors when interacting with others. The intervention was conducted over two weeks in addition to regularly scheduled interventions provided by two professionals. At the end of the 2 weeks, the teen's parents and two teachers reported a global-scale improvement, as measured by the Social Responsiveness Scale 2 (SRS-2) School-age Form, as well as on several of the subscales, which demonstrated the promise of augmented reality interventions with autistic children.

A comprehensive literature review of immersive virtual reality (VR) headsets in post-secondary education was conducted by Concannon et al.. The authors identified three types of student engagement in the VR environment. They concluded that educating educators would spur the adoption of VR as a pedagogical method that has been shown to have multiple benefits compared to traditional instruction. The authors noted that concerns about the cost and accessibility of head-mounted displays may be reduced with the availability of mobile phone-based headsets. The authors identified an additional concern, the adaptability of learning in a VR environment to the real world.

LaDisa and Larkee described an immersive virtual environment for research, teaching, collaboration and outreach at Marquette University. The authors outlined processes used during the design phase to identify potential users. The system favored by potential users was a CAVE Automatic Virtual Environment as it enabled collaboration through a shared visualization experience. Modifications to address lag time, eye fatigue, and simulation sickness were noted. Examples of CAVE immersive visualization system projects in Engineering, Arts and Sciences, Health Sciences and Nursing were highlighted.

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