Integrating Extended Reality into Educational Contexts: Insights from a Postgraduate VR Course at UNIOESTE

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Abstract

This paper presents the outcomes of a postgraduate course on virtual reality conducted at UNIOESTE in 2024, which aimed at bridging theoretical concepts and practical implementations of extended reality for educational purposes. Three student groups developed and piloted XR solutions: one focusing on immersive Geography lessons for Elementary School, another on virtual explorations of dinosaurs, and the third on augmented and virtual tools for teaching Mathematics. We discuss their experiences, reflect on the primary challenges encountered, and highlight future directions for XR technologies in diverse instructional contexts. The analyses are related to methodologies for integrating XR, user perspectives, barriers, innovation, and long-term sustainability.

Keywords

XR, technology education, case studies

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1 Introduction

The global increase in computer-based systems, smartphones, and internet ubiquity has paved the way for new forms of Interactive Media in Education [1]. Among these, extended reality (XR)—encompassing virtual reality (VR) and augmented reality (AR)—stands out for its capacity to provide immersive experiences that can significantly enhance learning outcomes. Educators can simulate complex phenomena and foster skills such as communication, creativity, and critical thinking.

Despite its potential, XR adoption in educational settings faces important challenges: inadequate infrastructure, limited teacher training, and budget constraints [9]. To tackle these issues, a postgraduate VR course was offered at Universidade Estadual do Oeste do Paraná (UNIOESTE) in 2024. Graduate students researched, developed, and tested XR applications to foster authentic learning experiences for various educational levels. This paper presents the three resulting XR projects and synthesizes their findings.

2 Context and Methodology

The VR course was delivered over one academic semester within a postgraduate technology-in-education track. The main pedagogical strategy combined theoretical foundations (i.e., design of immersive experiences, user-centered design, and evaluation methodologies) with practical lab sessions on Unity, 360° video editing, and basic AR/VR prototyping tools.

Participants included twelve students already active in educational or technology fields. They were divided into three teams, each tasked with designing, implementing, and testing a small-scale XR solution linked to an educational theme of their choice. The teams drew upon participatory design principles, gathering user feedback from teachers, professors, and actual K–12 learners.

Data were collected through:

- Observations of in-class and remote discussions.
- Iterative feedback surveys from pilot users (children, teachers).
- Structured reflection sessions.

The resulting projects reflect varied disciplinary foci—Geography, History (dinosaurs), and Mathematics—thereby addressing multiple perspectives on how XR might be integrated into the classroom [2, 4, 5, 7].

3 Projects Overview

3.1 Immersive Virtual Expedition: Geography

One group focused on teaching Geography to third-grade students, inspired by Cheng and Tsai [3], who proposed VR field trips to local landmarks. Their project created a 360° virtual tour of the Iguaçu Falls, leveraging affordable cardboard headsets. Students could virtually "walk" along the park's main trail and observe the waterfalls, vegetation, and wildlife. Early findings indicate increased learner motivation and a deeper sense of local heritage awareness. However, infrastructural hurdles (access to devices, reliable internet) and varying student comfort with VR hardware emerged as significant challenges.

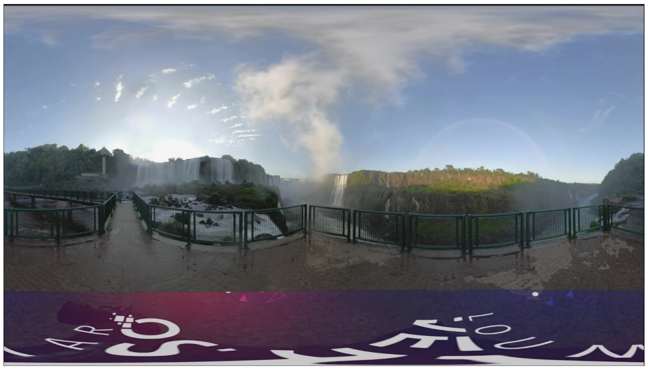

Figure 1: Final prototype developed for a 360° virtual tour of the Iguaçu Falls [4].

3.2 VR Dinosaur Exploration: Geology and History

A second team adapted the methods proposed by Krajvcovivc et al. [6], who applied immersive 3D models of dinosaurs to contextualize Mesozoic environments for young learners. The course participants deployed Unity to render a virtual Paleontology lab, enabling visitors to approach lifelike dinosaur reconstructions. Survey responses from pilot testers highlight heightened engagement and curiosity. Yet, team members reported difficulties in developing specialized 3D models and ensuring comfortable user navigation to mitigate motion sickness or disorientation—issues consistent with current literature on VR interface design [2].

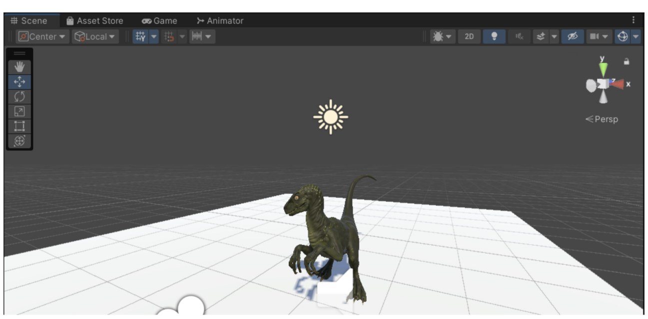

Figure 2: Final prototype developed for the VR Dinosaur Exploration [2].

3.3 AR/VR Game for Mathematics

A third group built upon Mouali et al. [8], who investigated the role of both AR and VR in facilitating the four fundamental arithmetic operations. Their prototype, implemented in Unity, used either pass-through VR or augmented reality to overlay numbers and mathematical operators in real space. Preliminary evaluations from local elementary teachers showed optimism regarding improved problem-solving and active student participation. However, adopting such technologies at scale depends on teacher readiness, ongoing technical support, and well-structured lesson plans—conditions still sporadic in many educational settings.

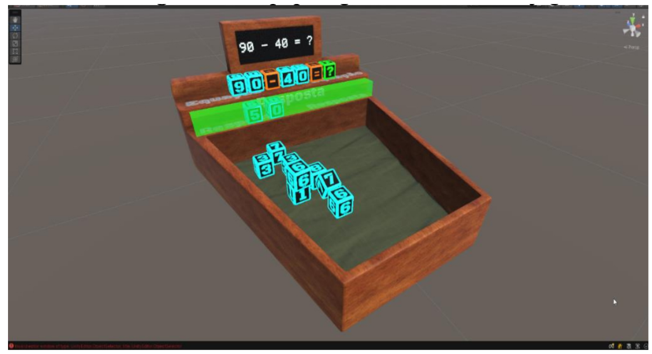

Figure 3: Final prototype developed for the AR/VR Game for Mathematics [7].

4 Main Insights and Challenges

All three teams engaged in iterative prototyping, bridging theory and hands-on design. Collaborative approaches enhanced teacher and student buy-in, echoing prior findings that early stakeholder feedback reduces usability and pedagogical alignment problems [9] [8]. Nonetheless, successful implementation also required adapting course content and training participants in XR-specific pedagogy.

Teachers were enthusiastic about XR's capacity to increase students' sense of presence and contextual understanding. They highlighted perceived benefits for motivation, particularly with subjects deemed traditionally "dry," such as arithmetic or basic geoscience. Their reflections align with calls for more active, experiential models of learning [1] [4].

The projects revealed structural, technological, and teacher-training barriers. Even when hardware (e.g., headsets, smartphones) was available, not all teachers felt confident integrating XR modules into the existing curriculum. Basic digital skills, combined with the absence of robust IT support, can hamper consistent adoption—mirroring broad sector challenges [9].

These XR solutions have demonstrated that immersive, visual, and spatial interactions accommodate diverse learning styles. The dinosaur project illustrated how VR fosters imaginative engagement, and the mathematics AR game offered customization for different skill levels [8]. Such outcomes underscore the technology's inclusivity potential, though more rigorous accessibility research is warranted.

Current discussions point toward a near-term future where XR-based collaborative learning may expand in distance learning programs, hybrid classrooms, and professional development contexts. Sustainability of these implementations depends on partnerships with local governments, teacher-training universities, and private-sector contributions.

Figure 4: School teachers testing the developed solutions.

Figure 5: Children testing the developed solutions [4].

Student teams raised data privacy questions, especially when VR/AR tools track head and hand movements. Meanwhile, environmental sustainability pertains to responsibly sourcing devices and extending hardware lifespans. Clear guidelines and public policies are necessary to protect data and ensure equitable opportunities for all learners.

5 Conclusion

This study reports on a postgraduate VR course at UNIOESTE designed to push theoretical and practical frontiers in XR-based education. The three resulting projects spanned immersive Geography, dinosaur-focused VR explorations, and an AR/VR math game. Their outcomes highlight strong potential for XR to revitalize classroom engagement, contextual learning, and skill development. However, scaling such interventions requires robust technology infrastructure, sustained teacher capacity-building, and supportive policy frameworks.

As XR technologies continue to evolve, future work should deepen research into inclusive instructional designs, cost-benefit analyses of large-scale implementations, and long-term impacts on student performance. By actively involving educators, students, and policymakers in shaping the XR ecosystem, we can collectively harness the immersive power of XR to enrich learning experiences while addressing financial, ethical, and logistical realities.

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