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BOOK REVIEW

Virtual Reality in Curriculum and Pedagogy: Evidence from Secondary Classrooms

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The aim of *Virtual reality in curriculum and pedagogy: Evidence from secondary classrooms* is to 'stimulate a deeper conversation about the pedagogical value of iVR by sharing insights into what happens when you take this emerging technology out of the controlled conditions of laboratory and put it into the dynamic natural setting of the school'.

The introduction starts with the author's story of how she connected with a school principal to do research in schools. It then explains technical terms used in the book, including outlining the difference between immersive virtual reality (iVR), the focus of the book, and screen virtual reality. This section also helps readers new to the field understand such terms as positional tracking, degrees of freedom, interaction and navigation, cybersickness and learning affordance. The chapter ends with a brief outline of the key ideas in the book and the content of the next seven chapters.

The second chapter gives a brief history of virtual reality research, with a focus on use of iVR for education in schools. This section introduces the five learning affordances of virtual reality as being first-person order experiences, natural semantics (understanding the basis of something before learning about the abstract equivalent), size and scale manipulation, reification (transforming abstract ideas into perceptible representations), and transduction (extending a user's ability to experience what they cannot normally sense). It also discusses ethical and legal considerations, particularly with children given how real virtual environments can seem. Other things to consider include the potential for users to experience cybersickness, with symptoms similar to motion sickness, and privacy implications.

The next chapter summarises research related to the pedagogy of iVR, highlighting the need to blend signature pedagogies of specialist subjects with the learning affordances of iVR. It presents the Actions Pedagogy for Immersive Learning (APIL) Framework, an iVR-specific Framework designed to support schoolteachers to make informed educational decisions regarding iVR applications. The Framework introduces three realms — teacher, learner and technical, each with five actions, such as asking, considering, reflecting, checking and developing. Teachers would need to do some actions on their own and some with their learners. The chapter also introduces two scaffolds to illustrate pedagogically different experiences within iVR and encourage thoughtful 'choreography of learning'. The first scaffold classifies iVR according to the degree of learner-embodied interaction and autonomy

in the learning experience. The second scaffold discusses moving beyond the 'tech as tool' metaphor, recognising that iVR can be a tool, but can also be the whole experience.

Having set the scene with research and frameworks, the fourth chapter outlines both school contexts and the methodology for the two studies that are the heart of the book. The next chapter describes the context-specific practical and technical issues that the two teams encountered when doing their research. This includes difficulties in timetabling, finding the right physical space, overcoming technology policies and processes, and responses to 'ethical conundrums' resulting from working in classrooms, rather than lab settings. The book shares specific strategies on addressing ethical issues, such as posters developed to give students necessary information and having a 'spotter' with students while in the virtual environment.

Chapter 6 details results from the use of iVR with two Year 9 science classes at a 'low-income high-school community' in New South Wales, Australia. The selected learning outcome was 'A student can analyse interactions between components and processes within biological systems'. Students worked in groups of three to build a 3D representation of the body organ of their choice. They built their model, cross-section or diorama in the 'no code create' software Minecraft VR. Time in iVR was restricted to manage the risk of cybersickness and because iVR equipment had to be shared between teams. Multiple teams juggling finite resources required teams to coordinate with peers and manage their projects carefully to achieve the outcomes.

The study used pre- and post-knowledge tests to assess the acquisition of lower order content knowledge in the iVR group and a control group. The two groups spent the same number of hours learning, with the iVR group spending 60% of their time working with iVR. The control group spent these hours in a traditional classroom setting. Test results showed no significant difference between the two groups in understanding the topic. However, screen capture recordings of team interactions and teacher and student interviews, indicated that the iVR group developed significantly in skills such as collaboration, effective communication, and problem-solving, as a result of the iVR component of their learning. The study also assessed on- and off-task behaviour in iVR. The thought was that the experience might be overwhelming and distracting for students, especially if they were new to the environment, and this risked cognitive overload. The result showed that with no explicit instruction or scaffolding, most groups 'exhibited metacognitive processes and positive examples of regulation for learning, especially socially shared regulation'. The research team found that most teams were on task at least 80% of the time. Even the team for whom Minecraft VR proved too distracting demonstrated collaboration, communication and regulating behaviour, just not towards the biology-focused learning outcome. This chapter also shares one in-depth case study, which enables readers to understand how the learning affordances of iVR contributed to deeper learning.

The seventh chapter shares the story of the second iVR project, which was in a 'rural, low-income community' in New South Wales, Australia. The context was a senior drama class and iVR was used to help the students develop the 'abstract notion of directorial vision'. They worked in groups of three to develop prototypes for costumes and set designs for a contemporary Australian play, using the 'no code create' 3D drawing program Tilt Brush. The teaching team used a highly experimental process, learning with their learners how to use the iVR to support the learning outcomes. Teachers perceived a risk of cognitive overload, particularly early in the process, due to the many features of Tilt Brush, the intensity of the virtual experience and the complexity of the students' task, i.e., translating abstract

concepts into symbols. They broke the creative process down into three intersecting phases — orientation, preparation and production, and provided different learning supports at each stage.

Over time, during their projects, groups moved from co-operation, where teams agreed on specific tasks to be done individually, to collaboration, where students interacted fluidly in and out of Tilt Brush to modify the design or give feedback and suggestions. An in-depth case study illustrates how the process worked and student and teacher perspectives on how iVR was able to support the learning process. The case study includes dialogue captured from video recordings, focus groups and peer-to-peer interviews and images from Tilt Brush, which, while very different from true immersion, gives some sense of what was created. Benefits from using iVR included greater engagement, enriched learning across 'content mastery, effective communication, critical thinking and problem-solving, collaboration, self-directed learning, and an academic mindset'. Another benefit noted was the elevation of students who were talented but tended to be more reserved. The author also comments on the powerful effect of 'levelling the playing field of privilege' through a rural, low-income community with evidence of an achievement gap, being able to use iVR in a similar way to cutting-edge international theater projects.

The final chapter discusses the lessons learned from the two research projects and outlines questions still to be answered when considering the use of iVR in schools. The research showed that the main barriers to classroom implementation were not pedagogical but physical — difficulty finding suitable physical spaces, and technical — lack of reliability of iVR equipment and constraints imposed by school Internet networks. There were also equity issues, with boys being more likely than girls to have had prior experience in iVR and students having different access to devices. Pedagogically, teachers were able to leverage the signature pedagogies in how they used iVR. For science, this was the use of representational models to teach about physical and conceptual aspects of phenomena, for drama the signature pedagogy was improvisation. As students were able to enter a virtual world and work with others to create their own part of it, they experienced a greater level of immediacy, authenticity and autonomy when learning than when using screen-mediated virtual reality or in traditional collaborative classroom contexts.

In looking to the future, the last section notes the need to better understand ethical, practical and technical considerations when using iVR in school settings, the importance of co-designing research with teachers to further investigate how iVR might add value to learning in schools, the increasing importance of teaching pre-service teachers and the teaching profession about the technical and pedagogical potential of iVR, and the need for policymakers to also understand the opportunities and challenges with using iVR.

In my view, *Virtual reality in curriculum and pedagogy: Evidence from secondary classrooms* effectively achieves its aim as stated in the first paragraph. It provides a gentle introduction to virtual reality for those new to the topic, with explanations of terms and summaries of the history of virtual reality and the pedagogy of IVR. At the same time, the summaries will still be of interest to those more familiar with the research because they tackle complex issues stemming from the immaturity of use of this technology and the range of opportunities and challenges it offers educators, particularly those working with children in schools. They also offer frameworks to help those wishing to work with iVR navigate this complexity.

The four chapters that outline the methodology, the nuts and bolts of using the technology and the honest stories of the two iVR projects, contribute significantly to the iVR conversation. They are honest, practical accounts of what went well and what might be better to do differently, with evidence to support both. The higher-level descriptions of each project, supplemented by one in-depth case study for each, rounded out by reflections on the pedagogical implications, give readers a real sense of what happened and what was learned without having too much to read. I can imagine busy teachers might find time to read a book this size, which is an important way to contribute to a deeper conversation, by including practitioners as well as researchers in the process.

So, in summary, the book is an accessible starting point for those new to the field wanting to understand iVR, its potential benefits and issues yet to be resolved, and assess whether this technology might be relevant in their context. For those who have decided they wish to move into using iVR, it provides the right blend of inspiration, practical advice and things to look out for. For those already using iVR it contributes reflective insights which can supplement their existing knowledge and experience.

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