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Inclusive authentic e-learning: Enhancing equity and accessibility through virtual site visits

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The growing shift to digital education environments has accelerated the need for inclusive, flexible, and pedagogically sound learning strategies. Authentic e-learning, when paired with virtual site visits (VSVs), offers learners opportunities to engage with complex, real-world contexts in ways that are both accessible and equitable. This paper explores how VSVs can support authentic learning goals by eliminating traditional barriers associated with physical site visits, using the example of a detailed virtual simulation of the mechanical plant room in the Alan Gilbert Building at the University of Melbourne. Drawing from constructivist, experiential, and situated learning theories, this case study illustrates how virtual environments can foster deep learning and skill development. It also outlines inclusive design practices, challenges in implementation, and strategies for promoting equity. Through a case study and practical design experience, the paper proposes that inclusive VSVs are not just a temporary substitute, but a lasting innovation for 21st century education.

Keywords: Authentic learning, virtual site visit, accessibility, inclusivity, equity, case study

1. Introduction

The rapid shift toward digital education, particularly following the COVID-19 pandemic, has underscored the need for inclusive and meaningful online learning (Ahmad et al., 2024; Uzza et al., 2022). Virtual site visits (VSVs) are one way to enhance authentic e-learning by offering students virtual access to environments that replicate real-world professional contexts (Jordão et al., 2024). These digitally immersive environments align with the pedagogical foundations of authentic learning, as they encourage exploration, interaction, and situated knowledge construction. By incorporating VSVs into higher education, educators have the opportunity to offer flexible, equitable, and engaging learning experiences that transcend the limitations of physical space.

Authentic e-learning is informed by constructivist and experiential theories of learning, which emphasize the importance of context, reflection, and active engagement. Kolb's (2014) experiential learning cycle—comprising concrete experience, reflective observation, abstract conceptualization, and active experimentation—serves as a cornerstone for designing learning tasks that mirror real-life professional challenges. Herrington et al (2014) define authentic learning environments as those offering meaningful, real-world relevance; sustained investigation; and opportunities for reflection and collaboration.

VSVs align with these principles by simulating workplace environments and technical systems in interactive, multimedia-rich contexts. Situated learning theory supports this alignment, suggesting that learning is most effective when embedded in social and physical contexts that reflect real-world practice (Lave & Wenger, 1991). Connectivism theory extends this to digital environments, highlighting the role of networks and information flows in learning (Dunaway, 2011). Finally, the cognitive apprenticeship model reinforces the design of VSVs by emphasizing guided participation, expert modelling, and scaffolded tasks to help reinforce learning (Collins et al., 2018).

The case explored in this study—a virtual simulation of the mechanical plant room in the Alan Gilbert Building at the University of Melbourne—serves as an example of how immersive technologies can be leveraged to expand experiential learning. Informed by current pedagogical theory and institutional strategy (Makda, 2025), this initiative aims to address structural barriers to learning access while improving the quality of engagement with technical content. This paper critically examines the rationale, development, implementation, and implications of this virtual tool.

2. Case study

Feedback from the Bachelor of Design students at the University of Melbourne consistently indicated that in-person site visits were a highlight of the Environmental Building Systems subject, particularly the visit of the mechanical plant room in the Alan Gilbert Building. The 2021 End of Subject Survey's (ESS) data revealed students' strong appreciation for these physical experiences due to their capacity to connect theoretical knowledge with practical systems. The site visit is very effective as it submerges students into a gritty environment where their senses are overloaded and overwhelmed, and where the stark distinction from the drawings they see on paper and the scale of the equipment make them realise that there is a lot more to what is taught to them in class. However, the plant room can be very noisy, and this can make communication and explanation challenging. Moreover, the nature of a mechanical plant room can create health and safety issues if students stay there for too long, or if large groups of students are taken at once. Restricted access to the plant room also makes it impossible for students to revisit the site afterward, and unpredictable events such as equipment maintenance schedule or COVID-19 pandemic, make access to the plant room (and sites in general) unreliable and thus jeopardising the use of physical site visit as a core learning component. However, the logistical challenges of accessing the plant room—ranging from safety protocols to limited group sizes—necessitated a new approach.

A virtual site visit of the mechanical plant room was developed using Unity and based on photogrammetry and 3D modelling (Figure 1). Its interactive interface allows learners to navigate through the plant room and interact with HVAC systems, pumps, chillers, boilers and air-handling units, with embedded media to support understanding. The design was grounded in inclusive pedagogy and user-centred design principles outlined in the university's teaching and learning strategy.

Students accessed the VSV via their personal laptops or desktop screens, navigating the space using keyboard or mouse controls. They could move through the plant room, zoom into equipment, and interact with virtual objects to trigger explanatory media. This non-VR approach ensured broad accessibility and minimized hardware requirements, supporting equitable participation across diverse learning contexts. The VSV was integrated into the subject as a learning activity, accompanied by classroom discussions, reflection tasks, and scaffolded assessments to reinforce the learning outcomes. While formal evaluation is ongoing, initial student feedback has highlighted improved engagement and comprehension. Future iterations of the project aim to include structured pre- and post-engagement surveys.

Figure 1. Interactive view of the virtual site visit (VSV) showcasing the mechanical plant room in the Alan Gilbert Building at the University of Melbourne.

Several studies have highlighted the value of immersive and interactive environments in higher education. Shojaei et al. (2023; 2022) found that virtual construction site visits, when properly scaffolded, yielded learning outcomes comparable to physical visits. They noted increased engagement, stronger retention, and greater student satisfaction. Similarly, le Brasseur (2023) reported that students appreciated flexibility, interactivity, and realism in VSVs. However, many implementations of virtual learning tools lack instructional coherence or accessibility planning when not coherently integrated in the subject's curriculum.

This study sought to fill this gap by combining immersive technologies with inclusive design and authentic learning theory. The Alan Gilbert simulation was developed not merely as a technological demonstration, but as a pedagogically integrated resource (Ahmad et al., 2024; Jordão et al., 2024). The broader rationale aligns with institutional goals for blended and hybrid learning, particularly within professional degrees (Makda, 2025).

3. Promoting equity and accessibility

VSVs can remove several traditional barriers to participation in experiential learning. Physical limitations, safety concerns, geographic constraints, and scheduling difficulties often prevent equitable access to in-person site visits. VSVs, on the other hand, enable repeatable, self-paced exploration from any location, expanding access to students who may otherwise be excluded for the barriers.

In the plant room simulation, specific design decisions were made to enhance inclusivity. Features such as translated captions, audio narration, and simplified navigation supported diverse learning needs (Ahmad et al., 2024). These align with Universal Design for Learning (UDL) principles, which advocate for multiple means of engagement, representation, and action (Skov & Lykke, 2023). These features also allow for more equitable participation among students with cognitive, sensory, or physical impairments (Uzza et al., 2022), ensuring that learners can interact with content in ways that suit their needs and preferences.

Digital simulations enable learners to pause, rewind, and explore complex systems at their own pace, enhancing comprehension and reducing cognitive overload. As Shojaei et al. (2023) note, students reported increased confidence and engagement when interacting with accessible and scaffolded VSVs. In particular, learners who struggle with traditional lecture formats can benefit from visual and kinaesthetic approaches provided by immersive simulations.

VSVs contribute to skill development by enabling students to practice systems thinking, spatial analysis, and technical language interpretation in a risk-free environment. The visual and interactive nature of these environments makes them especially useful for learners with different educational backgrounds and abilities. Furthermore, such experiences promote a sense of belonging and academic confidence among students who may otherwise feel marginalized in face-to-face settings or in noisy and dusty operational environments. Moreover, and in line with pressing and relevant sustainable approaches, VSVs also help reduce the cost and carbon footprint associated with travel and organisation of the traditional site visits.

Institutional strategies that support VSV adoption (Taylor et al., 2022)—such as inclusive digital content policies, academic accommodations, and digital skills training—can amplify these benefits. This aligns with broader equity frameworks, like the University of Melbourne's Advancing Students and Education Strategy, which emphasizes access and participation across diverse student cohorts.

Finally, embedding VSVs within curriculum assessment cycles further validates their value, ensuring they are recognized not only as optional resources but as integral components of learning pathways. As part of authentic learning design, they offer students opportunities to demonstrate competencies in real-world scenarios, bridging theory and practice in a way that is inclusive and meaningful.

4. Design strategies

From the experience with the Alan Gilbert Building's VSV, we observed that its success depends not only on their technical fidelity but on their pedagogical integration. Effective virtual environments are purposefully aligned with intended learning outcomes and offer structured pathways for inquiry and reflection.

Key design strategies include:

- **Scaffolding**: Prior activities that familiarize students with system schematics and terminologies help prepare them for exploration. Guided prompts during the VSV can encourage critical thinking.
- **Alignment with outcomes**: VSVs should support clearly defined outcomes, such as interpreting technical layouts or assessing mechanical system efficiencies.
- **Multimodal learning**: Integration of text, audio, video, and interactivity ensures accessibility and caters to different learning preferences.
- **Collaborative features**: Tools such as shared annotations, live group walkthroughs, competitive challenges or integrated discussion boards enhance peer learning and communication.

In the Alan Gilbert plant room simulation, students could engage in reflective journaling to deepen their learning and sharing with their peers or participating in group problem-solving exercises and diagram annotations that could bridge digital observations with theory and practical applications.

5. Limitations

While the benefits of VSVs are substantial, their implementation requires institutional support. Investments in infrastructure, faculty development, and technical support are essential. Instructors need training not only in using digital platforms but also in designing pedagogically sound virtual learning experiences. The importance of interdisciplinary collaboration among instructors, learning designers, and IT professionals to develop scalable and high-quality virtual experiences is also paramount to the success of VSVs development, and it would help create an exchange community of VSVs that more students can access as learning resources. Furthermore, digital equity remains a concern (Taylor et al., 2022; Uzza et al., 2022). Despite the accessibility of virtual learning, disparities in device access and broadband connectivity persist. Institutions must address these issues through policies like device loan programs, widespread Wi-Fi access, and inclusive learning management systems.

While VSVs offer promising enhancements to digital education, they are not without limitations. Unlike real-world visits, they may not fully replicate the dynamic, sensory, or social dimensions of field experiences. Technical glitches, limited interactivity, and cognitive overload can also reduce their effectiveness if not well-designed. In addition, not all disciplines may find VSVs equally suitable. For highly tactile or relational professions (e.g., nursing or social work), VSVs may need to be paired with live simulations or community-engaged learning.

Moreover, while immersive technologies can democratize access, they also risk creating new divides if institutions fail to provide the necessary hardware, software, and training (Makda, 2025). Equity in VSV adoption thus requires systemic attention to infrastructure, staff readiness, and student support. Ongoing evaluation is essential to ensure that VSVs are enhancing—not replacing—rich educational practices.

6. Conclusions

The development and implementation of virtual site visits, such as the mechanical plant room of Alan Gilbert Building at the University of Melbourne, demonstrate the potential of immersive technology to transform higher education. These tools support authentic learning by replicating professional contexts, promoting accessibility, and enhancing learner engagement.

Future research should examine long-term impacts on academic performance, skill transfer, and student satisfaction. There is also scope to explore how VSVs can integrate real-time data, such as from building sensors (Yeganeh et al., 2025), and adaptive learning systems. Moreover, cross-institutional collaboration (Ahmad et al., 2024) could expand the reach and sustainability of VSVs, creating shared repositories of open-access simulations.

In conclusion, virtual site visits represent a significant step forward in making experiential learning more equitable and scalable. When guided by pedagogical principles and inclusive design, they offer an innovative complement to traditional methods—meeting the demands of contemporary learners and advancing educational equity.

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