education sciences

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Bandura in Virtual Reality: Examining Self-Efficacy-Related Learning Through Immersive Classroom Simulations

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Abstract

This study investigates how immersive virtual reality (VR) simulations support international postgraduate preservice teachers (PSTs) in preparing for their initial professional experiences in Australian early childhood settings. Positioned within growing concerns about PST readiness, confidence, and cultural adjustment, the study examined the use of VR as a preparatory pedagogical tool. Sixty-six PSTs participated in human-in-the-loop mixed-reality teaching simulations in which they interacted with avatar children aged 3 to 5 in a realistic classroom environment prior to their professional placement. Guided by Bandura's four sources of self-efficacy, video analysis examined how these simulated experiences contributed to PSTs' self-efficacy-related practices, decision-making, and cultural readiness. Three themes emerged: (1) a movement from anxiety to relational regulation through social–emotional learning, (2) the use of simulation to bridge the theory–practice gap in classroom management and inclusion, and (3) the role of technology-supported reflection in enabling pedagogical revision through repeatable practice. The findings indicate that the simulation design compressed mastery experiences, modelling, credible feedback, and emotional regulation within a structured learning context. Participants demonstrated opportunities for reflective engagement with classroom dynamics in a low-risk environment before placement, including moments of hesitation, revision, and growing interactional control, highlighting the value of a programme-wide, technology-infused approach to immersive simulation in early childhood initial teacher education. Rather than directly measuring changes in efficacy beliefs, this study shows how mixed-reality rehearsal can operationalise the conditions that support efficacy formation within a repeatable pedagogical environment. In doing so, the paper contributes to current debates on technology-infused teaching by positioning mixed-reality simulation as a coherent model for future-oriented ITE design.

Keywords: virtual reality (VR); technology infusion; early childhood initial teacher education (ECITE); pre-service teachers; Bandura's self-efficacy; pre-practicum preparation

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Academic Editors: Yi Jin and Teresa Foulger

Received: 10 April 2026
Revised: 17 May 2026
Accepted: 26 May 2026
Published: 29 May 2026

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1. Introduction

Immersive virtual reality (VR) is increasingly recognised as a powerful educational tool that enhances professional preparation by providing realistic and interactive environments for skill practice. In the context of Initial Teacher Education (ITE), VR is gaining popularity as a way to improve preservice teachers' (PSTs') readiness for their professional placements. The persistent theory–practice divide in teacher education remains a global challenge, with preservice teachers often feeling underprepared for complex classroom realities (Hong

et al., 2025; Mello & Van der Merwe, 2026). Professional experience is central to teacher education, allowing PSTs to apply their knowledge, develop pedagogical skills, and build confidence under the guidance of experienced educators (Hillyar et al., 2025; Pendergast et al., 2022). However, preparing PSTs, particularly international students, for their first placement presents significant challenges. Many face uncertainties regarding cultural norms, classroom expectations, and responsive teaching practices (Devi et al., 2026).

International students often face challenges as they adjust to new educational cultures and classroom environments while also meeting professional expectations. Teacher educators, therefore, need pedagogical approaches that make professional expectations visible and support the transition from coursework to practice in more robust ways (Hong et al., 2025; Mello & Van der Merwe, 2026). In Australian early childhood (EC) settings, PSTs are expected to respond to both children's verbal and nonverbal communication, regulate emotions, and implement relational pedagogies aligned with local standards of care, behaviour guidance, and inclusion. For international postgraduate PSTs, these expectations can increase uncertainty and anxiety, limiting opportunities to practise pedagogical decision-making and hindering the development of confidence during early placement experiences (Lee et al., 2025).

Practice-based teacher education emphasises the importance of real-world experience, reflection, and the gradual application of essential teaching skills before PSTs begin their classroom placements. Mixed-reality simulations provide authentic, low-risk environments in which preservice teachers can rehearse teaching practices without impacting real learners (Dalinger et al., 2020), while practice-based learning approaches are increasingly positioned as one way to address the theory–practice divide in teacher education (Mello & Van der Merwe, 2026). In these simulations, PSTs interact with virtual avatar children in simulated classrooms, making real-time decisions related to behaviour management and instructional strategies. This structure allows PSTs to develop skills at their own pace, repeat scenarios, and learn from mistakes without impacting actual learners, supporting the development of professional judgement rather than surface-level performance.

Contemporary VR platforms increasingly adopt a human-in-the-loop design approach (Lindberg & Jönsson, 2023). The role of simulation specialists is central to maintaining fidelity, as they dynamically shape avatar responses in real time to reflect authentic classroom interactions (Mello & Van der Merwe, 2026). This approach allows the complexity of behaviour to be tailored to PSTs' readiness, helping manage cognitive load while maintaining challenge. Unlike static case studies, mixed-reality simulations enable authentic, low-risk rehearsal in which unpredictability can be sustained without consequences for real learners (Dalinger et al., 2020). Unlike scripted case studies or peer role-play, VR requires PSTs to make immediate decisions and respond to unpredictable child behaviours, supporting the transfer of theoretical learning into practice (Finn et al., 2020; Goff, 2023). Research also suggests that the emotional intensity and complexity of VR scenarios can be calibrated to create safe yet challenging learning environments (Gresele et al., 2025).

A key advantage of VR is its ability to provide standardised, repeatable practice scenarios featuring avatar children. This enables PSTs to test strategies, receive feedback, self-evaluate, and refine their practice without risking harm to actual learners (Arriagada-Hernández et al., 2025). A growing body of research suggests that VR simulations can support preservice teachers' development of classroom management skills, confidence, and authentic learning experiences. However, outcomes are often uneven and dependent on pedagogical design (Hong et al., 2025). Simulation platforms also support approximations of practice by allowing PSTs to rehearse pedagogical decision-making in scaffolded environments (Ledger et al., 2022). VR also facilitates vicarious learning by allowing international PSTs to observe peers or facilitators model effective teaching strate-

gies (Arriagada-Hernández et al., 2025), which is particularly valuable for international PSTs unfamiliar with Australian EC contexts. Immediate, targeted feedback from teacher educators functions as verbal persuasion, strengthening PSTs' beliefs in their capacity to manage classroom interactions. At the same time, the psychologically safe nature of VR supports emotional regulation in complex situations (Goff, 2023). However, research also highlights challenges, including limited transfer of learning, technological constraints, and inconsistent pedagogical integration (Hong et al., 2025; Ledger et al., 2022).

Foulger (2020) argues that integrating technology into teacher preparation programmes is essential to developing PSTs' capacity to use technology effectively and with confidence. In this study, VR is conceptualised not merely as a tool, but as a form of technology infusion embedded across curriculum, pedagogy, and assessment. This positions immersive simulation as part of a broader programme design in which technology shapes how professional learning is organised, enacted, and evaluated. This position aligns with the Technological Pedagogical Content Knowledge (TPACK) framework proposed by Koehler and Mishra (2008), which emphasises the integration of technological, pedagogical, and content knowledge. In this sense, the design of VR learning experiences in ITE is not only technological, but pedagogical and epistemic, requiring careful alignment between what PSTs are learning, how they rehearse practice, and how that learning is assessed. Teacher educators play a critical role in modelling effective technology use, designing technologically enriched curricula, and inspiring PSTs to adopt innovative practices (Jin et al., 2023). Adaptive simulations that closely mirror professional teaching contexts further support PSTs' ability to translate theory into practice (Davis et al., 2022).

While VR integration in ITE continues to expand, much existing research has focused on primary, secondary, and special education contexts. A smaller but growing body of literature examines immersive and mixed-reality simulations in early childhood teacher education (ECITE). Recent synthesis and empirical work suggest that simulation can support confidence, classroom decision-making, and opportunities for authentic rehearsal, particularly when learning is scaffolded through repeated practice and feedback (Hong et al., 2025; Ledger et al., 2022; Samuelsson et al., 2022). Similarly, Goff (2023) reports improvements in classroom management, behaviour guidance, instructional clarity, and responsiveness to children's behaviour. Using Bandura's four sources of self-efficacy as a theoretical framework, Goff (2023) highlights the need for further research examining the contribution of VR-simulated practicum experiences to PST self-efficacy and preparedness for early childhood contexts internationally. At the same time, outcomes should not be overstated, as gains in confidence are often uneven, context-sensitive, and shaped by the quality of pedagogical integration rather than by the technology alone (Hong et al., 2025). Collectively, this emerging literature suggests that VR holds particular promise for EC PSTs, whose work relies heavily on emotional attunement, responsiveness, and relational pedagogy.

In the Australian context, VR is increasingly relevant to national priorities aimed at preparing "classroom-ready" graduates (Australian Institute for Teaching and School Leadership, 2023). Research indicates that immersive simulations support the development of essential professional skills, including classroom management, instructional decision-making, communication, and cultural responsiveness. These benefits are especially evident during periods of placement disruption, such as those experienced during the COVID-19 pandemic (Dalinger et al., 2020; Sasaki et al., 2020). Despite this growing body of work, limited research has examined how VR supports PSTs' mental, emotional, and practical readiness for placement through a theoretically robust lens such as self-efficacy (Davis et al., 2022; Gundel & Piro, 2021).

The simulation used in this study is more accurately described as a human-in-the-loop mixed-reality simulation (Mursion®). However, I retain the term VR when referring to the broader literature. To address this gap, this study examines how immersive simulation creates pedagogical and emotional conditions that support self-efficacy-related learning among international postgraduate PSTs preparing for their first professional placement in Australian early childhood settings. In doing so, it builds on wider work in simulation-based teacher education while remaining attentive to the more specific challenges faced by international early childhood cohorts in Australian contexts (Hong et al., 2025; Lee et al., 2025). The paper contributes to the special issue by showing how mixed-reality simulation can be embedded as part of a coherent ITE design rather than treated as a discrete innovation. Rather than presenting VR as an isolated intervention, it positions immersive simulation as one way teacher education programmes can connect curriculum, pedagogy, assessment, and reflective practice within increasingly digital, practice-based learning environments. However, less is known about how human-in-the-loop mixed-reality simulation supports self-efficacy-related learning for international postgraduate preservice teachers preparing for placement in Australian early childhood settings. Accordingly, this study addresses the following research question:

How does human-in-the-loop mixed-reality simulation support self-efficacy-related learning among international postgraduate preservice teachers preparing for their first professional placement in Australian early childhood settings?

2. Conceptual Framework: Bandura's Self-Efficacy in Technology-Infused ITE

This study examines how immersive simulation can support conditions for preservice teachers' (PSTs') readiness for professional placement, using Bandura's theory of self-efficacy as the primary analytical framework. In this paper, Bandura's framework is used to interpret observable interactional practices, reflective talk, and affective responses aligned with efficacy formation, rather than to claim a direct measurement of changes in efficacy beliefs. Self-efficacy refers to an individual's assessment of their ability to organise and execute actions necessary to navigate future situations. It affects the tasks they choose to undertake, the effort they invest, and their performance under challenging and stressful conditions (Bandura, 1977).

Importantly, Bandura posits that beliefs in one's efficacy regulate both behaviour and emotional arousal asymmetrically: individuals tend to act more on the basis of their perceived capabilities than on fear itself, and improvements in perceived coping capacity can reduce anticipatory anxiety. According to Bandura, there are four main sources of efficacy information: (1) mastery experiences, (2) vicarious experiences, (3) verbal persuasion, and (4) physiological or affective states. These sources do not function independently; instead, they interact collaboratively to shape PSTs' perceptions of their future performance in classroom settings (Bandura, 1977). Research indicates that teachers with low self-efficacy are less likely to exert effort in effectively working with students (Hoy, 2000). In contrast, teachers with high self-efficacy have a significant positive impact on their students' overall success (Bandura et al., 1997; Ingvarson et al., 2005).

Immersive simulation is particularly effective in activating all four sources within a single pedagogical approach. It offers precise control over task complexity, opportunities for repeated practice, immediate feedback, and a psychologically safe environment for facing challenges (Goff, 2023). Please see the four sources below, which discuss VR simulations and PSTs' preparedness for professional placement.

2.1. Mastery Experiences

In this study, mastery experiences are conceptualised as PSTs' repeated, scaffolded interactional attempts within simulation through which pedagogical action becomes observable, revisable, and more deliberate. Mastery experiences are the most important way to build self-confidence in teaching. They come from succeeding in challenging situations. VR simulations allow teachers to practice essential skills, like managing student behaviour, asking questions, and explaining concepts. Teachers can use short scenarios that repeat and gradually become more challenging. Universities that include brief teaching episodes followed by quick feedback have found that future teachers feel more capable in key areas. These areas include teaching lessons, managing classrooms, engaging students, and responding to their needs (Goff, 2023; Pendergast et al., 2022). Research shows that practising in immersive environments leads to better results, especially in classroom management and student interactions (Hoy, 2000; Goff, 2023). This means that VR experiences align well with the skills that new teachers find most challenging (Hoy, 2000; Han et al., 2025).

2.2. Vicarious Experiences

The findings revealed that vicarious experiences are conceptualised as PSTs' observation of peer modelling, educator demonstration, and replayed interactional practice that make effective pedagogical moves visible. VR helps teachers improve their skills through vicarious learning. This involves watching peers in simulation exercises and reviewing recordings of their own teaching. With clear observation guides, these recordings help PSTs identify effective techniques and areas for improvement. This process helps them use their past performances as useful examples. Beyond fully interactive VR environments, formats such as 360-degree classroom videos can help reduce anxiety and boost confidence (Anton et al., 2023). When these videos are paired with clear criteria and guided discussions, they provide valuable learning benefits even in less interactive settings (Han et al., 2025).

2.3. Verbal Persuasion

We observed how verbal persuasion is conceptualised as specific, credible feedback that helps PSTs reinterpret errors, recognise progress, and plan revised pedagogical action. Verbal persuasion is most effective when the feedback provided is credible, specific, and directly linked to observable progress. Programmes supported by virtual reality (VR) typically include brief, goal-oriented debriefing sessions after short practice enactments. During these sessions, specialist trainers provided feedback in each session aligned with pre-service teachers' (PSTs') instructional intentions (Goff, 2023). Evidence from both implementation studies and synthesis research indicates that multiple short cycles of enactment and feedback are more beneficial than single, extended simulations. This approach helps sustain attention, manage cognitive load, and reinforce persuasive messages through repeated practice (Han et al., 2025).

2.4. Physiological and Affective States

The findings further demonstrate how physiological and affective states are conceptualised as PSTs' visible hesitation, emotional recalibration, and growing capacity to remain interactionally engaged under pressure. Bandura highlights that how we see our ability to succeed affects our emotions, with a sense of control helping to lower stress. Immersive simulation offers a safe way to face tough classroom situations, such as students being off-task, showing strong emotions, or being defiant, without putting children at risk. This method allows PSTs to practice teaching and self-control strategies while feeling in control of the situation (Muir et al., 2013; Pendergast et al., 2022). Additionally, simulations that include real-time feedback help instructors adjust the emotional intensity and task difficulty

as needed. This ensures that the challenges PSTs face match their skills and prevents them from feeling overwhelmed. Such an environment helps regulate emotional responses while providing a meaningful challenge, which aligns with the formation of efficacy beliefs.

3. Materials and Methods

This study adopted a qualitative multi-case study design (Priya, 2021) situated within a constructivist framework to investigate how VR experiences supported international PSTs' self-efficacy-related learning and cultural readiness prior to their first Australian early childhood professional placement. The case was defined as a programme-embedded implementation of Mursion® across one postgraduate early childhood cohort, with each simulation group treated as a bounded case within the broader learning design. A multi-case study approach was selected to capture variation in how PSTs interpreted, enacted, and reflected on the same pedagogical intervention in an authentic yet simulated context. Treating each simulation group as a bounded case enabled comparison of variation in interactional patterns across a shared pedagogical design. This approach is particularly appropriate for experiential simulation research, where learning emerges through interaction, reflection, and contextualised practice.

3.1. Data Collection

The study was conducted within a Graduate Diploma in Early Childhood Teaching programme in Australia that enrols a high proportion of international postgraduate PSTs preparing for their first professional experiences in Australian early childhood settings. Data were collected across four teaching blocks delivered between 2023 and 2024. All identifying information was removed to maintain anonymity and confidentiality. Ethical permission was obtained prior to data collection. Before collecting data, the researchers provided participants with an explanatory letter and consent forms. Data collection involved video data, PSTs' brief in-class reflections completed immediately after each simulation, and observation notes from the instructors who facilitated the virtual simulation sessions. These reflections were typically 5–10 min in length and focused on immediate pedagogical noticing, emotional response, and perceived areas for revision.

3.2. Participants

A total of 66 pre-service teachers (PSTs) from diverse cultural and linguistic backgrounds participated in this study. Many participants were international students unfamiliar with Australian early childhood discourse, pedagogical expectations, and classroom interaction norms. They brought rich, diverse cultural and linguistic backgrounds from China, India, Singapore, Malaysia, and Vietnam. As they prepared for their first placement, they had no work experience in Australian early childhood settings. The cohort consisted of students with prior degrees obtained in Australia or internationally; some were new to Australia, with a few months of experience at the time of data collection.

To prepare the cohort for their very first professional placement in an Australian early childhood setting, a VR simulation experience was introduced early in the programme as a scaffolded learning opportunity to practise interacting with children before the practicum. The simulation was embedded within a core unit, with lesson plans and scenario design directly aligned to the unit learning outcomes. The teacher educator initially demonstrated the simulation to model effective interaction strategies, after which PSTs engaged in the VR activity themselves. This structured sequencing supported gradual immersion, reduced performance anxiety, and made expectations explicit.

3.3. VR Simulation Design

The VR activity utilised a Mursion® human-in-the-loop mixed-reality simulation of an Australian early childhood classroom populated by four to five avatar children. Each avatar was animated in real time by a trained interactor to represent distinct personalities, behavioural tendencies, and developmental characteristics (see Table 1). Mursion® combines artificial intelligence with live human facilitation, enabling dynamic, responsive interactions that replicate the unpredictability of real classroom contexts while maintaining a low-risk learning environment.

Table 1. Summary of Avatar Children and Their Key Traits.

Avatar	Key Traits
Luna	Highly energetic and playful learner who prefers movement-based activities; enjoys busy environments; can be mischievous, still developing sharing and turn-taking skills, but shows strong empathy toward others.
Matteo	Quiet, analytical child who prefers structured, predictable settings; tends to observe before joining; enjoys experimenting and technology; responds well to clear expectations and independent or parallel play.
Andre	Sociable, tactile learner who responds strongly to visual stimulation; eager to share observations and easily distracted; frequently references family; enjoys humour and lively interaction.
Anna	Enthusiastic but detail-focused communicator who may be shy at first; becomes expressive and talkative once comfortable; tends to interpret situations literally and seeks clarity when things feel uncertain.
Brandon	Quick learner who grasps concepts easily; may lose focus while waiting for others; highly curious, expressive, friendly, and enjoys storytelling.

Note. This table presents the five avatar children in the VR simulation, each with distinct behavioural and learning characteristics that mirror the diversity typically found in early childhood settings.

Specialist trainer-controlled avatars using voice modulation, gesture tools, and AI-supported prompts, allowing PSTs to engage in authentic social, behavioural, and communicative exchanges. As recent work on simulation fidelity argues, simulation specialists play a central role in shaping authentic and responsive interactions by dynamically adjusting avatar behaviour in real time (Mello & Van der Merwe, 2026). This form of mixed-reality rehearsal also reflects broader claims that simulation offers strategic, low-risk practice in which preservice teachers can rehearse complex pedagogical moves without affecting real learners (Dalinger et al., 2020). The simulation's design aligns with Bandura's four sources of self-efficacy by providing mastery experiences, vicarious learning opportunities, verbal feedback, and emotional regulation within a psychologically safe environment.

3.4. Pedagogical Integration and Learning Cycle

The simulation was embedded within a coherent technology-infused learning design that operationalised core pedagogical principles within initial teacher education. Curriculum integration was strengthened by aligning simulation scenarios directly with unit learning outcomes and assessment criteria, particularly in domains where VR demonstrates strong effects, such as classroom management and social–relational interaction (Hillyar et al., 2025; Pendergast et al., 2022; Luke et al., 2025; Dalinger et al., 2020).

Modelling was embedded across multiple layers, including expert demonstration by the teacher educator, adaptive responses from interactors, peer observation, and watch-back artefacts generated from video recordings. After watching the video recording back, the PSTs shared in class. These elements rendered effective practice visible and supported the development of shared professional language. Practice and reflection occurred through short, iterative learning cycles: plan, enact, receive feedback, review, and re-attempt, designed to systematically support mastery, vicarious learning, and persuasive feedback while regulating arousal (Goff, 2023; Davis et al., 2022; Gundel & Piro, 2021). Repeated engagement with immersive technologies also contributed to the development of PSTs' technology self-efficacy, normalising digital pedagogies likely to be encountered across contemporary early childhood contexts.

PSTs worked collaboratively in small groups of two to three and delivered a short lesson to the avatar children via Zoom. Each group participated in one to two simulations across the teaching blocks, depending on timetable scheduling and cohort organisation. Each simulation session lasted approximately 20 min, with individual PSTs interacting directly with the avatars for 10–15 min. Across the dataset, this produced approximately 22 h of video data for analysis. During these interactions, PSTs were required to manage children's responses, support engagement, and adjust communication strategies in real time.

All simulation sessions were video recorded via Zoom to support structured reflection. Participants later reviewed recordings to analyse conversational turns, reflect on pedagogical decision-making, and observe how different avatar characteristics responded to their approaches (see Table 1). This reflective component was critical in supporting deeper learning, enabling PSTs to connect simulated experiences with emerging professional identity, confidence, and cultural readiness for placement.

4. Data Analysis

Data analysis was conducted through a rigorous and iterative qualitative process. Initially, two authors independently analysed the video data and observations to apply codes across all data sources. The analysis combined deductive coding informed by Bandura's four sources of self-efficacy with inductive coding that captured emergent interactional patterns, tensions, and pedagogical moves that were not fully explained by the framework alone. The authors then met to compare interpretations, reconcile coding differences, and collaboratively develop a shared codebook. This process supported consistency and analytical transparency. The initial phase of analysis was guided by Bandura's four sources of self-efficacy: mastery experiences, vicarious experiences, verbal persuasion, and physiological/affective states as a theoretical framework (Bandura, 1977). A thematic analysis approach was employed, involving systematic coding, categorisation, and the identification of emerging themes, with particular attention to PSTs' interactions captured in video data and how raw excerpts were progressively interpreted into codes, sub-themes, and broader analytic claims.

Analysis was ongoing and reflexive. During subsequent meetings, the authors revisited and refined codes and themes, explicitly interrogating potential researcher bias and discussing how our roles as teacher educators may have shaped interpretation. Video data were particularly valuable because they enabled repeated, close analysis of interaction, pacing, hesitation, response timing, and repair, rather than relying solely on retrospective self-report. This process also enabled the identification of learning opportunities afforded by immersive VR experiences that may support PSTs' development of self-efficacy. Across four teaching blocks, the study also informed iterative refinement of the programme across cohorts. Themes were refined to align with the research questions, with a particular fo-

cus on how immersive VR simulation fostered PSTs' mental, practical, and professional readiness for their first placement through enhanced self-efficacy.

To ensure trustworthiness, methodological triangulation was applied. Themes were required to recur across at least two of the three data sources (video recordings, PSTs' in-class feedback and observations) and to appear in more than one video group. Patterns identified in only a single data source or group were retained as sub-themes or analytic memos until further corroboration occurred. Emergent codes, categories, and themes were interpreted in relation to the research questions and the study's implications. Finally, elements of Bandura's four sources of self-efficacy (Bandura, 1977) were used to categorise themes related to PSTs' immersive VR teaching and learning experiences, particularly those associated with confidence building, cultural understanding, and reflective practice. Section 5 presents the three main themes identified, and the research data helped us create a framework that integrates practice-based, theoretical, and technological knowledge.

5. Findings

Three key themes emerged from the thematic analysis: (a) the connection between VR, social–emotional learning (SEL), and self-confidence; (b) the perceived benefits of integrating VR into teaching and learning; and (c) the relationship between pedagogy, innovation, and the use of VR in education. Together, these themes show not a simple upward trajectory, but a process marked by hesitation, revision, and increasingly deliberate pedagogical action. As illustrated in Figure 1, PSTs moved between discomfort, experimentation, feedback, and more confident reflective practice, with each theme capturing a distinct aspect of that process.

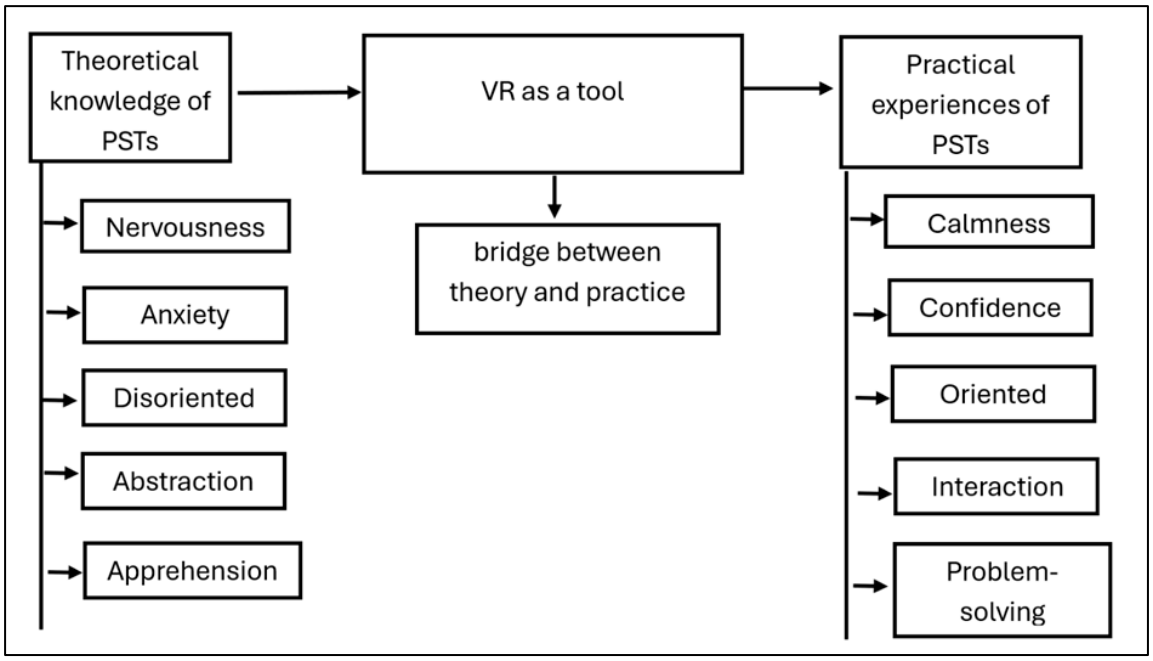


Figure 1. VR as a bridge between theoretical knowledge and practical experience of PSTs.

5.1. Theme 1: From Anxiety to Relational Regulation: SEL as a Mechanism for Efficacy-Related Learning

Analysis of PSTs' reflections revealed a trajectory in which emotional responses to the VR experience shifted from self-focused anxiety to confident, relationally attuned engagement. Initial interactions were characterised by nervousness, disorientation, and concern about "saying the right thing," reflecting heightened self-monitoring at the outset of the simulation. Early expressions such as "It's nervous" (V1, 11:37) captured this

affective state. However, scaffolded debriefing by the specialised trainer ("It's OK. We had a good conversation with the children," V1, 11:46) supported PSTs to reinterpret arousal as manageable rather than inhibiting. As the interaction progressed, PSTs articulated this emotional recalibration explicitly, noting that "It was better than we expected. . . still got some work to do" (V1, 12:21–12:28) and expressing forward-looking confidence ("I think we can do better next time," V1, 12:31). These reflections indicate a shift from performance anxiety toward an expectation of growth through practice.

As PSTs' interactional fluency increased, so too did indicators of self-confidence and professional self-worth. This was evident in their capacity to offer concrete feedforward suggestions, such as the need for "more organisation to lead them to the final results" (V1, 12:39–13:02). Importantly, PSTs began to articulate links between their own emotional regulation and children's participation, noting that nervousness could inadvertently limit children's engagement and require deliberate strategies to sustain interest and inclusion. Such comments demonstrate emerging SEL awareness, as PSTs recognised the reciprocal relationship between teacher affect and children's communicative opportunities.

These cognitive and emotional shifts were mirrored in practice. During moments of conflict or heightened energy among the avatar children, PSTs employed calm, prosocial language that named emotions, de-escalated tension, and redirected attention to shared norms. Statements such as "We like playing fine together, but we don't want to hurt each other because we're friends, right?" (V1, 4:07) and "Please be nice with each other" (V1, 9:06) illustrate growing competence in emotionally responsive classroom discourse. These brief but purposeful interventions reflect an increasing capacity to translate SEL principles into action within the simulated environment.

PSTs also demonstrated heightened relational sensitivity through acts of personalisation. One participant reflected, "Maybe remember their name is important because I pronounced one of the kids' names incorrectly" (V1, 18:29), indicating awareness of how small interactional details shape relationships. Similarly, PSTs acknowledged children's everyday disclosures (e.g., "Mummy doesn't let me have the Coke or lemonade") with validating responses such as "OK, we understand your point" (V1, 10:19–10:24). These moments mark a shift from self-preoccupation toward other orientation, signalling increased empathy and relational attunement.

Collectively, the data illustrate an emotional and professional learning arc in which PSTs moved from uncertainty to ease, from internal worry to relational engagement, and from avoidance to confident presence. At the same time, this movement was not linear. Some PSTs remained hesitant, missed interactional cues, or required repeated prompting before shifting from self-focus to child-centred responsiveness. These moments of strain are important because they show that efficacy-related learning in simulation involved effort, uncertainty, and revision rather than immediate success. This progression, supported by the VR environment and guided reflection, underpinned PSTs' developing readiness to transfer SEL-formed strategies into professional placement contexts.

5.2. Theme 2: Bridging the Theory–Practice Gap in Classroom Management and Inclusion

This theme captures how PSTs used VR simulations to develop practical classroom management and inclusive interaction strategies. PSTs consistently described the simulations as authentic and as a safe bridge between coursework and classroom practice, often comparing VR favourably with their prior expectations. The simulations enabled PSTs to rehearse multiple challenging interactional moments, such as managing conflict, silence, silliness, and imaginative tangents, within iterative cycles of practice, reflection, and re-engagement. Several PSTs referred to reviewing recordings of their sessions to iden-

tify effective strategies and areas for improvement, indicating that VR supported learning through observation of their own and others' practice.

Across simulations, PSTs demonstrated increased attention to turn-taking, pacing, and behaviour guidance. Many noticed early patterns of conversational dominance, with one PST observing, "Most of the time is one child carrying off the conversation" (V4, 18:03). In response, PSTs adopted strategies aimed at promoting equitable participation, including explicit turn-allocation such as "one each" and collective framing ("Everyone is a winner," V3). PSTs also refined their use of classroom norms, shifting toward concise, positively framed expectations (e.g., "Please be nice," V3, 9:06). Changes were observed in lesson pacing, including movement directly into the activity following children's introductions (V3, 2:28), followed in later rehearsals by deliberate pausing to listen before responding.

PSTs identified and adjusted behaviour guidance strategies over successive rehearsals. For example, conditional or extrinsic incentives (e.g., "If you don't sit properly, you're not going to get a big ice cream," V6) were replaced with neutral redirection and acknowledgement of effort. During peer debriefs, these shifts were summarised as adopting a facilitative stance, with one participant stating, "Just ask them more questions rather than ask us" (V6, 12:46–12:53).

The simulations exposed PSTs to a range of child participation styles, including quiet listeners, highly enthusiastic contributors, and playful boundary-testing behaviours. PSTs practised strategies for inviting quieter children into the interaction, such as direct but gentle prompts (e.g., "Do you want to say something, Mateo?"), while also structuring enthusiastic participation through turn-taking routines to ensure space for all children. PSTs refined question design over time, moving from abstract prompts to more concrete formulations. For instance, when asked, "Do you think this is important for you guys?" an avatar responded, "I don't know" (V7, 7:18–7:32), prompting PSTs to adjust subsequent questioning.

PSTs also extended conversations related to environmental responsibility by building on children's contributions, using prompts such as "We need to take care of the trees" (V8, 11:11) and "Pick up your rubbish" (V8, 11:27). In addition, they practised sustaining imaginative contributions that had initially been redirected. Examples included validating and extending children's imaginative statements (e.g., "I rode my bike to the moon," V6, 6:51–7:05; "I created a monster, its name is Bob," followed by "It's a cool monster," V6, 6:46; "I named it Bob," V6, 5:51). Across rehearsals, PSTs increasingly used affirmation and follow-up to remain with children's ideas rather than closing them down.

Overall, the VR rehearsals provided PSTs with observable opportunities to practise and refine classroom interaction strategies, resulting in a set of concrete approaches for managing participation, behaviour, and diverse communicative contributions. Analytically, this theme shows that simulation did more than help PSTs "bridge theory and practice." It made interactional judgement visible and revisable in real time, allowing PSTs to test, abandon, and refine strategies within the same pedagogical cycle. This theme aligns with Bandura's verbal persuasion, mastery experiences, and physiological/affective states.

5.3. Theme 3: From Reflection to Pedagogical Revision: Technology as Infrastructure for Repeatable Practice

Analysis of the dataset indicates a consistent shift from affective response to pedagogical action during VR-supported teaching rehearsals. Preservice teachers (PSTs) used debrief sessions to analyse their instructional moves and identify a specific change for subsequent attempts. One PST reflected, "I am sitting and analysing my work. . . I learned things about myself," capturing a broader pattern in which reflection was oriented toward immediate pedagogical adjustment rather than general self-evaluation.

PSTs demonstrated increased alignment between pedagogical intention and instructional language across successive rehearsals. Instances of abstract or developmentally misaligned questioning were identified and revised, for example, reframing prompts from "How would you connect with that playground?" to "What do you like about this place?" Similarly, PSTs recognised moments where children's imaginative contributions were prematurely redirected (e.g., "Let's go back to the picture", V9, 6:51–7:05) and subsequently practised sustaining these ideas long enough to include peers before returning to the instructional focus (e.g., "It's a cool monster", V9, 6:46). These adjustments were explicitly linked to feedback received during debriefs and enacted in subsequent attempts.

The data also show changes in classroom management and motivational strategies. PSTs identified ethical and relational concerns associated with reward-based approaches. They replaced these with inclusive routines, such as consistent naming, structured turn-taking, and verbal acknowledgement of children's contributions. These practices were trialled, reviewed, and refined within the same VR session or across repeated simulations.

Across cases, a recurrent cycle was evident: PSTs named an emotional or interactional challenge, attempted a pedagogical strategy, received specific feedback, and reattempted the strategy with modification. Over time, reflective language shifted from first-person affective statements (e.g., "I'm nervous") to professional problem-solving terminology (e.g., simplify, slow down, invite one at a time, acknowledge feelings, link back to purpose). This pattern indicates the development of pedagogically focused self-regulation within a technology-mediated repeatable teaching environment.

The three themes together illustrate a coherent transformation. Social–emotional learning highlights PSTs' progression from apprehension to empathy and self-regulation. The perceived advantages showcase specific management and differentiation strategies that were practised safely in VR. Meanwhile, the alignment of pedagogy and innovation demonstrates how PSTs utilised the technology to support EC goals rather than overshadow them. By the final cycles, they were able to articulate practical routines that are ready for placement, such as using names for inclusion, validating feelings, inviting individual participation, briefly staying with imagination, simplifying questions, and connecting back to the learning goals. Taken together, these findings suggest that immersive simulation created a concentrated pedagogical environment in which multiple sources of efficacy information were encountered, interpreted, and acted on within the same cycle of practice. These reflect both emotional growth and pedagogical intentionality.

6. Discussion

This study contributes to emerging VR research in teacher education by showing that immersive simulation functions not only as a rehearsal tool but also as an integrated pedagogical environment. It operationalises multiple sources of self-efficacy within a single, repeatable learning cycle. Rather than claiming direct measurement of efficacy change, the study examines how international PSTs enacted, interpreted, and revised self-efficacy-related practices through interaction with avatar children, guided feedback, and structured reflection. In this sense, the value of mixed-reality simulation lies not simply in confidence-building. It lies in how it compresses mastery, modelling, persuasion, and affective regulation into one pedagogical space. For the special issue, the paper offers a grounded account of how technology infusion can be organised programmatically, not just technically, so that immersive tools support pedagogical judgement, reflective practice, and professional readiness within ITE.

Across the three themes, the findings point to a more specific argument than simple alignment with Bandura. The simulation environment accelerated the movement between emotional responses, pedagogical actions, feedback, and re-attempts. This matters because

Bandura's sources are often discussed as analytically distinct, whereas in this study, they were experienced by PSTs as relationally entangled and pedagogically simultaneous. In early childhood contexts, where communication, affect, responsiveness, and interactional timing are central, this compression appears especially significant.

In Theme 1, the journey of preservice teachers (PSTs) from initial nervousness to composed, purposeful interaction highlights the transformative potential of immersive virtual reality (VR) in fostering self-efficacy-related learning, as outlined by Bandura (1977). Initially, these PSTs experienced a sense of arousal often described as "nervousness." However, this feeling was not simply eliminated; rather, it was reframed through targeted brief practice sessions and structured debriefings. These interventions created an environment where PSTs could experience manageable success even under pressure. What is especially important here is that affective regulation was not separate from pedagogical development. In this study, learning to remain calm, listen, and respond relationally was itself part of becoming able to act pedagogically in EC settings.

As PSTs engaged with avatar children, they developed a more deliberate interactional stance. They used calming language, empathic acknowledgement, and clearer relational framing to manage conflict and sustain participation. This extends Bandura's framework in an EC direction by showing that efficacy-related learning in early childhood is not only individual or cognitive. It is also embodied, relational, and interactional. PSTs were not merely building private beliefs about competence. They were learning how competence is enacted through tone, timing, emotional regulation, and responsiveness to children in the moment.

This interpretation extends broader research showing that short, coached mixed-reality simulations can support efficacy-related development when they combine enactment, observation, feedback, and opportunities for reattempt (Samuelsson et al., 2022; Hong et al., 2025). At the same time, the field cautions that many reported gains are based on self-reported confidence. Such gains do not necessarily indicate sustained pedagogical change over time (Hong et al., 2025). The significance of the present data, then, is not that they prove stable efficacy change. It is that they reveal how PSTs moved from nervousness toward empathy, timing, and interactional control within a structured early childhood rehearsal environment. The observed SEL trajectory from disorientation to enjoyment, confidence, and professional behaviour, therefore, extends current work on simulation-based learning by showing that efficacy-related development in ECITE is inseparable from relational pedagogy, affective regulation, and interactional responsiveness. It also reinforces the need to interpret such gains through pedagogical design rather than through technological novelty alone (Hong et al., 2025; Samuelsson et al., 2022).

Theme 2 further shows that simulation did more than provide safe practice. It made pedagogical judgement observable and revisable. PSTs could see when questioning was too abstract, when participation became uneven, or when behavioural responses closed down interaction rather than extending it. This matters theoretically because the environment did not simply confirm prior knowledge. It exposed the fragility of that knowledge in action and created conditions for immediate repair. For international PSTs, this was particularly important because the challenge was not only the technique, but also learning how pedagogical decisions are culturally and interactionally realised within Australian early childhood settings.

This finding reinforces a central point in the literature: the value of VR is not inherent to the technology itself. It is produced through pedagogical design, scaffolding, and integration into teacher education programmes (Hong et al., 2025). Simulation platforms matter because they make decision-making visible through approximations of practice,

allowing PSTs to rehearse, review, and revise responses within a controlled environment (Ledger et al., 2022).

In this study, visibility was crucial for surfacing differentiation, turn-taking, questioning, and culturally responsive communication that might otherwise have remained abstract in coursework. Rather than showing simply that VR is useful for classroom management, these findings indicate that mixed-reality rehearsal supported efficacy-related learning by making behaviour guidance, participation management, and interactional clarity available for immediate revision. This extends work positioning simulation as a structured form of deliberate practice in teacher education, where repeated rehearsal, targeted feedback, and refinement occur within a controlled pedagogical environment (Gravett et al., 2023). The pedagogical value of the environment lay in its repeatability and in the speed with which PSTs could test, evaluate, and modify their responses before entering placement.

Theme 3 underscores that the contribution of innovation depends on how tightly it is pedagogically organised. In this study, recorded lessons, peer feedback, and repeated rehearsal did more than accompany the technology. They turned the technology into a structured mechanism for noticing, reflection, and pedagogical revision. This helps explain why PSTs were able to move from affective reactions toward more deliberate professional language and action. The use of short practice cycles, regular opportunities for reflection, and consistent integration of technology supported pedagogical refinement. It also strengthened PSTs' confidence in working within digitally mediated teaching environments. For PSTs preparing for early childhood settings, this is significant because technology did not displace relational pedagogy. It enabled repeated rehearsal of the relational, communicative, and interactional work required by EC teaching (Lindberg & Jönsson, 2023; Australian Institute for Teaching and School Leadership, 2023).

Our research aligns with Foulger's (2020) assertion that teacher educators need to integrate technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) into a cohesive framework known as Technological-Pedagogical-Content Knowledge (TPACK). This comprehensive approach not only enhances teaching methodologies but also deepens PSTs' understanding of technology, enabling them to bridge the gap between theoretical knowledge and classroom practice (Arriagada-Hernández et al., 2025). Ultimately, by developing a holistic understanding of TPACK and effectively utilising technology, teachers can create enriched learning environments that foster student engagement, collaboration, and equity (Jin et al., 2023; Llanos Ruiz et al., 2025).

While virtual reality is often positioned as a discrete innovation or supplementary learning tool, this study's findings illustrate how immersive simulation can serve as a programme-wide technology infusion within initial teacher education, rather than a standalone intervention. Technology infusion refers to the systematic and purposeful integration of digital tools across curriculum, pedagogy, and assessment. In other words, technology becomes embedded in how professional learning is designed, enacted, and evaluated (Foulger, 2020). In this study, VR was not introduced as a novel activity. It was embedded early in a core unit and revisited across multiple teaching blocks, allowing preservice teachers (PSTs) to engage in repeated cycles of enactment, feedback, reflection, and re-enactment. This study extends simulation-based ITE research by demonstrating how mixed-reality simulation can serve as a pedagogical infrastructure within ECITE rather than as a one-off confidence-building intervention.

This programmatic design aligns VR use with broader ITE goals, including the development of pedagogical judgement, emotional regulation, and professional language, rather than positioning technology as content in its own right. By standardising interactional scenarios while allowing adaptive responses through human-in-the-loop facilitation, VR enabled consistent access to high-quality practice opportunities across cohorts, supporting

equity and scalability at the programme level. Across four teaching blocks, the study also informed iterative refinement of the programme across cohorts. Repeated exposure also contributed to PSTs' technology self-efficacy, normalising the use of digital pedagogies and reducing reliance on ad hoc or individualised technology adoption. These findings position mixed-reality simulation as a scalable model for the future of teacher preparation in technology-rich learning environments. They also suggest that its value depends on sustainable integration within course design, staffing, and assessment, rather than on one-off adoption. For future ITE design, this means immersive simulation is most powerful when embedded as part of a coherent, programme-wide approach to rehearsing practice, reflection, and feedback.

From a curriculum perspective, immersive simulation functioned as a connective thread across theory, practice, and reflection, operationalising Technological Pedagogical Content Knowledge (TPACK) through authentic rehearsal rather than abstract discussion. This approach demonstrates how a purposeful infusion of technology can enhance coherence across an early childhood ITE programme, ensuring that digital tools support, rather than compete with, relational and pedagogical priorities. As such, VR offers a sustainable model for programme-wide technology integration that prepares PSTs not only to teach effectively, but also to engage confidently with technology-rich professional environments.

This study is especially significant for international PSTs, who often face two intertwined challenges in professional preparation: enacting essential teaching practices and adapting to the language, routines, and educational expectations of a new context (Lee et al., 2025). The findings sharpen this discussion by showing that early successes in mixed-reality rehearsal, such as resolving classroom conflict or engaging a previously quiet child, can shift PSTs from anxiety toward more deliberate pedagogical decision-making. This extends broader work on simulation as a strategic practice by showing how scaffolded rehearsal can support readiness for practice in culturally unfamiliar early childhood contexts (Dalinger et al., 2020; Gravett et al., 2023; Hong et al., 2025).

VR technology offers consistent and repeatable opportunities for PSTs to practice, reflect, and refine crucial interpersonal skills. Across the wider literature, these simulations are valued for providing low-risk, feedback-rich environments in which PSTs can test interactional strategies, revisit decisions, and prepare for the communicative demands of placement (Dalinger et al., 2020; Gravett et al., 2023; Hong et al., 2025). In our own context, this is particularly relevant for PSTs with limited familiarity with local classroom cultural norms, where simulation can make expectations more visible before practicum (Lee et al., 2025). The relevance of this study is particularly pronounced in the Australian educational context, where there is a strong emphasis on "classroom-ready" priorities. These priorities incentivise reliable pre-practicum preparation that focuses on rehearsing skills related to classroom communication, interaction, and cultural responsiveness (Australian Institute for Teaching and School Leadership, 2023; Sasaki et al., 2020).

By concentrating specifically on the interactional demands placed on early childhood educators, this study fills a noticeable gap in the literature, which has traditionally been centred on primary and secondary education settings. Our research demonstrates how VR can scaffold crucial elements of effective teaching, including responsive interaction, emotional attunement, and relational pedagogy, specifically tailored to support international cohorts of PSTs. This approach not only enriches their professional practice but also enhances their overall effectiveness in diverse classrooms.

7. Design Implications, Limitations, and Future Research

This section discusses design implications, limitations, and future research. In line with existing recommendations that emphasise the role of VR as a tool to enhance, rather than

replace, traditional methods of supervision and live practice (Davis et al., 2022; Dalinger et al., 2020), our findings suggest a framework comprising five key design principles to improve pre-practicum preparation for PSTs. These principles also speak to wider questions about how emerging technologies can be integrated into ITE in ways that are pedagogically coherent, durable, and meaningful. These principles are as follows:

1. Foster early mastery through low-stakes entry experiences: It is crucial to create initial opportunities for PSTs to engage with VR in settings that are low-stakes, allowing them to gain confidence and competence without the pressure of high-stakes outcomes. This approach encourages experimentation and reduces anxiety associated with performance. This principle is supported by Theme 1, where PSTs' early nervousness became more manageable when the simulation created space for low-risk attempts, emotional recalibration, and guided re-entry.
2. Iterate in short cycles, accompanied by focused debriefs: Using short iterative cycles of a Mursion® mixed-reality simulation allows for rapid feedback and reflection on the learning process. Coupled with targeted debrief sessions, this strategy helps PSTs analyse their experiences, understand their strengths and areas for improvement, and continuously refine their teaching practices. This principle is grounded in Themes 2 and 3, where repeated enactment, feedback, and re-attempt enabled PSTs to refine questioning, pacing, turn-taking, and relational responses.
3. Make interactional work visible using watch-back features and noticing guides: By using watch-back functionalities, PSTs can revisit their VR interactions, enabling them to observe their own teaching methods and interactions with children. Noticing guides further assist them in identifying key moments that can inform their teaching strategies and enhance pedagogical awareness. This principle reflects Theme 3, in which PSTs used recordings and reflection to identify missed cues, conversational dominance, and more effective ways of extending children's contributions.
4. Calibrate emotional responses in real time through human-in-the-loop control: Integrating a human element allows for real-time feedback on emotional and social dynamics during VR sessions. This responsiveness enables PSTs to adjust their approach to children's engagement and classroom management as they practice, thereby building their emotional intelligence and adaptability. This principle is supported by Theme 1, where emotionally responsive facilitation and debriefing helped PSTs reinterpret anxiety as manageable and remain engaged in the interaction.
5. Align scenarios and debriefing criteria with expected competency assessment outcomes: The VR scenarios presented to PSTs must be closely aligned with the competencies and outcomes expected in their assessments. Therefore, we need to ensure that the practice they receive is relevant and meaningful, ultimately supporting their growth in areas such as classroom management and social and relational interactions with children. This principle is reinforced across all three themes, which show that the strongest learning occurred when simulation tasks, debrief prompts, and pedagogical goals were tightly connected.

At the same time, our data highlights a critical tension noted in existing literature. When VR simulations fail to be sufficiently adaptive or grounded in robust educational theories, the technology's novelty may overshadow important pedagogical considerations. As a result, for VR to have a sustained impact on teacher development, it is vital to maintain explicit theoretical alignment, establish clear language goals, and calibrate levels of challenge appropriately. In line with Jin et al.'s (2023) findings, we advocate integrating technology into ITE programmes. This infusion is essential for supporting the development of technology integration competencies among teacher educators and for providing targeted

professional learning opportunities that focus on effectively designing impactful learning experiences for PSTs.

While this study was conducted within a single institutional context and did not include a comparative design, it provides a focused and in-depth examination of VR implementation in authentic practice settings. These findings offer a strong foundation for future multisite and comparative studies to explore further the relative effectiveness of VR alongside other pedagogical approaches. To enhance future research, we recommend incorporating validated performance rubrics that specifically evaluate interactional moves, conducting brief affective check-ins at various points during the training cycles, and implementing follow-up measures to assess the durability of the observed effects during the practicum phase (Gresele et al., 2025; Samuelsson et al., 2022; Taggart et al., 2023). Additionally, longitudinal studies are needed to investigate whether early successes, as indicated by effective VR experiences, predict outcomes such as retention in the profession, confidence in teaching practices, and the application of responsive pedagogy during placements, particularly for international PSTs. A further limitation is that the study did not include longitudinal follow-up in the practicum, nor did it directly measure efficacy beliefs through a validated self-efficacy instrument. The findings, therefore, speak to conditions that support efficacy and observable pedagogical learning within simulation, rather than to stable changes in efficacy over time. This future agenda is best read alongside broader field-based concerns about sustained transfer, efficacy development, and pedagogical integration (Gravett et al., 2023; Hong et al., 2025; Samuelsson et al., 2022).

8. Conclusions

This study argues that immersive virtual reality (VR), more precisely operationalised here as human-in-the-loop mixed-reality simulation, is pedagogically significant not because it simply boosts confidence, but because it organises multiple efficacy-supporting conditions within a repeatable learning environment. For international PSTs preparing for early childhood placement, this matters because readiness is not only about knowing what to do. It is also a matter of learning how to respond relationally, regulate emotion, and make interactional judgements in real time. More specifically, this study shows that mixed-reality simulation can make interactional judgement, emotional regulation, and reflective revision visible before placement, thereby strengthening the pedagogical conditions that enable self-efficacy-related learning.

The contribution of this paper, then, is not to treat self-efficacy as a simple outcome of simulation. It is to show how efficacy-related practice can be made observable, discussable, and revisable within ECITE through structured cycles of rehearsal, feedback, and reflection. In contexts where relational pedagogy, communication, and cultural responsiveness are central to effective practice, this positions human-in-the-loop mixed-reality simulation as more than a preparatory add-on. It positions simulation as a pedagogical infrastructure for helping PSTs move from uncertainty toward more deliberate, responsive, and professionally grounded practice before entering placement. Across four teaching blocks, the study also informed iterative refinement of the programme across cohorts. In this way, the paper contributes to the special issue by offering an empirically grounded account of how immersive simulation can be designed as part of coherent teacher preparation rather than as technological novelty alone. Future research should now examine how these efficacy-supporting conditions transfer into practicum settings over time, particularly through longitudinal and comparative studies that track pedagogical performance, emotional regulation, and professional confidence across diverse early childhood contexts.

Author Contributions: Conceptualization, J.C.; Methodology, A.D.; Validation, A.D. and J.C.; Formal analysis, A.D. and J.C.; Data curation, A.D.; Writing—original draft preparation, A.D. and J.C.;

writing—review and editing, A.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was approved by the University Human Research Ethics Committee (ethics approval number 7853, date of approval: 8 July 2024).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The analysis file and anonymised transcript data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial intelligence
AITSL	Australian Institute for Teaching and School Leadership
CK	Content knowledge
EC	Early childhood
ECITE	Early childhood initial teacher education
EC PSTs	Early childhood pre-service teachers
ITE	Initial teacher education
PK	Pedagogical knowledge
PST	Pre-service teacher
SEL	Social–emotional learning
TK	Technological knowledge
TPACK	Technological pedagogical content knowledge
VR	Virtual reality

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