Virtual Reality in an Online Introductory Mining Course

Technology Use Plan

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Section I: Context

I am an instructional designer at the University of Arizona within the University Center for Assessment, Teaching, and Technology. In my role, I support a variety of faculty members in several departments who offer undergraduate and graduate college-level courses as part of Arizona Online. Although I work with several different subjects, I am the assigned liaison between UCATT and the newly created School of Mining and Mineral Resources, which is currently developing a mining minor for students from various disciplines. Although the courses are currently being designed for an in-person modality, I focus more on what these courses will look like when adapted to an online environment.

Online students generally have much different backgrounds than traditional in-person students. They tend to have additional responsibilities, particularly around caregiving and employment, appreciate the recognition of these circumstances, and value interactions with fellow students (University of Arizona, 2022). Furthermore, 53% of respondents are comfortable using new software and applications (University of Arizona, 2022). Their comfort level and the nature of online learning indicates that these students could be more willing to use novel technologies as early adopters of innovative learning (LaMorte, 2022). There is no current data on the students in the mining minor due to its early stage and initial enrollment numbers, but as there will be several pathways offered, it is fair to assume a diverse cohort.

For this specific project, I am focusing on the most developed core minor course, MIN 226: A Balanced Future - Sustainability and Minerals. Designed as an introductory course, it explores the transdisciplinary challenges and opportunities of producing, using, and recycling mineral resources throughout the mineral lifecycle alongside the impacts and implications on people, the environment, industry, and governance. As the first step into the minor, the course covers material related to each of the seven possible tracks, which are:

1. Mining and recycling
2. Leadership and communication
3. Business and economics
4. Data analytics and automation
5. Environment
6. Health and safety, and
7. Society and policy.

The course includes readings, writing assignments, practice problems, in-class participatory seminars, physical and online field trips, and a final presentation. In order to effectively translate the hands-on nature of the course to the digital realm, I propose the use of virtual reality (VR). I predominantly see this being used as a tool to explore mine sites and mineral resources through their lifecycles. Although Arizona is known for its mines and access to mining professionals, the geographic dispersal of online students will likely preclude them from experiencing authentic mine sites.

Section II: Standards

Although the University of Arizona doesn't follow any specific standards, many of our best practices align with the Association for Educational Communications and Technology standards (AECT, 2012). In particular, Standard 2 (Content Pedagogy) is met through the ongoing creative usage of technology and non-standard tools, Standard 3 (Learning Environment) is met through Quality Matters and UDL standards for effective and holistic learning environments, and Standard 4 (Professional Knowledge and Skills) is met through ongoing and supportive cross-department collaboration. In addition, the activity will also align with the following published ISTE Standards for Students:

- 1.1d—Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.
- 1.3d—Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
- 1.4b—Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
- 1.6c—Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations. (ISTE, 2016)

Students meet standards 1.1d, 1.4b, and 1.6c using VR technology as they will become familiar with cutting-edge technological concepts and usage. Standard 1.3d is met through the simulation provided by the VR technology as learners experience realistic situations correlated to their learning. Ideally, this assignment further push them towards the role of early adopters (LaMorte, 2022).

Section III: Affordances and Relative Advantages

Last semester, I assisted in reading proposals for the Provost's Investment Fund and was struck with the number focused on the potential use of augmented and virtual realities. One suggested digitizing the University of Arizona's collection of mineral resources to ensure distance learners could benefit from university property. In addition, technological improvements over the last fifty years and increased support from the industry have led to more accessible virtual realities for the public—even for those who only have smartphones (Paíno Ambrosio & Rodríguez Fidalgo, 2020). These insights, combined with ongoing conversations in my work around connecting students to meaningful in-person situations, prompted my interest in the use of VR for distance learners.

VR is an ideal tool for "problems… that cannot be reproduced in the physical world, those that cannot be studied safely or involve physical risks, those whose experimentation carries a high economic cost, and "what would happen if...?" kind of problems (Paíno Ambrosio & Rodríguez Fidalgo, 2020, p. 7)." Therefore, it is advantageous for difficult-to-replicate scenarios, to improve student safety, reduce costs, and run simulations. When used for distance learning, it can help place students in the same space and provide the same access to materials that otherwise would be inaccessible due to geographical and temporal distance.

The use of this technology best aligns with ideas of constructivism as it allows students to be active participants in the meaningful creation of knowledge through experiences (Ertmer & Newby, 2018). By using VR to replicate real situations they otherwise could not access, learners experience "authentic tasks anchored in meaningful contexts (Ertmer & Newby, 2018, p. 172)" that facilitate hands-on knowledge creation, transfer, and storage. The emphasis on active learning can be enforced through interactive virtual spheres that allow learners to explore, apply knowledge, and problem-solve to more effectively code, retrieve, and use rote and social knowledge. Situated cognition, a theory under the umbrella of constructivism, supports the immersion of "learners in an environment that approximates as closely as possible to context in which their new ideas and behaviors will be applied (Brill, 2010, p 50)." Clearly, the empirical benefits from the active application of knowledge via authentic problem-solving alongside knowledge organization and retrieval neatly align with ideas of VR as simulation.

Section IV: Learning Environment

Although learners will be taking online courses and thus be in an uncontrollable physical space, the learning environment will be the created virtual environment, which will be a fully immersive, three-dimensional, active mine site. The creation of this environment will be the most costly element as it will require a collaborative process between multimedia specialists and likely game designers. Hopefully, as a core component of the program, the cost could be subsidized by student tuition and student workers—particularly within the UA game design program—although I do not have an estimate on the realistic cost of this project.

Beyond the construction of this environment, students will only need their smartphones and cardboard box goggles. The goggles can be made with scrap cardboard or purchased for approximately $15 and is therefore not prohibitive for learners to obtain on their own. When in the simulation, learners will ideally locate a comfortable and quiet space to “plug in” that will increase immersion. They will also use chat software (like Discord) to communicate with their peers later in the activity. As explained in the preceding session, these resources encourage active participation in authentic situations, thus improving the learning experience, outcomes, and skills.

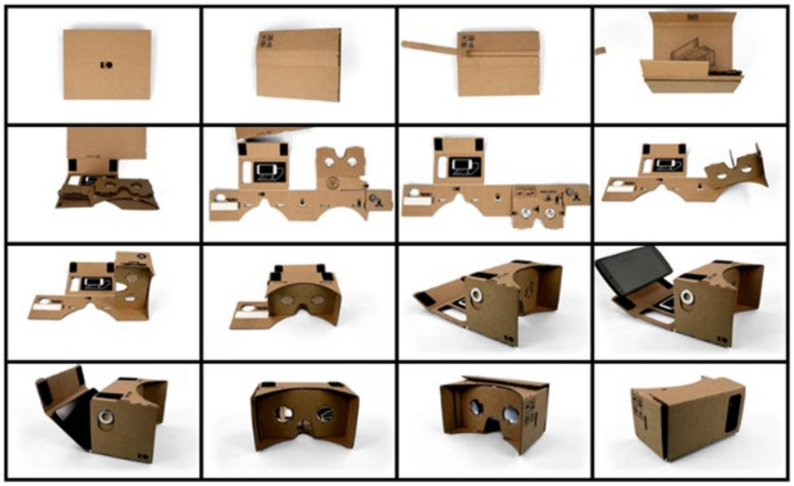

Figure 1: Steps to create cardboard VR headset (Carney, 2023).

Section V: Integration Strategies

Creative technologies can support online learners by providing access to experiences they would not otherwise have. In this activity, inspired by constructivist and situated cognition approaches, learners will be placed into groups and play the role of different professionals on a mine site based on their intended track. Through a VR simulation recording of an actual mine site, they will be able to examine and explore the site at which there has been an issue and work together to propose a solution. This project will take one week and be part of a mid-semester module on mine operations. The students will:

1. Self-select into groups of at least three (contingent on enrollment numbers). Ideally, students will be in groups with members from three separate minor tracks.
2. Explore the VR mine site with their smartphone and cardboard glasses.
3. Reflect on ideas for solutions to the mine issue (as assigned by the instructor).
4. Synthesize personal and group solutions synchronously with group members over Discord while again situated in the VR mine site. This will allow them to revisit their

original ideas while exploring areas and solutions not otherwise considered as individuals.

5. Critique proposed solutions and draft a mutually agreeable proposal through Discord.

By placing learners in the real-life context and social environment promoted by situated cognition, they will experience authentic situations in which they can improve their contextual understanding, problem-solving, recognition of behavior, and knowledge structuring in a way that will prove helpful in their professional lives (Brill, 2010). Due to the dispersion of online learners, VR is the only way these learners can experience being physically at a mine site in a collaborative community.

A case-based learning simulation further ensures students will benefit from discussion with their peers by experiencing the full exploration-to-solution pipeline of applied knowledge that, again, strengthens knowledge transfer in authentic situations (Blackmon et al., 2010). Furthermore, the importance of decision-making "requires students to synthesize information from a variety of social disciplines (Blackmon et al., 2010, p. 176)," which allows them to pull from their majors and ensure diverse insights in their community of innovation. Students move through individual-level attributes that promote individual motivation and interest through shared tools, dynamic use of technology and preceding skills, and autonomy that then fuse together in group work with their diverse peers, hands-on solution exploration, and post-activity reflection (West, 2018).

Section VI: Evaluation

Students will be assessed through their initial notes, their finalized group proposal (which will also be how the instructor can assess their understanding on mine operations), and an individual self-reflection focused on technology and community experiences. Constructivist approaches value social and internal solutions more than rote repetition of knowledge; the qualitative process documentation will help determine if students are getting the full benefit from this activity. Due to the social nature of the project, quantitative data will be less helpful. Ideally, later core MIN courses will collect additional qualitative data on student-to-student interaction to determine if the early introduction to constructivist-inspired collaboration through creative technology has long-term effects in the field. The instructor will compile data on the variety of solutions and any "holes" in the simulation over three-year cycles. UCATT completes course refreshes every three years, so the alignment with this timeline will ensure the most effective changes and allow budget preparation for the new footage.

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