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Designing an Immersive Virtual Reality Classroom Exploring Behaviour Support Strategies

Visuality Design in and for Education

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Abstract

In this research the authors explore ClasSimVR, a proof-of-concept immersive virtual reality (IVR) application. This software is designed to support pre-service teachers (PSTs) implementation of a School-Wide Positive Behaviour Interventions and Supports (SWPBIS) approach to challenging student behaviours. ClasSimVR offers users the opportunity to engage with immersive hypothetical scenarios, whereby virtual students display challenging behaviours. Users respond to these behaviours with a range of possible actions aligned with a SWPBIS approach. The authors draw on a research-through-design (RTD) methodology to explore the design process of ClasSimVR. The article investigates the implications of an expert evaluation (n=5) conducted as part of the design process of creating ClasSimVR. More broadly, this research contributes to the discourse surrounding the design and implementation of immersive learning environments in educational contexts.

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Keywords

visuality design – immersive – virtual – reality – classroom – simulations – behaviour

FEATURE This article comprises a video, which can be viewed here.

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1 Introduction

The rise of immersive virtual reality (IVR) is already impacting sectors ranging from medicine to construction. Within education, the potential application of IVR is vast and transformative (Slater & Sanchez-Vives, 2016). Whilst IVR is increasingly being used in initial teacher education (ITE) courses as a tool to assist in the preparation of pre-service teachers (PSTs), its overall uptake remains limited (Ledger & Fischetti, 2020). As one considers future possibilities in the delivery of ITE courses, it is timely to consider how emerging technologies may enrich learning outcomes.

IVR involves the use of a head-mounted display (HMD) and can be defined as an interactive computer-generated environment where immersion is a key goal of design (Chalmers, 2017). The stereoscopic HMD displays of IVR enable greater potential to represent visuospatial elements when compared to traditional forms of two-dimensional environments. Research has associated higher levels of immersion to improved learning outcomes (Alhalabi, 2016; Loup et al., 2016; Sankaranarayanan et al., 2018) with Çakiroğlu and Gökoğlu (2019) reporting that IVR can be used to improve targeted real-world skills.

It can be argued that IVR offers unique educational affordances when compared to other forms of two-dimensional media (Cooper et al., 2019; Slater & Sanchez-Vives, 2016). For instance, the interactive possibilities in IVR allow for the detection of real-time finger movements and gestures in three-dimensions and positional tracking that offers users the chance to physically interact with the virtual environment. The multisensory possibilities and interactivity with three-dimensional audio tracking, haptic and motion tracking controllers within IVR potentially can facilitate unique learning opportunities, and promote experiential, active hands-on learning (Markowitz et al., 2018). The concepts of immersion and presence are central to IVR; with Slater and Sanchez-Vives (2016) stating that immersion describes the technical capabilities of a system, whereas presence is the subjective experience of being immersed. More specifically, presence can be thought of as a user's sense of psychologically leaving their real location and feeling as if transported into a virtual environment (Weech et al., 2019). Or, as succinctly put by Heeter (1992), presence is the feeling of 'being there'. This allows virtual spaces, such as virtual classrooms, to be experienced in similar ways to their real-world equivalents.

In relation to this project, IVR classrooms offer a range of potential benefits. They can present PSTs with challenging experiences that allow them to practice new skills in a safe and controlled space (Jensen & Konradsen, 2017). They offer users an opportunity to experience professional situations that they may not otherwise have had the chance to experience; for example, supporting a specific challenging student behaviour or having difficult conversations with parents (Thompson et al., 2019). Within ITE programs, IVR environments could serve as an effective complementary digital tool alongside in-school placement experiences.

There are already several simulations designed to assist PSTs with developing their behaviour support skills and knowledge. Human-in-the-loop (HITL) applications appear to be the most widely implemented and have a growing body of evidence supporting their use (Ersozlu et al., 2021). HITL simulations involve a human interactor working in real-time to help enable the synchronous voice and body responses of characters in a virtual classroom (Ledger & Fischetti, 2020). Seufert et al. (2022) tested a HITL IVR classroom for developing PST's behaviour support competencies. They found what the authors refer to as "*a higher benefit in the enhancement*" of PST's behaviour support competencies in the IVR group; further concluding that the immersion of the IVR classroom fostered a high degree of presence and allowed for realistic teaching scenarios.

There are various advantages associated with HITL systems. In particular the potential for real time feedback from a human and more effective opportunities to practice interpersonal skills when compared to other designs (Dieker et al., 2016). However, one could argue there are also limitations, with the requirement of a real-time human operator increasing cost, accessibility and ultimately impacting scalability (Breitenbach, 2020). Of focus in this research is the design of an IVR environment that avoids some of the limitations associated with HITL systems, we will return to this point in a moment.

This research explores the proof-of-concept high-fidelity IVR classroom environment ClasSimVR. It investigates the pedagogical, the IVR and the ITE related design principles and considerations involved in ClasSimVR's development. ClasSimVR aims to help prepare PSTs for challenging situations they may face in classrooms or while on placement. The scenario designs of ClasSimVR are underpinned by the principles of School-Wide Positive Behaviour Interventions and Supports (SWPBIS), a framework designed to boost the adoption, implementation, and use of positive and preventative evidence-based strategies within schools (Sugai & Horner, 2009). ClasSimVR was intentionally designed to align with a SWPBIS approach considering the uptake of this behaviour support model in many school jurisdictions globally. In sum, the design of ClasSimVR is intended to help PSTs learn valuable aspects of the teaching profession and to facilitate connections between what they learn during their ITE course and professional contexts.

2 Methodology

This study is underpinned by a research-through-design (RTD) methodology. The design and development of the proof-of-concept, ClasSimVR, involved completing five iterations of the RTD model depicted in Figure 1. We have drawn on the work of Lawson and Dorst (2013) to inform the RTD process; which involves the application of specific design skill sets in planning and designing, creating and developing, testing and lastly, reflecting and managing. When one of the design skill sets becomes the focus of the research, this is referred to as a stage. RTD positions research as being underpinned and inseparable from the processes of designing the project, with the theory and knowledge emerging from these processes (Findeli, 1998). The key knowledge and landmarks of the RTD process are now discussed.

Each iteration of the RTD model involved what we describe as the significant addition of new or improved elements to the proof-of-concept. The

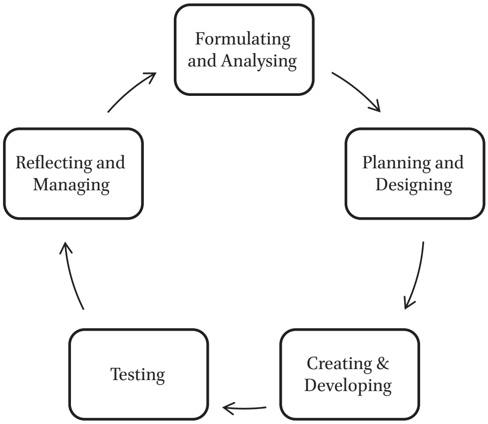

FIGURE 1 This study's research-through-design model

first iteration involved a significant focus on the first two stages of the RTD model (analysing and formulating/ planning and designing) as research into the content for the three scenarios and the SWPBIS-associated practices. The creating and developing stage of the design model consisted of creating the explorable primary years classroom, a scene management system, basic user interface and interactions between digitised user hands and the environment. The conclusion of the first iteration determined the future direction of subsequent iterations, with an emphasis on the creating and developing stage of the RTD model. The *second iteration* introduced player-controlled movement via teleportation, a refined user interface system, the teacher and first student character and the addition of basic animations. The *third iteration* involved the development of a user tutorial, the creation of the three scenarios and nine associated SWPBIS practices and the use of the unity timeline system to allow for self-paced exploration and learning. The *fourth iteration* saw the addition of 11 diverse virtual students with multiple animations, classroom audio, more detailed animations of the scenarios and the user responses system for the SWPBIS practices. The expert review was conducted during the *fifth iteration*.

The expert review was undertaken to help inform the alignment of the scenarios and strategies in ClasSimVR with a SWPBIS approach. Our review only considered experts that had published at least three peer-reviewed research papers in the SWPBIS field. A survey was emailed to 30 potential experts, with a total of five response; the experts evaluated the overall alignment of the scenarios and strategies with a SWPBIS approach and offered their feedback. The data was then analysed using thematic analysis to systematically identify and organise themes or patterns of meaning across the data set (Braun & Clarke, 2006).

VIDEO 1 ClasSimVR gameplay walkthrough. (See here.)

3 ClasSimVR: a Proof-of-Concept

ClasSimVR users role-play as a PST character in first-person view (see Figure 2). Upon launching, users undertake a brief tutorial to familiarise themselves with navigating the IVR environment through the controllers. Users then enter a scene that introduces them to the central principles of SWPBIS, and the application of these strategies in the virtual school. Upon completion, users are transported into a busy virtual classroom environment (see Video 1). The visual

FIGURE 2 In-game screen capture of introduction scene of ClasSimVR

elements have been created to mimic the contemporary design of a primary classroom that align with a SWPBIS approach; in that physical arrangement of the tables enables for small, specifically selected groups to work together and intends to minimise crowding and issues related to intersecting foot traffic (Scott et al., 2007).

ClasSimVR users are approached by the classroom teacher who provides contextual information and instructions for the simulation. The teacher explains that this class is part of a school that embeds a SWPBIS approach into their pedagogy. Users are then instructed to explore the classroom and intervene if they observe a challenging behaviour. Following that, users progress into a free roam exploration, which incorporates three scenarios and a conclusion. The exploration scene (see Figure 3) enables users to freely navigate the digital environment through the eyes of a teacher, simulating a physical classroom environment.

FIGURE 3 ClasSimVR virtual classroom exploration via teleportation

ClasSimVR is designed to elicit user's knowledge, based on an assumption that users have what we describe as a 'novice capacity' to support behaviour. In other words, they are likely to be in their first or second year of their PST qualification. There are three scenarios and in each one virtual students display what is described in the behaviour research literature as challenging behaviour (Powell et al., 2007). These challenging behaviours are represented in our application as 1) *disengaged students*, 2) *off-task* and 3) *low-level disruptive* behaviours that teachers often encounter (Clunies-Ross et al., 2008). Users are prompted to respond by performing one of the three behaviour support strategies suggested (see Figure 4). Once users have made their choice, they receive feedback through the virtual students' responses, teacher responses or menu text.

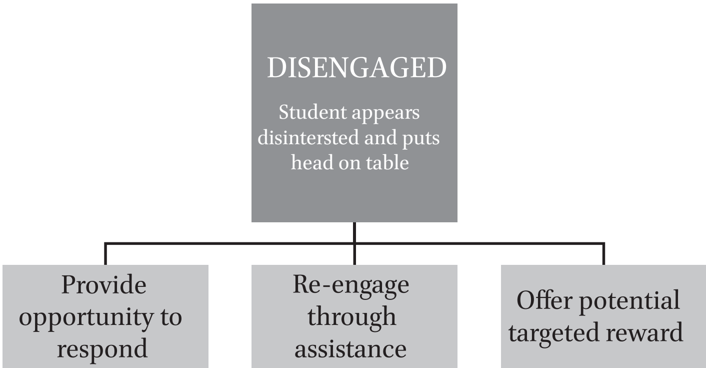

FIGURE 4 Example of user response options and related challenging behaviours

The possible strategies align with SWPBIS-related strategies mentioned in the literature, including options from the primary prevention tier(Mitchell et al., 2017). For example, strategies such as redirection, providing opportunities to respond and re-engagement are choices users may select across different situations in the application. The selection of such strategies offers users positively framed initial response strategies which are SWPBIS-aligned practices and act as an alternative to the discipline-oriented strategies. Collectively they represent positive preventative strategies that users can implement in the virtual classroom. It is the intention of the designers that further offline debriefing and group-based learning experiences would likely compliment learning experiences offered by ClasSimVR.

4 Expert Review

The results from the thematic analysis are divided into two sections. These sections represent the first two synthesised themes from the systematic coding process in: The alignment of ClasSimVR embedding a SWPBIS approach and suggestions for the improvement of ClasSimVR. The results are now reported, inclusive of the implications and actions taken in response to the analysis.

4.1 *The Alignment of ClasSimVR with a SWPBIS Approach*

The central theme involved a general agreement among the experts that most of the strategies aligned with a SWPBIS approach. Expert 3 reasoned that "*the strategies themselves are typical PBIS classroom practices, thus they align with a PBIS approach*", whilst Expert 2 explained that "*all the strategies you have listed have the potential to align with an SWPBIS approach*". Four out of five experts rated the overall alignment at seven or above (on a 10-point scale). These relatively high scores imply ClasSimVR broadly aligns with a SWPBIS approach. However, there were two caveats. The first was that they only potentially aligned, with their alignment being contingent on many factors surrounding their implementation. Expert 4 captured this succinctly in the statement "*the strategies that you have chosen could mostly align, dependent on their framing and ultimately their delivery*". The second was that they aligned but are inherently limited by virtue of being responsive to student behaviour. With Expert 2 noting that they aligned with the provisos of "*in so far as a PBIS strategy can be reactive*" and that "*SWPBIS … is more about prevention than initial response*". This led to the creation of a new scene which is now discussed below.

4.2 *Suggestions for the Improvement of ClasSimVR*

A total of 14 suggestions were made by the experts. Amongst these were some common elements which result in three substantial changes. The first being the creation of the earlier mentioned SWPBIS introduction scene that emphasises the significance of prevention and helps contextualise the strategies within a broader SWPBIS framework. Expert 2 suggested "*it is essential that the strategies you offer are seen to be contextualized within a broader SWPBIS framework"* adding to this that their advice is "*to have multiple layers to the introduction*" and to "*speak to the systems in place within both the class and the school in detail*". The two other changes involved the inclusion of real-time differentiation as strategy and a change in the virtual student behaviour for Scenario 3.

5 IVR Design Principles and Considerations

The use of interactivity is a cornerstone of ClasSimVR. Users are given a set of hand controllers that digitise ghost hands (which are themselves holding virtual controllers) into the virtual environment. These allow user to pick up objects in the virtual classroom (see Figure 5), with most objects being interactable. Integrating gestures that align with the real-world equivalent action is an important design consideration (Johnson-Glenberg, 2018); with this feature being utilised to allow users to act out some of the practices for supporting behaviour. This use of IVR represents a way of learning behaviour support practices that may not have previously been used.

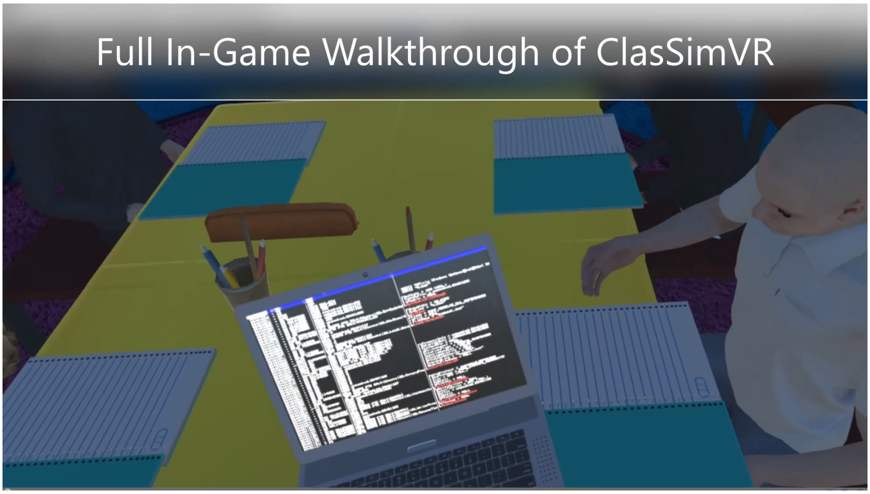

FIGURE 5 Interactive environment with virtual hand controllers enabling user interaction with scene objects

The controllers allow users to navigate the virtual classroom. A single laser pointer can be emitted from the digitised controller and is automatically switched from left hand to right hand when the user pulls either trigger. The laser pointer acts as teleportation control, by pointing and pulling the main trigger, users create a large arrow that represents the area they will teleport to and the direction they will be facing. The free roam exploration is combined with a non-linear gameplay, where users can trigger scenarios as they explore the classroom rather than in a predetermined order. This allows users to move around the classroom at their leisure and intends to create a more authentic classroom experience for users.

The controllers also allow users to interact with the user interface (UI). This system lies at the core of the user experience (UX). The UI was designed to work using the same laser pointer system as that which triggers the teleportation. This simplifies the control systems to make the UX more streamlined. The UI itself is designed for clarity and ease of navigation (see Figure 6). Large bright text is illuminated against a dark grey background, with the textbox highlighting into a bright green when the laser pointer is directed at it. The options are limited to three choice and a help button serves as additional information.

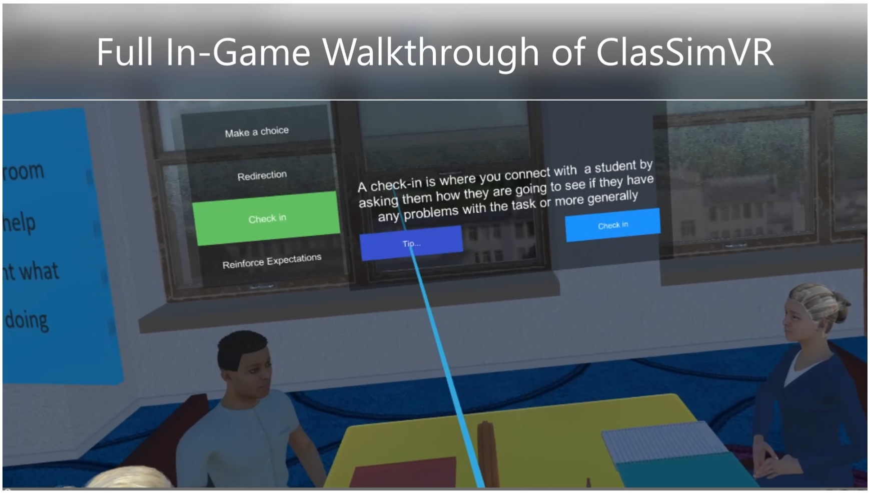

FIGURE 6 User interface and laser pointer

The design principles and considerations are dependent on a user experiencing a sense of presence. Hence, promoting this is central consideration in the design of ClasSimVR. The use of an HMD is integral for presence; with this helping to absorb the user in the visual design elements of the virtual classroom. These visuals elements are designed to add authenticity to the experience by mirroring aspects of a primary classroom, for instance tables are laid out in small groups, the teacher's desk is not positioned as the centrepiece of the room, the warm and colourful furniture and decorations and the posters and student work which adorn the walls.

The use of three-dimensional audio further fosters a sense of presence. A continuous background track of typical classroom sounds plays, whilst the key sounds and dialogue of the virtual characters move realistically in relation to the user. This intends to further surround the users' senses in the IVR environment. Altogether, ClasSimVR is designed to immerse users and foster a sense of presence.

6 Pedagogical Design Principles and Considerations

The central pedagogical design principles and considerations are now discussed. Broadly, ClasSimVR is designed to promote experiential learning and utilises constructivist-aligned pedagogy. It is designed to support learners by offering opportunities for users to reflect and by affording them control over aspects of their own learning. Users undertake ClasSimVR entirely at their own pace, which promotes a sense of agency in their learning progression. The intention is to create time and space for thinking and reflection during the experience itself, as recommended by Johnson-Glenberg (2018). Moreover, no instructor, trainer or teacher is required to be present, thus PSTs can undertake it independently in their own time.

Focusing on the learning of behaviour support is a key design principle and consideration of ClasSimVR, as it does not require PSTs to teach content, but to simply explore, learn and do (João, 2018; Kolb & Kolb, 2005). When PSTs are asked to teach, there is typically a raft of necessary skills and knowledge that are simultaneously asked of them. These range from public speaking to explanations of detailed content knowledge. Several existing virtual classrooms require PST to teach whilst learning to support behaviour. Having an opportunity to focus solely on building the skills and knowledge needed to effectively support challenging student behaviours may act as an effective scaffold for users.

7 ITE Related Design Principles and Considerations

ClasSimVR does not require the presence of an instructor and it can serve as a stand-alone learning experience. Many existing virtual classrooms require the use of a one-to-one teacher or instructor to implement the program (Lugrin et al., 2016; Ledger & Fischetti, 2020), which could limit its accessibility (Breitenbach, 2020). ClasSimVR has been designed to be flexible in its usage, so it can be used as a stand-alone experience or used in conjunction with a facilitator where debriefing occurs afterwards. Furthermore, it can be embedded as part of an ITE course, act as an adjunct to a course or it can simply be used on its own. Offering more freedom around how ITE educators could utilise it could improve its accessibility and uptake.

8 Discussion

ClasSimVR is an exploratory platform targeted at helping PSTs learn SWPBIS practices focused on supporting low-level challenging behaviours. To the authors' best knowledge, this represents the first use of an IVR environment for this purpose. This research contributes the knowledge gained from the design and development of a new prototype, which has been externally reviewed by five behaviour-support experts. Furthermore, ClasSimVR itself could provide an adaptable new foundation for future virtual classrooms that target behaviour support. It could function as a building block or template for future designs, systems and knowledge in this space.

This research demonstrates a novel use of immersive technology in the way it is designed to utilise interactivity. ClasSimVR requires that PSTs physically interact (via their movements with hand controllers in IVR) with the virtual environment and to act out the practices for supporting behaviour. These gestures allow users a chance to practice similar physical actions and responses to what a teacher might make when responding to similar behaviours.

The design principles and considerations utilised by ClasSimVR to promote immersion and presence further offer a contribution to the research discourse. Beyond the value of interactivity discussed prior, using digitised hands to make the classroom objects interactive could enhance the sense of presence experienced by the user. Furthermore, the audio and visual design of ClasSimVR is intended to mimic many aspects of a real-world primary classroom. The combination of the use of an HMD with a visually rich virtual classroom environment, along with the use of three-dimensional audio where the sounds and dialogue of the virtual characters move realistically in relation to the user, are both designed to boost presence. Ensuring environments include a diversity of interactive and multisensory elements when attempting to promote immersion and presence is suggested as a consideration of future IVR classrooms with ITE.

The design of ClasSimVR is likely to be of value to research discourses exploring associations between interactivity and experiential learning. As discussed, the learning experience of ClasSimVR has been designed to afford the user control over key aspects of their own learning such as the pace at which they learn, the time to reflect during the experience and how they navigate and progress through it. It also affords users a scaffolded learning experience with three guided introductions that prepare users for the more substantive exploration scene. ClasSimVR may serve as an example for future IVR environments of how to utilise these considerations.

ClasSimVR targets the early stages of ITE programs by focusing only on the teaching and learning of behaviour support skills (first- or second-year PSTs). As mentioned, by avoiding a focus on the myriad of other skills involved in teaching, PSTs have an opportunity to solely develop their behaviour support skills and knowledge. Once they have a foundational understanding of this space they could then progress into more demanding situation where they are asked to support behaviour while teaching a class.

Also discussed previously, ClasSimVR does not require a human operator. Whilst this may circumvent some of the limitations associated with HITL systems surrounding the physical and financial resource requirements and accessibility (Breitenbach, 2020), it creates other issues. Notably, the capacity to deliver real-time, targeted feedback is diminished. Given the complex nature of supporting behaviour, ideally other learning experiences will compliment those offered by ClasSimVR.

The complexities, resources and time required for PSTs to learn to effectively support behaviour presents ITE educators with many practical issues. By virtue of being a IVR environment, ClasSimVR requires no real-world classroom or students for PST to learn and practice, thus addressing possible ethical issues associated with entrusting novice PSTs with real students. Furthermore, the safe space it allows for mistakes, practice and experimentation has been suggested by Bautista and Boone (2015) to potentially alleviate some the performativity pressures often experienced by PSTs during professional practice. This research affirms the work of McGarr (2021) who holds that simulations, including virtual classroom environments, could add an extra layer of authenticity and experience to the ITE experience of PSTs. However, Theelen et al. (2019) cautions us that simulations should not aim to replace placements but instead may act as a complimentary learning tool to help prepare PSTs. Careful consideration needs to be given to the extent to which the content and delivery of IVR experiences is of educational value.

It is important to note that no empirical evidence has been collected yet that indicates the efficacy or otherwise of ClasSimVR, and hence all the claims and possibilities we discuss are tentative. The former represents a limitation of this research. Future research is intended to explore the usage of ClasSimVR with cohorts of PSTs as a mechanism for improving the software further. We may also build a higher fidelity version of the application. In sum, ClasSimVR serves as a proof-of-concept immersive application designed to support PSTs understanding and application of SWPBIS practices.

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