Integration of simulation technology with assessment in initial teacher education

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Simulated learning environments have rapidly evolved in recent years and are gaining traction as an effective tool in teacher education (Australian Institute for Teaching and School Leadership, 2023; Frei-Landau et al., 2023). This paper explores the use of virtual classroom simulation in initial teacher education at an Australian university. It considers the alignment of simulation activities with mandated learning outcomes, and the challenges in assessing simulation-based learning in ways which are fair, authentic and effective. These issues are analysed within a detailed review of how simSchool, an online virtual classroom gaming platform, has been innovatively integrated within the curriculum and assessment of three undergraduate initial teacher education courses. Each case study report includes an instructor-led evaluation of key elements of the assessment design process, enabling comparison of the different strengths of each approach. The paper concludes by summarising the salient aspects of successful integration and assessment of simulation technology in higher education. This contribution to the discourse of simulation pedagogy seeks to encourage more academics to test the affordances of simulation technology in their teaching by adopting approaches that are tailored for student cohorts and precisely aligned with learning outcomes.

Implications for practice or policy:

- Academics should tailor simulation activities for their cohort and learning objectives.
- Assessment must be precisely aligned, fair, authentic and effective.
- Learner engagement may be increased by careful introduction and management of expectations, with clarification of learning opportunities.
- Ongoing evaluation of simulation activities and assessment is important to maintain high quality teaching and learning.

Keywords: simulation, initial teacher education, assessment, higher education, case study

Introduction

Simulation environments have been gaining popularity as an educational modality in higher education for many years (Chen et al., 2023; Okuda et al., 2008). An established body of research promotes simulation for instructional design and assessment, yet adoption of simulation in initial teacher education (ITE) has lagged, and while growing in popularity, it arguably remains underutilised (Ledger, Burgess et al., 2022). This paper reports on the implementation of simSchool (https://www.simSchool.com), an online virtual classroom gaming platform, in the secondary, primary and early childhood ITE programmes at a regional Australian university. Since its introduction in 2022, use of simSchool has been refined and increasingly integrated in course assessment. SimSchool contributes an alternative to traditional assignments and offers less scope for plagiarism using generative artificial intelligence. However, due to the intricacy that each course and simulation experience bring, establishing assessment that is valid, feasible and reliable has its complexities. This paper offers an exploration of such considerations, before reporting examples of simSchool's integration in teaching and assessment in three courses. These case studies are collectively evaluated, with recommendations made regarding approaches to simulated learning and its role in assessment.

Overview

The ITE context

Teacher education faces several challenges in the Australian context, as reflected by recent reviews and reports. Of note are the Quality Initial Teacher Education Review (Department of Education, 2022) and subsequent Teacher Education Expert Panel (TEEP) report (Department of Education, 2023). Two of four key recommendations from the TEEP report focused on strengthening programmes to better prepare graduates and improving the quality of practical experience in teaching. A persistent challenge for ITE providers is the integration of theory and practice, and whilst Australia has been criticised as being "years behind in ITE reform" (Fahey & Joseph, 2023, p. 1), the same challenge is reported in New Zealand (Whatman & MacDonald, 2017) and the United Kingdom (Spielman, 2019). In Australia, the ITE regulatory context is framed by policy requirements set by ministers, government and teacher regulatory bodies at both state and federal level, who are external to ITE providers themselves (Department of Education, 2023, p. 8). It is expected that Australian teaching students exiting ITE programmes demonstrate graduate standard attainment across all components of the seven Australian Professional Standards for Teachers (APST) and should then continue to progress through three further levels (Australian Institute for Teaching and School Leadership [AITSL], 2017).

Acknowledging that the following is a simplification of a complex issue, a fundamental tension exists between introducing theory and strategy to commencing students who lack practical experience to connect it to; or, conversely, the impossibility of sending trainees into classrooms without good theoretical understanding. ITE providers must navigate this tension as best as possible (McCormick et al., 2013), alongside managing the invaluable learning that occurs during practicum alongside the multiple costs to students and institutions. For example, students might be away from other classes, normal housing and paid employment. This is significant when 74% of students enrolled in non-school qualifications in 2021 also worked, 32% of them full-time (Australian Bureau of Statistics, 2021). Completing practicums may particularly impact students enrolled in online degree programmes, which are rapidly growing in ITE (AITSL, n.d.).

A less quantifiable yet significant cost is borne by universities and host schools, who dedicate limited resources to supporting trainee teachers. For these reasons among others, ITE programmes typically incorporate practicum placements towards the end of programmes or at equally spaced intervals, positioned to serve as a summative assessment of skills. In some countries, this is mandated by regulatory bodies (c.f. Chapter 3 of Hall et al., 2018). A further issue is inconsistency between students' practicums, because they occur in different schools and locations, with support from different practising teachers (Goldhaber et al., 2021). They, therefore, inevitably offer different learning opportunities, and students receive differing qualities of support and feedback. Ultimately this translates into varying degrees of professional preparation, including managing student diversity (Department of Education, 2023; Rowan et al., 2021). This highlights a broader equity issue, particularly when performance in practicum comprises a core part of attainment of APST requirements.

These structural challenges are compounded by declining enrolments and a broader crisis in the teaching sector. In response, universities are expanding access to more diverse student groups, which is positive, but may also deepen inequities in opportunity, support and assessment (Thomas, 2012). The present study was situated at a regional university with high proportions of enrolments from non-traditional backgrounds such as low socio-economic status, first in family and Indigenous students; see demographic data in Table 1. The university's regional location also means students may need to travel long distances for practicums. This enables valuable experience in rural and remote contexts yet creates logistical challenges for students and staff. Students will always need experience in schools, which are inherently inconsistent. Australia's graduating teachers report feeling less prepared for the classroom than their peers in comparable countries (Fahey & Joseph, 2023). Simulation technologies offer complementary virtual experience alongside traditional practicums, improving consistency and equity, making simulation an attractive tool to address these challenges.

Table 1
The socio-economic profile of the undergraduate student cohort at the University of Newcastle (adapted from The University of Newcastle, 2024)

% of students	Demographic background
81%	Have external commitments such as work, community or family
59%	Are non-school leavers
45%	Are first in family
32%	Have a mental or chronic health condition
24%	Are from low socio-economic status or disadvantaged backgrounds
18%	Experience a disability
5%	Are Indigenous

The role of simulation

Simulation-based training can bridge theory and practice in an engaging and motivating way. It provides early insight into classroom management, which for some pre-service teachers is their first perspective as teacher rather than student. Simulated classrooms provide experience of the multiple decision-making schemas that underpin effective teaching (Ledger, Spray, & Kett, 2022) and can be systematically varied to offer all students experience in diverse teaching and learning contexts; they therefore allow students to benefit from equal access to a range of simulated environments, giving insight into different stages of learning, curricula, differentiation and student behaviour. This means that when new teachers graduate, it is possible to know they have all received consistent simulated training, in addition to their school-based experiences. This is particularly relevant in the context of preparing pre-service teachers to support diverse learners, an issue consistently identified as challenging by teachers in Australia (Rowan et al., 2021).

This paper focuses on the affordances of one commercially available simulation technology, simSchool. SimSchool is a game-based platform underpinned by artificial intelligence algorithms representing the cognitive, social, emotional and physical complexities of the classroom. It was developed at the University of Western Oregon in the early 21st century (Gibson & Halverson, 2004; Zibit & Gibson, 2005) and is now used worldwide. SimSchool displays a classroom populated by avatar students and invites the user to manage this class via dropdown menus offering a range of options for interaction. An example of this view is show below (Figure 1), and a detailed description of simSchool and our institutional context is available in Spray et al. (2023). The introduction of simSchool in this university's ITE programmes was predicated on several anticipated benefits. Firstly, the simulated classroom allows students to safely practice developing skills, without fear of failure. The software enables unlimited repetition of scenarios, allowing students to experiment with pedagogical approaches. This may support students' teacher self-efficacy; equally, it may serve to correct overconfident students by exposing them to the realities of student behaviour and the difficulty of managing competing priorities with multiple students (Spray, 2022; Spray et al., 2023).

Another advantage of simSchool is that it provides instant feedback via a detailed individual user dashboard, giving participants rapid understanding of their strengths and weaknesses, directly informing ongoing practice. This data is collated into a cohort overview for instructors, informing their focus on broader pre-service teacher development. All this is accessed by students using their own devices, with data analytics automatically delivered. Beyond the initial cost of subscription, there is no additional cost to the institution in students' repeated use of the simulation package, regardless of how many scenarios they play, how many times they repeat a scenario or how much feedback they access. Users only need to play the simulation for 15 minutes to receive feedback, and it can be paused as required so it does not demand extended screentime. In increasingly hybrid learning contexts, with ITE shifting online (AITSL, n.d.), the asynchronous nature of simSchool makes it an equitable option when designing learning for students studying on campus or by distance. The virtual nature of this technology means there is also zero logistical cost in placing students in real schools, no travel time or costs and no reputational or relationship management to be considered.

Figure 1. Example of a simSchool classroom

simSchool's game-based learning approach invites users to try to improve virtual students' academic and affective outcomes and receive a quantitative review of their performance. This goes beyond simple gamification (Wiggins, 2016) and has been likened to a simulated apprenticeship in which the user is coached with constant feedback (Zibit & Gibson, 2005). This feedback facilitates data-based decision-making, an essential element of classroom formative assessment (Van der Kleij et al., 2015). Pre-service teachers' experience in simulated classroom practice also fits Grossman et al.'s (2009) pedagogies of practice, which presents professional learning as representations, decompositions and approximations of practice. Simulation thus contributes to teacher knowledge development, showing significant impacts on users' attitudes, skills and capabilities (Theelan et al., 2019; Yilmaz & Hebebci, 2022).

simSchool is highly customisable, meaning the format of resources and feedback can be tailored to reflect local norms, such as a university lesson plan template or national standards of teacher accreditation. Simulated scenarios can be tailored to contain particular content and adapted to a range of learning outcomes. Users may teach an individual student, a small group or a full class. Class composition can be adjusted to include varying proportions of students with specific characteristics, for example, gifted and talented or students with English as an additional language. Additionally, the integration of simSchool activities within curriculum is flexible. It might be used for a single activity, a short module, through the full duration of a course or across an entire degree program. Beyond simSchool itself, instructors can design any number of associated activities to extend on students' learning following engagement; a number of these are illustrated in this paper. This enables use of simSchool to connect with multiple aspects of the APST. Table 2 indicates the clearest connections between simSchool and the APST, which outlines seven broad standards, each divided into substandards which are described at different levels of proficiency. This does not suggest that simSchool should be the primary method for developing these skills; rather it illustrates the potential and flexibility of simSchool within ITE.

Table 2
simSchool's alignment with the APST (adapted from Spray et al., 2022)

APST (AITSL, 2017)	Element – Graduate career stage
Standard 1: Know students and how they learn	1.1 - Physical, social and intellectual development and characteristics of students
	1.3 - Students with diverse linguistic, cultural, religious and socioeconomic backgrounds
	1.5 - Differentiate teaching to meet the specific learning needs of students across the full range of abilities
	1.6 - Strategies to support full participation of students with disability
Standard 2: Know the content and how to teach it	2.1 - Content and teaching strategies of the teaching area
	2.2 - Organise content into an effective learning and teaching sequence.
	2.3 - Use curriculum, assessment and reporting knowledge to design learning sequences and lesson plans.
	2.5 - Know and understand literacy and numeracy teaching strategies and their application in teaching areas.
Standard 3: Plan for and implement effective teaching and learning	3.1 - Establish challenging learning goals
	3.2 - Plan, structure and sequence learning programmes
	3.3 - Use teaching strategies
	3.4 - Select and use resources
	3.5 - Use effective classroom communication
	3.6 - Evaluate and improve teaching programmes
Standard 4: Create and maintain supportive and safe learning environments	4.1 - Support student participation
	4.2 - Manage classroom activities
	4.3 - Manage challenging behaviour
Standard 5: Assess, provide feedback & report on student learning	5.1 - Assess student learning
	5.2 - Provide feedback to students on their learning
	5.3 - Make consistent and comparable judgements
	5.4 - Interpret student data

It is prudent to remain aware of the limitations of simulation training. It is not a replacement for on-the-ground experience of classroom practice. Nor is simSchool a virtual reality simulation; rather it embraces a somewhat pixelated, retro user interface, reflecting its game-based origins. This means that management of users' expectations is pivotal, because overselling the simulation experience may fuel disappointment and disengagement due to first responses to the visual interface. Nonetheless, with appropriate guidance, simSchool can contribute to preparing pre-service teaching students to enter practicum ready to engage at a higher level and equipped with an increased repertoire of strategies, priming them to benefit from more nuanced aspects of their school-based experience.

Integrating assessment

Many students in higher education also work (Australian Bureau of Statistics, 2021) and have limited time and energy for study, so assessed tasks tend to receive greater student attention. To support students' engagement with simulation, therefore, it should be integrated in course assessment. From a theoretical perspective, it is evident that many elements of simulation-based learning align with dimensions of authentic assessment, including realism, cognitive challenge and evaluative judgement (Villarroel et al., 2018). Teaching and learning should therefore be designed to maximise those aspects of the activity, without allowing assessment to undermine the freedom from consequences which is a key benefit of simulated training. These complexities have led to simulation methodologies as an emerging field, emphasising the importance of professional development for educators implementing simulation-based experiences (Watts et al., 2020).

Although in-person practicum is where final assessment of teaching performance belongs, simulated practice arguably serves as direct preparation for real classroom experience; thus, it is not inauthentic to assess simulated performance as a precursor to the reality of school-based assessment. Simulation might even function as a threshold requirement prior to placement in schools when they take responsibility for real students' learning. In novice-practitioner contexts the key assessment debate is "to grade or not to grade": to offer participation credit for students following the pattern of preparation, practice and reflection, or to try and assess the quality of performance in those activities. A benefit of simulation is the repetition that students can experiment pedagogically. This represents the intentional deviation of simulation from reality, because no matter how poorly a trainee teacher may initially perform, they can reset and start fresh. It may be more ethical to assess students' final simulated performance, without penalising students who require more time or make more mistakes during their learning phase. When practising new processes, participation grades may be more appropriate; then, as students build expertise, formative graded assessment can inform that learning; and once opportunities have been provided for consolidation, it becomes reasonable to adopt a more summative approach to assessment.

Assessment may extend beyond simulated classroom teaching itself, because simulation can also engage pre-service teachers with elements of professional practice that go beyond classroom management. For example, users might be required to prepare by reviewing student and syllabus data before a simulation. Likewise, post-practice review is valuable, and with structured cycles of preparation, practice and reflection built into simulation activities, students can be guided to reflect upon a session and consider alternative approaches. Focus on teacher behaviours before and after classroom teaching is an essential part of ITE because these skills are key to becoming a reflective practitioner (Belvis et al., 2013). In fact, much of the learning associated with simSchool occurs during participants' post-simulation evaluation and reflection. Whether conducted independently or with peers, reflection should be exploratory and safe, with assessment employing carefully defined criteria to ensure freedom of expression. A simple option is to use participation-based, ungraded assessment rather than attempting to quantify qualitative differences between students' submissions. However, ungraded assessment may impact students' motivation and effort (McMorran et al., 2015). The balancing of such considerations is a constant feature in the design of simulation-based assessment. Examples of such deliberation and decision-making are outlined within the three case studies presented herein.

This study investigated the potential of simSchool to address issues in traditional models of ITE by providing opportunities for students to practise the planning, decision-making and reflection that underpin responsive teaching practice. Examples of the pedagogical integration of simSchool are presented and evaluated, and issues around simulation-based assessment are discussed, illustrating challenges and affordances of this technique. Investigation was framed by the following research questions (RQ):

- RQ1: How can simSchool be integrated within ITE programmes to support students' development towards course outcomes?
- RQ2: To what extent can simSchool be effectively used within course assessment?

Methodology

This study employed a multi-case study approach to explore the integration and assessment of simSchool within three compulsory ITE courses at a regional Australian university. Approximately 600 students from second-year primary, second-year secondary and third-year primary and secondary programmes participated in simSchool as part of their required learning activities. The evaluation of simSchool's use in these courses was ethically permitted by an institutional Quality Assurance approval (QA305). Semi-structured narrative reports from course coordinators were selected as the primary data collection tool and presented as three individual case studies to capture variance and commonality between the use of simulation in each course. SimSchool was integrated differently across the courses to align with specific learning outcomes and assessment needs. Assessment methods varied, with each course focusing on different aspects such as lesson planning, classroom management and inclusive teaching practices.

Customised simulation scenarios were developed to reflect authentic classroom environments, and students received individualised feedback to refine their practice.

A case study approach was appropriate because it is "an empirical inquiry which investigates a phenomenon in its real-life context" (Yin, 2009, p. 18, as cited in Priya, 2020). Beyond this, it is also a research strategy, allowing for in-depth exploration of a phenomenon while maintaining a strong focus on context and purpose (Priya, 2020). It is particularly appropriate for academics examining their professional practice (Harland, 2014). In this study, I created a narrative response structure incorporating intention, design, student assessment, evaluation, refinement and future focus. This structure was responded to by the coordinators of the participating courses (Kett, Rutherford and Rendoth). All authors then contributed to discussion of themes identifiable in the resultant narratives.

Pedagogical context

At The University of Newcastle, simSchool is one of three simulation technologies used in ITE. Typically, students encounter simSchool before other simulation environments or school-based practicums. The courses reviewed here are mandated for ITE students in the second and third years of their 4-year programmes. An overview of student cohorts is provided in Table 3. All three courses are large-scale; thus, they face the challenge of providing high quality learning opportunities in a logistically viable and sustainable way. In such contexts, the individualisation of simulation with immediate personal feedback is an attractive pedagogical option. In the case studies below, each course is briefly introduced, and the approach taken to simSchool is described and justified. This is followed by a broader discussion about the successes and challenges of effectively assessing students' simulation activities in an authentic and ethical manner.

Table 3
Overview of student cohort

	Case Study 1 K-6 pedagogies	Case Study 2 Classroom management	Case Study 3 Inclusive and special education
Enrolments	239	200	92
Male/Female	63/176	79/121	28/64
Student-degree specialism(s)	100% Primary	100% Secondary	63% Primary 37% Secondary

Case Study 1: Tailored teaching

Intention of simulation

This course introduces second-year primary pre-service teachers to effective teaching practices from kindergarten to Year 6 (K–6), approximately ages 6–12, and builds understanding of discourses and disciplines that inform primary teachers' practice. Students learn course content in weekly lectures, then participate in tutorials (approx. 30 students) and utilise simSchool in computer labs to implement theory. This course was one of the first to use simSchool in Australian ITE, and over multiple iterations the approach taken has been refined. The activities and assessment in this course are designed to build students' expertise in planning, delivering and revising lesson plans, which is directly transferable to their future classroom practice.

Simulation design

This course capitalised on customised scenarios to target specific learning outcomes. In collaboration with simSchool, three modules were designed for this course. In Module 1, students taught an individual child, Evan, who had a specific individual education plan. Students were directed to observe how Evan responded to a teacher-centred instructional teaching style. Students could experiment with instructional

activities and classroom management strategies, review feedback and consider how their choices impacted this student cognitively and affectively. Module 2 then situated Evan in a small group, leading students to consider how they might alter their methods when teaching in groups. Finally, Module 3 placed Evan within a whole class, creating a focus on how classroom dynamics influence children academically, socially and emotionally.

Assessment design

Throughout the course, students critically analyse traditional lessons with reference to the quality teaching framework (NSW Department of Education and Training, 2006), technological pedagogical content knowledge (Koehler & Mishra, 2009) and other pedagogies. The assessment of this required students to adapt a traditional lesson plan to better address Evan's needs in a whole-class context. Students were expected to transform the traditional lesson plan and validate how each pedagogy could provide quality learning. In tutorials, students collaboratively reconstructed the lesson plan in response to simSchool feedback from the first two modules. SimSchool is currently the only simulation platform that provides automated formative feedback during and after learning activities, allowing students to transform their lesson plans through repeated cycles of decision-making, experimentation and refinement. The default simSchool lesson plan was replaced with the university's lesson plan template, allowing incorporation of the local state's outcomes as determined by the New South Wales syllabus (NSW Education Standards Authority, 2024). Students' revised lesson plans were sent to simSchool, who programmed each one into the simulation task menu for students to teach from. Once students had taught at least 15 minutes of their own lesson plan, they received a feedback report aligned to the course learning goals, which were aligned with APST descriptors. Feedback from this simulation informed further revisions, before students submitted their final lesson plan to be assessed.

Evaluation

This course trialled the affordances of the simSchool environment to determine if this United States of America-based software could be adapted to align with the APST and the NSW curriculum. Embedded in simSchool was a student evaluation component, and results indicated students saw simSchool as most valuable for engaging with student background records to make instructional decisions and observing in-classroom behaviour and making inferences about instructional adaptations. However, some students found simulations repetitious and time consuming, and the interface slow and clunky. Accessing simSchool in laboratories generally worked well, but some students' expectations were not met when repeating modules at home with poorer Internet connectivity. This meant that simSchool modules might be recorded as incomplete, preventing students from progressing. In analysis of course grades, it was found that students with higher scores on simSchool's academic and emotional measures were also more likely to achieve higher marks on their course assignment. Comparisons of data over a 2-year period (2022–2023) showed that student engagement with simSchool increased, as indicated by a higher number of minutes played and improved effectiveness measures. It was, however, evident that students lacked strong skills in data literacy and critical analysis when presented with simSchool analytics. SimSchool's simulated apprenticeship is therefore more effective if students are taught how to successfully analyse and implement feedback.

Refinement

The most recent development in this course's use of simulation addresses the growing expectation that teachers should use data strategically to guide their decisions. In consideration of student feedback, the course assessment was redesigned with a stronger focus on data literacy (Kennedy-Clark & Reimann, 2022). Students are now required to explicitly evaluate the impact of their actions on student learning by comparing two of their APST-aligned simSchool reports. They will gain further insight and perspective from peer discussion of their reports, which will begin data-informed conversations.

Future focus

The refined simSchool focus described above will more explicitly support students to practise the skills of planning and reflection. In line with the APST, pre-service teaching students will have the opportunity to demonstrate interpretation of student assessment data to evaluate student learning and modify teaching practice. Focus groups will be conducted to explore existing survey findings. This additional evaluation alongside simSchool's data analytics will help determine whether students can be assessed directly on their performance in the simulated environment.

Case Study 2: Structured reflection

Intention of simulation

This classroom management course is situated in the second year of the Bachelor of Secondary Teaching, immediately preceding students' first in-school practicum. The cohort includes many different disciplinary specialisms, and this diversity informed the implementation of a "menu" of simSchool modules representing various age groups and disciplines. Students directed their own focus selecting a simulation module relevant to their interests. Subsequent group discussions allowed them to learn from others' experiences in alternative contexts.

Simulation design

simSchool's inclusion in this course is strategically positioned in the centre of the semester to support students' transition from theoretical study to real-world teaching in their first practicum. The course begins with teaching philosophies and classroom management, then simSchool is employed mid-semester to allow the practical application of that theory. Discussion in tutorials developed students' knowledge about lesson plans, strategies, reports and resources, after which engagement with simulated lessons commenced. SimSchool was introduced in face-to-face tutorials, where students learned to use the platform's dropdown interface, to select proactive and reactive interactions, read classroom activity data to monitor and manage the simulated students. They were required to explore a range of available pedagogical approaches, feedback techniques and relational interactions. After 15 minutes, students received data-rich feedback to highlight strengths and areas for improvement. Students then continued this as directed independent study, teaching several simulated classes over several weeks, with regular reflection on both their teaching data and own perceptions of the process. This simulation-based learning aligns with elements of APST 3, 4 and 5.

Assessment design

simSchool module reflection questions were presented to participants before and after accessing simSchool, focusing their attention on particular elements. After each simulation, participants responded to three questions about managing sensitive topics, the difficulty of discussions and how to differentiate approaches for varied learners. This introduction to reflective practice was ungraded, with marks awarded for participation and completion, because the main purpose of simSchool in this course is to build student engagement and experience. Their grades were therefore not dependent on their SimSchool performance, as measured by academic, emotional and overall gains in the simulated classroom. However, this data remained available for instructors to interpret and analyse to inform course teaching.

Evaluation

Feedback on the courses' online discussion board showed the main benefits of simulation identified by students were being able to plan, instruct and differentiate for diverse learners, and the explicit relevancy to the APST. The main limitations were being unable to speak naturally with students, the inauthentic use of dropdown menus and the sometimes lagging nature of the user interface. However, simSchool appears to have worked quite successfully for the 79% of students who completed their chosen module. A strong correlation was evident between completion of the simSchool assessment and achieving average or

above-average overall marks. Review of simSchool analytics showed that most students chose to do the minimum teaching minutes required, perhaps because only participation was assessed, rather than the quality of performance. Nonetheless, simSchool data and student feedback indicated that students did improve their learning through simulated practice. Not all students embraced their simSchool experience, but overall, they supported its continued use in this course. One clear area for improvement is that many students reported needing explicit teaching about how to reflect on qualitative and quantitative feedback.

Future focus

simSchool will remain a core part of this course's activities and a minor component (10%) of assessment. Students will continue to complete five 15-minute lessons, earning two marks for each lesson completed and reflected upon. In future delivery, greater emphasis will be placed on supporting students' data literacy skills, so they are better able to independently interpret their feedback and translate it into pedagogical improvements. This will directly support their future classroom practice.

Case Study 3: Decision-making for inclusion

Intention of simulation

This compulsory course addresses the inclusion of students with disabilities within mainstream classrooms. A full course redesign, including all assessment, was undertaken in early 2023 and trialled with the smaller second-semester cohort (n = 93). simSchool was identified to replace a multiple-choice quiz that utilised written scenarios and was an end-of-course summative assessment. In contrast, simSchool could operate throughout the semester, functioning as both formative and summative assessment and allowing close alignment with the APST. Further, it promotes supporting positive behaviour and establishing environments of belonging, in line with course learning outcomes.

Simulation design

An innovative approach was adopted with entirely bespoke modules designed and carefully curated to be fit-for-purpose. The course coordinator collaborated with simSchool designers to guide the customisation of a new simSchool character, Sadie, who represents a learner with attention deficit hyperactivity disorder. She is deliberately designed to not meet stereotypical expectations of a learner with attention deficit hyperactivity disorder, thus developing students' knowledge and understanding of variation in diagnostic presentation. Sadie featured in a sequence of four modules, across which her demeanour, behaviour and appearance change significantly. The modules were deployed in Weeks 2, 4, 8 and 10 of the 13-week semester, enabling students' understanding to be monitored. This gave teaching staff insight into students' learning and the opportunity to respond. Sadie demonstrates increasingly complex support needs throughout the modules. Students must play each module at least twice, for at least 15 minutes each time, between which they must review their feedback report. Alongside this, students are drip-fed details of Sadie's social, learning and home life, delivered as narrative descriptions and documentation such as parent communication records, behaviour support plans, literacy and numeracy assessments and a draft individual education plan. These documents contain key information that students require to demonstrate success. The increasing complexity of the scenarios and associated information maps the progression of their learning through the course and the APST. SimSchool is then linked to the final course assessment, where students assume the role of Sadie's teacher, designing research-evidenced lessons and resources to support Sadie's engagement in their own mainstream classroom.

Assessment design

This activity contributed 40% of students' final course grade, with each simSchool module weighted at 10%. Students' highest effectiveness percentage in each module was converted to a grade out of 10, so a 73% simSchool module score converted into 7.3% course credit. Each module had its own rubric, with formative and summative elements and differing criteria; this meant students could not succeed in Module 2 by repeating skills from Module 1. There was no maximum number of times students could play

each module or the amount of time they spent overall. Students could repeat the simulation freely, to achieve the highest mark. This sense of competition, to beat your own personal best each time, motivated students to actively engage in learning and assessment. It also allowed them to experiment with new strategies, make mistakes and try again, without fear of errors impacting their grades.

Evaluation

The use of simSchool in this course was reviewed by staff using simSchool data and student feedback. Informal feedback was gathered through tutorial discussions, covering issues such as useability, points of frustration and any broad concerns. This third-year cohort had previously used simSchool in second-year courses, so brought prior experiences and expectations. Some were concerned about unnatural interactions and logistical issues. These concerns were significantly reduced after students built additional familiarity with the platform's functionality. For teaching staff, back-end data revealed valuable fine-grained insights into students' decision-making. It also provided usage statistics such as average total time in simulation, and the distribution of this time, showing which students were "playing along" with the course progression as intended, and who left it all to the end of semester.

Refinement

Following the above evaluation, one major change was implemented regarding the grading processes. In beta testing, both academic staff and simSchool staff had tested Sadie and found that she became a great deal more challenging to effectively support as modules progressed. This was not reflected in students' grades, which averaged 87% and included many 100% scores. Upon investigation, it emerged that students had achieved success by teaching to the whole class, with their general success of the collective, masking Sadie's individual performance. Essentially, Sadie's learning was being undervalued in the simulation. This was problematic, undermining the validity of the assessment and completely misaligned with the philosophy of inclusive education. A new assessment method is being trialled, where scores for Modules 2, 3 and 4 comprise 5% whole-class success rating and 5% for Sadie's individual success. Module 1 remains unchanged to enable students to become comfortable with the platform. This redesign means students will now receive two different feedback reports for Modules 2–4: one for the whole the class and one for Sadie individually. This reinforces the importance of addressing Sadie's individual needs and those of the whole class, contributing to more authentic assessment.

Future focus

This course's use of simSchool is expected to continue and will be re-evaluated following the above revisions in assessment design. Future expansion may involve development of additional case study students, illustrating different diagnoses and presentations. This would enable the course coordinator to alter the case study used each semester, or even randomise case studies across the cohort, so class discussions could compare, contrast and analyse the evolution of their simSchool students and how to respond to their different needs.

Findings

RQ1: How can simSchool be integrated within ITE programmes to support students' development of course outcomes?

A range of evidence was used to evaluate the integration of simSchool, including participation data, student surveys and academic grades in associated assessment items. Despite this, there is no objective measurement of successful integration of simulation and assessment. Use of simulations in teacher education is typically based on the discretion of the course coordinator and not on an institutional model (Angelini et al., 2003). Therefore, any judgement of success is dependent upon the criteria and evidence chosen for evaluation. The goal with these three courses was to integrate simulation in a way that would engage pre-service teaching students in meaningful experiences contributing to course learning outcomes. One proxy for students' perceptions of task value is the time they voluntarily commit to an

activity. By this metric, students seemed to recognise the contribution of simSchool to their learning, because in all courses the average time students spent in simulation was above the minimum time required (see Table 4).

Table 4
Students' participation rates and results (2023)

	Case Study 1	Case Study 2	Case Study 3
simSchool participation	97%	94.5%	100%
simSchool-based assignment average grade	82%	79%*	87%
Average overall course grade	73.75%	75.29%	80%
Time required to be spent in simulation	45 min	75 min	120 min
Average time actually spent in simulation	99 min	88 min	180 min

All three case studies utilised simSchool's data-driven feedback, enabling students to engage in iterative learning cycles. These cycles of decision-making, experimentation and refinement directly contribute to students' development of core teaching skills aligned with the APST. In all cases, simulation informed reflective practice where students analyse their performance and outcomes, facilitating deeper understanding and continuous improvement. In Case Study 1, students' experiences of teaching Evan gave them insight into the importance of adjusting pedagogies according to learning environments (APST 2–3). In Case Study 2, students engaged with disciplinarily appropriate simulation modules before reflecting upon their practice, facilitating their development towards elements of APST 3, 4 and 5. The third case study represents the most continuous integration of simulation through the course, including close alignment to students' course learning outcomes. Case Study 3 was able to capitalise on the opportunity of a full course redesign, allowing simSchool to be deliberately woven throughout course activities and assessments. This highlights the importance of effectively integrating simulation within broader course design, learning outcomes and assessment. The more tightly students' simulation activities are aligned with the course content and purpose, the more students are likely to be motivated to engage with simulated teaching.

RQ2: To what extent can simSchool be effectively used within course assessment?

The case studies presented here show that appropriate integration of simSchool in assessment can contribute to the measurement of student performance and achievement of course outcomes. Specifically, case studies 1 and 3 leveraged customised scenarios, ensuring that simulation activities and assessments directly aligned with course outcomes and relevant elements of the APST. Both examples utilised assessment that was considerate of ITE students' current capacities and allowed opportunities for formative feedback and development. The depth of integration shown in Case Study 3, with multiple assessment points, enabled simulation-based activities to contribute 40% of students' final course marks. Appropriately, Case Study 2 employed a more flexible approach and combined this with ungraded assessment of participation and reflection, worth up to a maximum of 10% of students course credit. This illustrates that it is not always valid, appropriate or necessary to assess learners' performance in simulation-based activities, and that the incorporation of simulation-based assessment must be tailored to student cohorts.

Assessment was designed to be as fair, authentic and effective as possible in each case. It is possible that in some cases the evaluation of students' use of simulation may have been a little too fair – when entire cohorts achieve distinction (75%–84%) or high distinction (85%–100%) grades for an assessment item (Table 3), that item has failed in its task to differentiate between the highest and lowest performing students. However, if the purpose of the assessment is to motivate student engagement and participation, and repeated refinement of choice-making through unlimited attempts (Case Study 3), and the total marks available for the task represent a minor component of the courses' overall assessment (Case Study 2), then this issue can be mitigated within the holistic design of other assessment tasks within the course structure.

Implications

No one size fits all

As with all pedagogical design, it is essential to consider the needs and characteristics of each cohort before trialling suitable activities and assessments. This means different approaches are appropriate for different contexts, as evident in the three case studies outlined above. Just as no single design is suitable for integrating simulation and assessment in all courses, there is also no single simulation pedagogy that will engage all students all the time. This requires instructors to carefully and continuously monitor student activity, consider feedback and make balanced judgments about how to best address the learning needs and preferences of the cohort. Detailed evaluation of learning and learner analytics from simulation platforms and learning management systems can enable data-driven insights into patterns of student engagement and satisfaction. Even prior to such activity data, it is likely that prior knowledge and achievement will predict learner performance (Chernikova et al., 2020), so a fine-grained profile of the pre-service teacher cohort upon entry may allow for more nuanced management of expectations as well as differentiation in the simulation experience. Following use of simulation, the field would benefit from the development of stronger tools to evaluate the impact of simulation technologies, in line with recommendations from Angelini et al. (2023), who identified a lack of validated instruments.

Key principles of successful integration

It is clear that simulation can provide valuable opportunities for students to bridge the gap between theory and practice allowing them to build skills through safe experimentation with learning situations and repeated practise. With formative feedback during and after play, pre-service teachers can self-reflect and refine their practice. These affordances will be maximised if academic staff pay sufficient attention to four key principles of successful integration: (a) the design of simulation activities and assessment must be tailored for the specific cohort and learning objectives; (b) assessment must be carefully designed to be as fair, authentic and effective as possible for the particular cohort and intended learning outcomes; (c) the simulation component should be carefully introduced to students to manage their expectations, acknowledge weaknesses and clarify specific learning opportunities; (d) ongoing evaluation should be built in to the design of simulation activities and assessment, to continually monitor efficacy and inform revision as required. These recommendations are explained in more detail below and illustrated visually in Figure 2.

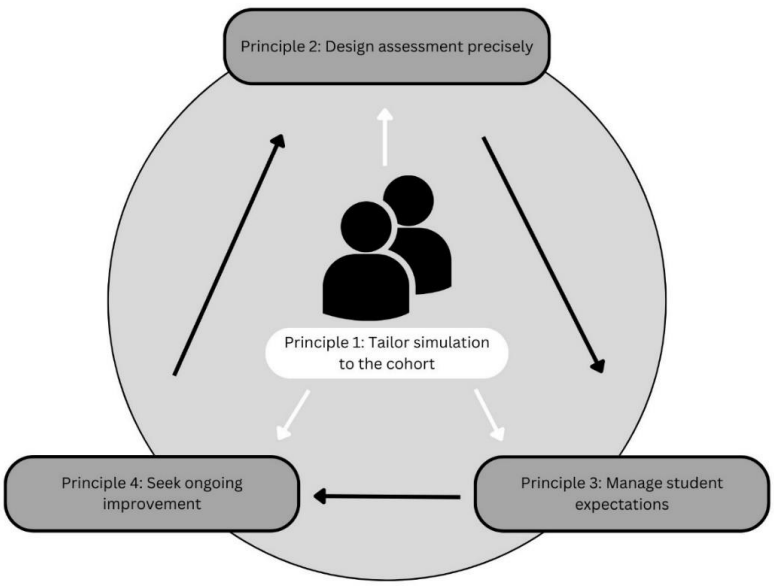

Figure 2. Relational diagram of the four principles of simSchool integration for assessment

Principle 1: Tailor simulation to the cohort

At any level of education, planning effective learning activities within higher education necessitates knowing learners and how they learn. This means ensuring that tasks are designed to be relevant, authentic, and appropriate to the stage of the target student cohort. When students recognise that they are being invited to participate in meaningful activities that assist them in achieving learning outcomes, they are far more likely to be motivated to invest themselves in those activities. Achieving this clearly depends on educators' understanding of their student cohort, and clear identification of the intended learning outcomes. That knowledge then enables the constructive alignment of teaching, learning and assessment, which are as important in simulation education as in other educational contexts (Biggs, 1996, 2012). When learning activities are not precisely designed to suit the target cohort, and do not directly support their learning, students are more likely to disengage. This can result in students being less prepared for future learning and professional practice (Brint et al., 2008).

Principle 2: Design assessment precisely

Designing learning and assessment entails the balancing of competing priorities – when to keep tasks formative and low-stakes, when to emphasise a focus on performance, and what kind of performance to define as representative of success. The navigation of these competing elements depends on educators' understanding of their student cohort, and clear identification of the intended learning outcomes (Principle 1). The case studies reported here illustrate a range of approaches to their assessment of simulation activities, including participation grades (Case Study 2) and performance grades (Case Study 3). It is essential that assessment items are fair, in that they do not assess skills that students have not yet been taught or cannot reasonably be expected to perform. They must be authentic, in demanding the demonstration of skills that will become part of students' future professional practice. Finally, they must be effective in motivating students to participate, tapping into specific professional competencies, and differentiating between students who perform at different levels.

Principle 3: Manage student expectations

Despite simSchool being marketed as a virtual game, it does not have the same cutting-edge graphics and game flow that many 21st-century undergraduates expect. Therefore, sufficient pre-briefing or preparation of the learners for the activity needs to be planned in simulation delivery. Pre-briefing has a positive impact on outcomes, learner satisfaction and attainment of learning objectives (Persico et al., 2023). Learner engagement is promoted by careful management of expectations, to acknowledge weaknesses and clarify specific learning opportunities. This "undersell and over-deliver" approach has been successful in the case studies reported above, helping students to approach simulation with an open mind; alongside targeted support from staff in identifying relevant professional learning, they are much more likely to commit time and energy to engaging with and benefitting from the process. The unlimited attempts option empowers students to take charge of their own outcomes, fostering a greater sense of responsibility for their learning.

Principle 4: Seek ongoing improvement

There is no such thing as a perfect learning activity or assessment task. Likewise, academics' knowledge of students is limited, leading to decision-making based on bounded rationality (Lee & Porter, 1990). Best practice is therefore constantly reflective, monitoring efficacy by investigating multiple sources of evidence, including from students, staff and statistics. The flexible and customisable nature of simSchool enables ongoing changes with adaptations implemented for each course iteration, promoting continual improvement. This is evident in the current case studies, which do not purport to illustrate best possible practice in the use of simulation. Rather they offer descriptive reports of the state of the actual in this field, with a strong recommendation to remain vigilant in attending to the performance of the activities and assessments, as much as the performance of students who participate in them. As seen in Case Study 3's revision of assessment to give greater weight to students' management of Sadie, small revisions in

response to attentive evaluation can result in significant improvements in the precision and authenticity of simulation-based assessment.

Summary

Simulation technology offers great potential to contribute to students' learning when it is carefully integrated, precisely assessed, considerately delivered and continuously evaluated. Instructors can achieve this by applying the four principles proposed in this paper and can thus improve students' teaching and learning experiences as well as enhancing their development of professional practice, both within their degrees and beyond. Implementing relevant module tasks, measuring student progress data, highlighting beneficial simulation opportunities and committing to ongoing and reflective evaluation can assist ITE students in developing robust and reflective professional practice. Further research is required to understand the longitudinal effects of integrating simulation-based learning for teacher development, particularly in the context of diverse student populations. Simulation training may also have a role in the ongoing professional development of in-service teachers. While these opportunities are explored, we encourage more academics to investigate the affordances of simulation technology within their teaching.

Author contributions

Author 1: Conceptualisation, Investigation, Data analysis, Writing – leading original draft, reviewing, editing; **Authors 2, 3 and 4**: Writing – provision of data, contribution to draft, review and editing.

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