Chapter 3

Simulation-based Learning

@ Teesside University

Context: Teesside University has established a reputation for cutting-edge simulation-based education across several disciplines, leveraging the affordances of digital transformation and pedagogic innovation to provide students with the most authentic learning environments possible. This chapter focuses on how simulation-based learning is implemented on the university's Diagnostic Radiography, Forensic Science, and Crime Scene Science courses, drawing on staff and student perspectives. Developing and deploying multimodal resources as a means of supporting simulation-based learning approaches can be a powerful way to engage students in exploring, representing, constructing, interpreting, and evaluating knowledge. On the courses in focus here, simulation-based learning integrates available technologies and tools as a means of supporting multimodal knowledge representations, where disciplinary content can be presented in the form of videos, educational apps, on websites and other interactive forms. In this chapter, academic staff demonstrate the need to carefully consider how the affordances of available technological tools, including collaborative online tools and software, offer new ways in which students can express their ideas, experiences, and identities that are authentic to discipline.

What is simulation-based learning?

Simulation-based learning in higher education offers a wide range of opportunities to immerse students in realistic scenarios, allowing them to practice complex skills and apply theoretical knowledge, and where educators can implement different types of scaffolding to facilitate effective learning. Operationally, simulation includes encouraging learner interaction with a real or virtual object, device, or person and where there are opportunities to alter the form and direction of this interaction through the decisions and actions made by learners. From this perspective, practically any type of interaction, from role plays to walk-throughs, standardized patients to highly immersive interactions with virtual objects or software, can be considered simulations (Rooney and Nyström, 2018). What makes simulations such effective educational tools are the opportunities they afford to adjust and tailor aspects of reality in ways that facilitate learning and practising (Jones and Barrett, 2017) – e.g., they can be set-up to address specific aspects of wider events, shorten response

times to encourage prompt decision-making, and provide immediate ‘in-process’ feedback to learners.

It is often the case that restrictions around certain resources on higher and further education programmes means the opportunity to engage in real-life scenarios and problem solving can be limited. These limiting factors can make practice in authentic learning situations inaccessible and render certain learning spaces less than optimal, particularly for novice learners. Crucially, through the appropriate integration of available digital tools, software and related material objects and resources, simulation-based learning approaches can be adopted to provide approximations of practice in which the complexity is managed to support learners’ engagement in specific aspects of professional practice learning. This helps to create a low-risk learning environment to facilitate the acquisition of complex skills (Elkington et al., 2022). Importantly, such tasks require individuals to employ multiple modes to convey meaning, including written text (linguistic), images (visual), sound clips (aural), hand gestures and facial expressions (gestural), and physical elements arranged in a manner that facilitates comprehension (spatial).

In-class role plays, simulated discussions, and communication with standardized patients or clients offer opportunities for simulation with little to no technology use, as no software or hardware is necessary to initiate the interaction (e.g., Davidsson & Verhagen, 2017). Increasingly, such approaches are being augmented with screen-based simulations that require computer-supported interfaces and some software that enable different and adaptive forms of interaction (e.g., Liaw et al., 2014). Simulation-based learning implies that learners take an active role in the skill development process where the focus is on the reconstruction of realistic, often complex, situations and the authentic interactions that individuals can participate in. Simulations can be designed to present multifaceted problems, requiring students to analyze information, prioritize, and make informed decisions, with post-simulation reflection and debriefing designed to facilitate important critical thinking in and self-assessment of learning development. In this way, simulation is not a fixed or stable entity, but a dynamic and situated set of activities that involve multiple practices and their associated configurations.

A Staff Perspective

Simulation as a complementary method

On each of the courses in focus here, simulation-based activities are deployed as a means of replicating real-world ‘in-practice’ and clinical settings with an emphasis on facilitating active learning for students to develop and hone relevant practical skills and decision-making. In this way, simulation serves as a crucial link between theoretical lectures and practical sessions, integrated with taught materials to support students to apply theoretical concepts in real-world contexts, thereby enriching their understanding and overall learning experiences.

Diverse simulation methods, such as virtual simulations and real-life scenarios, when aligned with predefined learning objectives enable staff to address specific goals and competencies, whilst also ensuring purposeful and relevant learning experiences across different modes of study. Combining different simulation methods offers a means of creating authentic yet safe learning environments that replicate real-world settings and scenarios, including physical, procedural, and contextual

aspects of practice that provide engaging and scalable immersive experiences for students, over time:

> *"For me it's about attempting to recreate a clinical environment. Mainly clinical based on the background of the diagnostic radiography and try to recreate that as much as possible and make it as authentic and safe as possible, aligned to the kinds of work that the students will be doing as part of their professional roles" (Diagnostic Radiography tutor).*

On the Radiography course, simulation outputs align assigned tasks with radiography practice. Students are tasked with compiling these outputs into individual portfolios for self-evaluation and feedback. Integrating simulation experiences into clinical portfolios is seen as crucial for documenting and showcasing professional development and readiness for future practice.

Simulation serves as a powerful tool for enriching practical learning experiences, particularly for students lacking access to physical spaces, labs, and equipment or when opportunities to access real-life settings or scenarios might be challenging. For example, Forensic and Crime Scene Science tutors use digital tools in the form of student iPads* combined with virtual walk-throughs of physical on campus spaces like the **Crime Scene House** to develop and model for ways of engaging with different crime scene scenarios.

Integrating digital technologies to enhance simulation-based learning

Careful integration of digital tools can enrich simulation-based learning, enabling scalable practices, real-time adjustments, peer support, and access to remote learning resources that when combined provide students with safe environments for experimentation and exposure to complex scenarios that might otherwise be unavailable to them. For example, integrated interactive technologies using iPads to facilitate augmented learning experiences that closely replicate clinical settings, not only promotes active engagement and peer learning beyond the classroom, but it also helps to boost student confidence in applying knowledge practically:

> *"We use augmented reality apps uploaded to student iPads to bring digital avatars into the space. So, the iPads were basically the viewing portal into the world, and you could walk around the avatars. We ended up with a big room with pairs of students and one iPad to each pair. You have one patient in front of that pair and multiplied [patients] throughout the class. The advantage was that this technology enables the tutor to adjust the condition of that patient, for all of the pairs at the same time or mix these up so different pairs are working to different conditions" (Diagnostic Radiography tutor).*

EXPERIENCE: Intentionally orienting available digital devices and platforms with which learners interact for the purposes of simulation-based learning sets up participatory approaches toward viewing, composing, and revising multiple aspects of multimodal artefacts as they are mediated through online and offline iterations of integrated reading, writing, designing, discussion, composition, and reflection.

Digital simulations expose students to a diversity of tailored practical scenarios, designed to enhance problem-solving and critical thinking skills in a controlled environment. For example, in the digital **Crime Scene Simulation**, students are able to virtually navigate different **External Crime Scene** settings curated by staff to situate and illustrate key protocols and practices through accompanying tasks and guided learning activities.

It is important educators ensure that the technical aspects of simulation-based learning closely replicate practice settings with realistic functionality. For example, virtual radiography software such as anatomy and ultrasound simulators are used to aid practical understanding and model a range of complex procedures. These simulators utilise principles of gamification to facilitate individual and group-based activities that promote active engagement and collaboration among students, showcasing the wider repertoire of socio-technical skills required of prospective practitioners:

> *"We embed ultrasound simulators that we use to demonstrate certain aspects of anatomy and can manipulate to isolate different conditions or scenarios for students to work through" (Diagnostic Radiography tutor).*

Design challenges for simulation-based learning

Effective simulation relies on clear and effective communication, device options, and student accountability, but faces challenges in the form of variable student digital literacy and consistency in access and resource availability. Such challenges require innovative solutions, such as designated simulation weeks in Radiography and flexible pedagogic designs:

> *"Simulation week provides structure and focus for practice, as well as a means of scaling simulation-based work that does not create logistical and resources challenges. Students engage in a variety of different authentic tasks and activities. For example, we ensure the 3M mannequin is pre-programmed, it's a digital thing and the technicians are watching via SMOTS cameras, and they are using triggers for when the student does something. As the students get to a certain point in the activity, then that triggers the change in the patient's condition, which is all developed around the SMOTS cameras and the fact that the technicians can view and watch their progress. None of what we do really is possible without digital technology" (Diagnostic Radiography tutor).*

Staff noted the challenge of shifting students' mindset from a transactional 'means-to-an-end' mentality to recognising the value of simulations for learning and professional development. Generating student buy-in through participatory approaches aids in enhancing student perceptions of the validity of simulation-based learning encouraging more active and intentional practice strategies.

There are several hurdles to effectively integrating digital technology into simulation-based learning environments, leading to an increased expectation for students to assume greater responsibility for their digital literacy. Students' educational digital literacy can be a major factor that impedes effective student engagement with simulation software meaning staff can be required to spend more time than initially planned on supporting students to navigate the different technical aspects associated with using particular devices and/or software.

Limited access to appropriate equipment and technical limitations of software are also a challenge for staff, necessitating timely troubleshooting and extra support for students to fully reap the benefits of simulation-based learning. For example, on the Forensic Science course, staff draw upon specialist open-source online simulation software for **Imaging** to provide students with a bank of resources that align to and simulate aspects of lab-based practice. These resources are chosen for their accessibility and utilised largely as a formative mechanism for students to review and rehearse lab-based procedures and associated use of relevant equipment ahead of in-person practical lab sessions:

> *"Ensuring the simulation software is compatible with student iPads enables flexible access to the materials at any point, as well as allowing students to review previous course content and apply this knowledge in simulation practice. The 360-software integrated with some of the software also provides opportunities for students to facilitate immersive learning through virtual tours or practice settings which offers a valuable learning resource for students to enhance their forensic skills" (Forensic Science Tutor).*

Tensions around ensuring relevant and meaningful simulation experiences for students highlight the trade-off staff sometimes have to make between authenticity and practicality when replicating real-world scenarios. Whilst accuracy and validity are critically important to simulation-based learning, staff also raised concerns about the transferability of simulation skills and the need for robust simulation-based training and continuous testing and adjustment of simulations for compatibility across devices and platforms for such approaches to remain relevant and authentic to future professional practice.

* All full-time Year 0 – 2 Undergraduate students are eligible to receive an iPad to support their studies through the Teesside Advance Scheme. The iPad is enhanced by the Future Facing Learning toolkit, which includes a collection of software apps. The toolkit is used inside and outside the classroom to support students in preparing for professional life.

Embracing active pedagogy and learner-centred approaches

Working to embed simulation-based learning, tutors employ a variety of active pedagogical strategies that enable students to engage with learning materials at their own pace, promoting deeper understanding and continuous engagement whilst prioritising ongoing feedback to guide students' progress and enhance their performance throughout simulation activities.

Tutors were quick to emphasise the significance of clear communication about the purpose and objectives of simulation activities, as well as notions of quality in relation to performance, to ensure full student participation. Additionally, tutors prioritise preparing students by demonstrating and scaffolding procedures and providing preparatory materials like digital workbooks to establish a solid foundation for successful simulation-based learning experiences:

> *"The workbooks and other resources linked to these allow students to review, work through and return to different aspects of practice work in their own time. It's about providing another learning opportunity to build confidence and understanding, something that can be repeated and built upon" (Forensic Science Tutor).*

Crucially, on each course, simulation-based learning is viewed and positioned as an integral feature in a broader developmental process that encourages self-discovery, reflection, and preparation for real-world professional practice settings. Tutors highlight the complementary relationship between simulation and reflection, where simulated exercises offer important formative opportunities for students to critically evaluate their actions, leading to enhanced self-awareness, resilience, and growth.

For example, building in regular debrief exchanges with Radiography students around simulation activities helps promote active engagement and communication skills as they reflect on and vocalise their observations and interpretations and foster a deeper understanding of their learning and performance. In this way, simulation-based learning opens new learning opportunities by exposing students to complex tasks or scenarios within less rigid constraints than clinical placements:

> *"For us, having regular debriefing sessions plays a central role in helping students consolidate their learning from their simulation experiences as they reinforce the connection between simulations and real-world practice and through dialogue interrogate and reaffirm or reevaluate their practice strategies and learning" (Radiography Tutor).*

Effective formative feedback is of fundamental importance for improving simulation-based learning through personalising the learning process and helping students to reflect meaningfully on their performance and guide future actions. Furthermore, external feedback from observers in structured debriefing sessions including combinations of verbal and digital feedback aid student self-assessment and identify areas for skills improvement.

PRACTICE: Offering a range of simulation-based learning activities can provide opportunities for students to participate in meaning-making across different forms of expression whilst also actively engaging students in productive dialogue regarding the affordances and constraints of different modes, mediums, and tools for the purposes of learning.

Nurturing inclusive and supportive learning environments

Simulated activities can foster a safe and supportive learning environment where students can explore, experiment, take risks, and learn from mistakes, without fear of judgment or negative consequences. Such learning environments benefit neurodiverse students, and support personalised learning, allowing students to learn at their own pace while enabling tutors to provide targeted and timely support and feedback:

> *“A lot of my more neurodiverse students are engaged more, and they've said because I've provided them with something structured and practical, something they can repeat, slow down, or discuss. And because they are replicating what they have been taught, it also encourages them actively listen. The experiential element coupled with structured support offers that balance” (Forensic Science Tutor).*

Tutors prioritise flexibility and adaptability, using multimodal approaches that promote inclusive practices and equitable participation. This is achieved through an emphasis on collaboration and holistic skills development with the deployment of simulation activities intended to familiarise students with real-world scenarios, reduce anxiety, and build confidence:

> *“Simulation of the crime environment or post crime environment is positioned as an extension of the investigative process. As they work and gain experience, the simulations become more than just the scene or scenario in focus, it's thinking about that scene in the context of an inquiry and the confidence they have in navigating it” (Forensic Science Tutor).*

Tutors need to carefully consider factors such as ideal group size and the preferred amount of time students should have on tasks set to maintain engagement and learning outcomes without disrupting other scheduled classes. Parity of opportunity and equitable participation are foundational features of simulation-based learning but can be difficult to navigate with large cohorts of students. Learn more **Here** about how the Diagnostic Radiography course uses integrated simulation to provide an inclusive and supportive learning environment.

Simulation-based learning emphasises the need for tutors to accommodate diverse learning needs and preferences, fostering flexible and adaptable learning designs. Tutors utilise multimodal approaches to promote inclusive education practices, allowing students to demonstrate understanding through various methods such as written, verbal, or audio-visual reflections. In practice, this provides a relatively controlled environment for students to learn complex procedures and skills, with outcomes extending beyond technical proficiency to include communication, teamwork, and problem-solving.

The Student Perspective

Preparing for a complex workplace

Students appreciate the authenticity of simulation-based approaches, closely emulating clinical settings and diverse workplace scenarios, such as crime scenes or clinical procedures, with the realism of related activities enhancing their perceptions of relevance and preparation for the complexities of their professions:

> *“I find it a lot more engaging to learn that way. I feel like I take in more information when I'm practically doing the actual simulation because the links and connections to practice are clear and relevant to the skills needed” (Forensic Science student)*

Exposure to diverse technologies and tools during simulations equips students with essential competencies for navigating modern workplace demands. In this way, simulation-based activities provide students with invaluable opportunities to apply theoretical concepts to practical settings, fostering deeper understanding and preparing them for the dynamic realities of their chosen fields. Furthermore, simulation-based activities model for professional standards and the expected behaviours and responses in clinical and practice settings (Student Comment):

> *“The simulation helps us to know how to react and behave in the clinical setting, because it imitates practice at different levels. So how some of the nurses will behave, how some of the HPs will behave and how we are expected to react and behave in response” (Radiography student).*

For Radiography students, simulations not only aid in learning development but also facilitate effective case management, allowing students to track their progress and accuracy in identifying pathologies within authentic cases. This engagement with real-world data fosters skill development and increases student investment in their learning journey, making simulation a valuable tool for professional preparation and advancement:

> *"We’re able to engage with a lot of different radiographs that map to different pathologies. So, for me, it's been very beneficial because then you've got the ability to work with a wide range of sources of information that directly relates to practice” (Radiography student).*

Students on the Crime Scene Science course reported that immersive experiences, such as those within a crime scene house, are beneficial as they promote active engagement by physically placing students within simulated environments. Students also referred to the value of group and team-based simulation activities that helped them to work together effectively, with particular emphasis on communication skills and shared responsibilities. When combined with independent tasks and reflection on past simulation episodes students reported a positive impact on their understanding and their ability to identify areas for improvement, fostering critical thinking:

> *“Having the simulations online where you can go into the rooms and things like that and have a crime scene set up that you can revisit when needed certainly helps when were being asked to reflect on the work we have completed. The simulations really do become a point of reference for learning” (Crime Scene Science student).*

Exposure to both teamwork and independent learning prepares students for the diverse demands of professional practice, ensuring they are well-equipped for real-world scenarios. Despite the inherent independence of the field, integrating collaborative and independent approaches optimizes students’ learning experiences, aligning with the realities of their future careers.

Listen to this podcast episode exploring multimodalities in higher education through the lens of simulation-based learning. Professor Sam Elkington (Teesside University) is joined by Dr Emma Hyde and Professor Ian Turner from the University of Derby who share their own extensive experience and expertise using simulation in learning and teaching.

Using technology to amplify learning, understanding, and confidence

The integration of technology into simulation-based learning can enrich students' practical learning experiences by providing hands-on opportunities to work with specialized equipment and technologies, helping them develop a deeper understanding of complex procedures, boosting confidence and readiness for real-world scenarios.

Students on the Crime Scene Science course referred to the crucial role technologies like the RECO THETA 360 camera assemblage plays in enhancing the effectiveness of simulations, enabling students to efficiently record and recreate different scenarios for the purposes of learning. The adaptable features of these technologies and tools allow students to visualize abstract concepts and complex data, promoting deeper understanding and application of theoretical knowledge in practical contexts:

> *"Using the 360 cameras to recreate and record crime scenes mirrors what we would do practically in the field […] we could stand it on the tripod, leave the room, press record from our iPads so it can go from your iPad to connect to your phone. We then use the images we create as the basis for our work either individually or in groups around different procedures or problems" (Crime Scene Science student).*

By integrating available digital technology and tools into simulation activities, students gain valuable insights into enactment of correct procedures and usage of equipment, allowing them to reconstruct real-world scenarios and familiarise themselves with diverse technologies they will encounter in practice. Specifically for the Radiography students, the use of specialised MRI software and other integrated technologies allows students to engage practically with complex tools, bridging the gap between theoretical knowledge and practical application:

> *"Using the MRI software provided the opportunity to work through real-life situations and scenarios whilst also getting to grips with the kinds of technologies and tools we would be expected to use in practice"* (Radiography student).

For many students, the integration of technology, such as iPads and simulation software, when used in combination with flexible and accessible simulation-based learning resources contribute to a positive and inclusive learning environment, enabling them to reinforce their understanding of concepts outside of scheduled classes, empowering them to take an active role in their learning. Integrated software also facilitates flexible learning experiences, transcending the limitations of the

physical classroom and enabling students to continue improving their practical skills remotely at their convenience:

> *"Being able to access certain simulations online through our iPads also meant we could draw on a range of resources and documents to support our work away from being in class. This is a massive benefit, particularly when you're able to repeat different activities over time either when I'm working at home or on campus" (Crime Scene Science student).*

INNOVATION: Students can be encouraged to stretch and connect their learning across artefacts through multimodal composition processes that promote intentional reflection, revision, and dialogue; receiving feedback on several aspects of their experiences that supports their learning development, as well as grasping and internalising the social norms of a wider professional learning community.

This combination of technology integration and active participation fosters a dynamic learning environment, promoting skill development and deepening understanding through immersive learning experiences that can be scaffolded to support incremental development for students. For example, Forensic Science students pointed to the value of being able to make use of digital visual aids and practical demonstrations capturing different aspects of practice (equipment usage or examining samples under a microscope), allowing them to build an appreciation of correct procedures in preparation for scheduled lab-based assessments:

> *"We've been able to go into different resources which demonstrate and work through the equipment and look at examples of certain procedures around using a microscope, things like that, so it's helped really visualize what we should be looking for and the correct ways of approaching different tasks" (Forensic Science student).*

A vehicle for personalised support

Teacher support plays a pivotal role in the success of simulation-based activities. Students were quick to illustrate how tutors provide essential guidance through initial software demonstrations, one-on-one assistance, and resources for independent learning, all of which help foster students' confidence and effective navigation of simulated environments. This helps to create a supportive atmosphere which encourages students to showcase their best work whilst providing opportunities for personalized support tailored to individual needs, ensuring comprehension and engagement:

> *"The level of support and guidance I receive from my tutors whether this is walkthroughs of certain software, discussions around tasks that have been set, or different resources that are there to support our practical work. All this has provided an environment where I feel I can ask questions and request further guidance as I work through things" (Radiography student).*

For students, hands-on guidance and continuous support during group activities further enhances their abilities to effectively utilize simulation tools, highlighting the importance of tutors in facilitating comprehension and engagement in simulation-based activities:

> *"Our tutor will go through different aspects of the work in more in-depth, showing us how to actually navigate through the various tools and scenes that he's posted answering questions all of the way through, either individually or from the group. That level of support quickly builds your confidence in the work" (Crime Scene Science student).*

Students are sensitive to their tutors' willingness to provide personalized support, including one-to-one support which encourages students to approach them for discussions related to simulations or any other aspect of their learning. This enables tutors to offer individualized support tailored to each student's needs, understanding their specific challenges, and providing guidance according to their learning style and level of understanding. This personalized approach ensures that students receive the assistance required to navigate simulation-based activities successfully.

PHILOSOPHY: In simulation-based learning multimodal activities offers inclusive instructional design opportunities that allow educators to use sound, image, text, and animation to make material clearer and more accessible for a diverse range of students.

Students highlight the benefits of utilising a structured timetable for simulation work where tutors also encourage them to be proactive when engaging with tasks, creating an environment where they feel supported in developing confidence in real-world clinical interactions:

> *"In terms of the two SIM days, we got provided in advance a timetable, workbooks, and pre-reading, all of which the tutor would work through. By the time I get to the simulation work itself, my confidence is up, and I feel like I can properly engage with what is presented" (Radiography student).*

Constraints on the quality of simulation-based learning

Whilst students acknowledged the impact of time and resource constraints on simulation-based learning, they perceived that more time dedicated to simulation work would be beneficial, especially for those lacking hands-on clinical experience:

> *"I appreciate the difficulties for staff when running the simulation work, but I would prefer it if we had more time to do simulation rather than just one day in a week. It is such a valuable experience and really does accelerate my learning" (Radiography student).*

Students preferred individual over group-based simulation activities for providing a sense that they had an equal opportunity to engage fully with the tasks set. They did, however, recognise that this was not always possible given the limitations on time and resources. Students also expressed a desire for expanded simulation usage across different modules on their course to enrich their learning experience and deepen their understanding of course content:

> *"It would be great if we could connect the simulation work, we did around crime scenes with other aspects of our course. As an approach for me simulation is the way forward and could be a central factor on many if not all modules" (Crime Scene Science student).*

The integration of simulation tools and activities into day-to-day teaching presents certain technical challenges that can negatively impact the learning experience. These challenges include use of low-quality images, and generic content that may not align with specific tasks, and complex interfaces leading to learner frustration and disengagement. The accessibility of digital technology and tools coupled with the variable digital literacy of students was also raised as a potentially significant barrier to participation; with some tools being more accessible and useful and user-friendly than others due to certain technical requirements (i.e., familiarity of certain software). This can be further exacerbated when students are expected to use multiple software packages simultaneously which requires a reliable WIFI connection and certain specification of device (Student Comment):

> *"I have found it is not always possible to run or access different digital resources at the same time, probably because my device is not up to scratch, but also I might be working at home where I don't have the best internet speed which can make working through certain tasks challenging at times" (Forensic Science student).*

Routes to Multimodal Practice: Simulation-based learning

Drawing on the combined perspectives of staff and students, this chapter has explored how simulation-based learning, used in Diagnostic Radiography, Forensic Science, and Crime Scene Science courses at Teesside University, is practised. Simulation-based learning, as it is presented here, appears to afford crucial pedagogic flexibility in the form of a variety of different roles, relationships, proximities, activities, and temporalities for students. This complexity problematises and disrupts homogeneous understandings of simulation practice and shows simulation spaces to be multiple, heterogeneous, and entangled with human and non-human actors, activities, materialities, and modalities. Furthermore, the integration of different technologies and multi-purpose digital devices (i.e., iPads) in the Diagnostic Radiography, Forensic Science, and Crime Scene Science courses has enabled a range of multimodal approaches to learning, teaching and assessment.

Key issues that arise from the design and implementation of simulation practices across the disciplines and contexts captured include 1) giving careful thought to the distribution of resources, opportunities, and outcomes among different groups of students in relation to digital and physical space, and 2) avoiding overly standardised practice arrangements such as making simulation practices uniform across different settings and situations. Both spatial injustices and standardisation issues may affect the quality, relevance, and authenticity of simulation practices, as well as the

learning and professional development of the participants. When used in ways sensitive to context, multimodal strategies can empower educators to explore new pedagogical practices, connect students with a wider range of technologies and resources, and support new forms of knowledge production.

Based on the insights gained from staff and student perspectives presented in this chapter, the following strategies might be considered as a means of optimising multimodality in simulation-based learning across different practice settings:

1. **Adopt a sociomaterial perspective:** A sociomaterial perspective views simulation as a complex and dynamic practice that is shaped by and, in turn, shapes the social and material arrangements of the site(s) where it takes place. A sociomaterial perspective can help to analyse and understand how different human and non-human actors, activities, and materialities interact and influence the simulation process and outcome. A sociomaterial perspective can also help to explore how an understanding of the different modalities afforded through simulation-based learning challenge the assumptions, norms, and values that underlie simulation practices, and to identify and address the potential sources of spatial injustices and standardisation that can negatively impact student learning.

2. **Involve students in co-active strategies**: The effective integration of available digital tools and technologies through simulation activities can promote significant learning, allowing a more expansive suite of pedagogic arrangements and assemblages that span the digital and physical tools and spaces mediating students' interactions with the wider learning environment. This calls attention to the multimodal ways in which educators and learners might co-construct knowledge artefacts over time through participative processes combinations of synchronous and asynchronous online learning for presentation, simulation, access to data and different resource formats, and virtual forms of collaboration, composition, and reflection. Co-actively involving students with these digital and physical tools and spaces generates connection to and a working appreciation of their diverse backgrounds, identities, and preferences, and can also enhance their engagement, motivation, and ownership of the simulation, and foster meaningful learning.

3. **Customise the simulation to the context and the objectives**: Integrating available digital tools and technologies, including access to appropriate software packages, can provide the means to customise simulation activities to ensure that the simulation is realistic, authentic, and relevant to different groups of students and situations. It is important that simulation activities and strategies are clearly aligned with key learning objectives and the outcomes to ensure pathways for progression and attainment. Customising simulations can also provide the flexibility to adapt and modify the simulation 'in practice' to personalise the learning experience, meeting the needs and abilities of the students, and to provide them with appropriate challenges and support.

4. **Facilitate continuous dialogue and feedback to students**: A key component of any simulation practice is the feedback and debriefing that it provides to students. Using available digital tools and technologies to support and facilitate continuous feedback and dialogue with students which can help to address spatial injustices and standardisation in simulation practice by facilitating reflection, evaluation, and transfer of learning. Such feedback can come in different forms, modes, and mediums, and at different times

throughout the learning process, from a multiplicity of sources and people – tutors, peers, as well as students themselves. Continuous dialogue and feedback in the form of regular structured debriefing can help to support and scaffold for personalised feedback to the participants, helping them reflect on their performance aligned to key learning outcomes. Facilitating such dialogic strategies can also help to connect simulation experiences with the prior knowledge and the future practice of the students, and to identify and address any gaps or issues that may arise from the simulation activities.

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