Simulation: A Complex Pedagogical Space

Simulation is a pedagogy that has been widely used in a number of educational settings (e.g. aviation, transport, social work, nursing education). While it can take a number of forms, it often involves an assortment of high-tech equipment (e.g. flight simulators, manikins) that seek to replicate that found in ‘real’ settings. Specifically, this paper provides an empirically driven exploration of how simulation laboratories, used in the professional education of nurses, medical and other health professionals in higher education settings, are practised. Informed by sociomaterial understandings, it problematises and disrupts homogeneous understandings of the simulation space found in much of the health sciences literature. It does this by providing a number of layers ranging from accounts of simulation in literature and empirically driven accounts of simulation in action through to more abstract discussion. The paper is attentive to both the distinct materiality of the spaces involved and the human activities that the spaces engender. This dual focus enables the consideration of spatial injustices as well as new directions for the development of simulation pedagogies.

# Introduction

There is growing awareness of the impact various physical spaces have on student experiences and thus their learning. While education and learning have long been considered in spatial terms (e.g. higher, further, lifelong, lifewide), the idea of learning spaces is currently a key factor in the redesign of much learning and of education. This is occurring in schools (e.g. MakerSpaces, open-plan classrooms), in organisations (e.g. activity-based work, open-plan offices), and in higher education institutions (e.g. flipped classrooms, collaborative classrooms, innovation hubs). It is the physical learning spaces in higher education institutions that are of interest in this paper.

Intensified by demands for *authentic* learning (Serrano et al., 2017), among the new spaces found in universities are ones that seek to simulate those found in professional practices. For instance, it is common to find microteaching rooms (teacher education), moot courts (law) and simulation laboratories (nursing, health and medical education) in contemporary higher education institutions. These transitional spaces are often heralded as providing student teachers, legal and health professionals with learning experiences that bridge professional education and work (Boud & Rooney, 2015; Cooper et al., 2010; Solomon, 2007). Furthermore, unlike professional placements, these on-campus spaces are said to have capacity for learning experiences to be standardised across cohorts (Issenberg et al., 2005; Onda, 2012). Further, given the difficulties of securing professional placements in some relevant fields, faculty often consider simulation as an alternative (Arthur et al., 2011; Hayden et al. 2014; Gaba, 2004).

Contemporary universities are making significant financial investments in creating these sorts of spaces (Adams Becker et al., 2017; Lasater, 2007; Tondeur et al., 2017) with the assumption that student learning occurs (Finkelstein et al., 2016). But does investment in infrastructure alone assure learning? We suggest that it is also necessary to understand how these material spaces work together with human activities (including pedagogy) to bring about learning (Carvalho & Yeoman, 2018). Like Carvalho and Yeoman (2018) and van Merriënboer et al. (2017), we also agree that learning can be enhanced through the alignment of pedagogy and space. It is in the spirit of such alignment that this paper explores pedagogies of simulation spaces in nursing, medical and health-related education (henceforth collectively referred to as the health sciences). Using an illustrative empirically driven case study, we contribute new insight into how these new learning spaces are practised.

Rather than understanding simulation laboratories as a space within, or stage upon, which learning happens, we seek to explore the interrelationships between simulation pedagogies, learning and these spaces - or as Carvalho and Yeoman (2018) suggest the “human–thing dependence” (*e* 1). In doing this we adopt a socio-material sensibility (Fenwick, 2010; Fenwick et al., 2011), and by doing so we are attentive to a multiplicity of enactments of humans and non-human objects (Fenwick et al., 2011 p. 154). With this as our starting position, we circumvent the smoothing over or ignoring of multiplicity. Rather, our intentions are more to seek them out in effort to present a more nuanced account - one that troubles the normative accounts evident in the bulk of simulation literature and renders “visible the heterogeneous entanglements” (Carvalho & Yeoman, 2018 *e* 1).

As the paper’s name suggests, we see simulation laboratories as complex spaces. To work *with* the multiplicity as well as to provide a measure of coherence for readers, our understanding of simulation spaces is presented via layers – each building upon and/or complicating the one before. We begin this in the first ‘background layer’ where we use literature to introduce the practice of simulation in the health sciences. We then provide background to the research informing our study before describing how (often overlooked) student observers disrupt homogenous notions of the simulation space. With this background complete, a second layer draws heavily on empirical data to illustrate pedagogy being enacted in the simulation space and tease out very different accounts of students’ experiences of it. A third layer then moves to explore the heterogeneous nature of the proximities, materialities, activities, temporalities and transformations that highlight spatial injustices for some groups of students. Finally, a discussion draws it together. The dual focus on simulation space *and* pedagogy enables us to consider new directions for the development of simulation pedagogies as well as raise questions around the standardisation of learning.

## Layer 1: Background

### **Simulation in the health sciences**

The term ‘simulation’ is broadly defined as the imitation of a process or situation (Nygaard et al., 2012). For example, in the health sciences the process of suturing may be simulated using real surgical needles, thread and chicken fillets. A second example is where the process of cardiopulmonary resuscitation (CPR) is simulated using manikins designed for this purpose. Simulating these processes enables students to develop their skills without being open to the life-or-death consequences of getting it wrong if practised on a human patient. This is desirable for the obvious reason that patient safety is of seminal importance to health professionals (Brock et al., 2013; Flanagan et al., 2014; Kelly & Jefferies, 2012). Situations with fewer life-or-death consequences are also simulated. For instance, students may practise carrying out a difficult conversation with a patient’s family or practise accepted communication protocols in complex emergency situations (Arthur et al., 2011; Brock et al., 2013; Kelly et al., 2014). Some also note simulation’s capacity to standardise the educational experiences of the growing student cohorts (Issenberg et al., 2005; Kelly et al., 2016; Onda, 2012). In combination, these warrants for simulation are intensified by the need to address the global shortage of nurses and other health-related professionals (Bucha et al., 2017; WHO, 2010).

It is little wonder then that the health sciences have made significant capital investments to create entire learning spaces (commonly called simulation laboratories) that simulate aspects of those found in the professional domain (Arthur, 2011; Cook et al., 2011). Notwithstanding low-tech material requirements for simulating suturing or practising communication protocols, it is not uncommon for university faculties to have simulation laboratories that replicate entire hospital wards, including, beds, trolleys, monitors and a full array of medical equipment, along with expensive high-tech manikins enabled with the capacity to replicate all sorts of human conditions. Such facilities require “major capital investments” (Lasater, 2007, p. 269).

Pedagogically, a cycle of simulation typically follows three phases: briefing, simulation and debriefing. The three phases of simulation pedagogy encompass different social and material arrangements, which impact on what knowings that is emphasizes and students learning in different ways (Ahn et al., 2015). A scenario/script outlining the circumstances of some medical emergency shapes the simulated action and presupposes the clinical responses that students should decide on (and enact) through correct clinical judgements (Tanner, 2006).

Simulation has become a *signature pedagogy* in the health sciences (Lusk & Fater, 2013). Hence, along with major capital investments in simulation spaces, there has also been significant intellectual investment. This investment culminates in a vast volume of research that evaluates, prescribes and develops models of simulation pedagogy (Dieckmann & Ringsted, 2013). The literature speaks to all phases of the simulation cycle, although research that focuses on the simulation itself (Berragen, 2014: Fritz et al., 2008) and debriefing (Husebø, 2013; Levett-Jones & Lapkin, 2014) is more extensive. There is also a significant number of articles that evaluate aspects of simulation and learning (Cook et al., 2011; Palaganas et al., 2014). Perhaps unsurprising, given the health sciences’ relationship with medical science, these evaluations (as well as most other simulation research) are characterised by normative accounts and impoverished theorisations (save the widespread use of some traditional educational theories).

In terms of the simulation space, fidelity is heralded in terms of ‘context’ (Fritz et al., 2008; Page & Daley, 2009) and the scenarios of practiced enacted within it (Dieckmann et al., 2007); the more ‘real’ the better. This ‘realness’ relates to how the materiality reflects; that of a practice a setting (e.g. a hospital ward, equipment); the human actors involved (e.g. nurses, patients, family members); the medical situation presented (e.g. dropped blood pressure, cardiac arrest); and the activities that are enacted (e.g. monitoring ‘vitals’, performing CPR, therapeutic touch, professional communication). This striving for the ‘holy grail’ of fidelity remains largely unchallenged.

An emerging tranche of simulation literature recognises the protocol-driven nature of the aforementioned research and seeks to address simulations’ neglect of theoretical groundwork (Berragan, 2014). In particular, Peter Dieckmann has been among the vanguard (Dieckmann et al., 2007; Dieckmann, 2009; Dieckmann & Ringstead, 2013) and has repeatedly called for new understandings of simulation generated through more theoretical means.

### **A sociomaterial approach**

Responding to these calls has produced an expansion of conceptualisations of simulation-based education with a growing number of studies providing new perspectives informed by sociomaterial or practice theorisations (e.g. Abrandt Dahlgren et al., 2016; Hopwood et al., 2014; Nyström et al., 2016a; Nyström et al., 2016b; Rooney et al., 2015). A sociomaterial approach provides a productive lens to disrupt the stable, singular and normative accounts of these educational spaces. For example, Hopwood et al. (2014) raise epistemological questions about what is actually being simulated. Rooney et al. (2015) present the vignette of students performing CPR in a simulation, while simultaneously kneeling on their ’patients’ burned arm, to illustrate how fidelity in a nursing simulation is “never completely stable” (p. *e*11). While such actions would be inappropriate in an emergency ward: the authors posit that in a classroom is it reasonable for educators to overlook some actions if the desired learning outcomes of the lesson is about something else (for example, professional communication). The assemblage of both professional *and* educational human roles, relationships, materialities, and activities in the simulation classroom renders fidelity problematic. Referring to the fidelity of a hospitality training program, Solomon (2017) concludes that simulation is “its own kind of real”. However, we suggest that it is “constantly worked on and produced through the actions and interactions of multiple bodies and objects” (Rooney et al., 2015 p. *e*11).

It is important to point out that a sociomaterial approach is not a unified one. A sociomaterial *approach* is the overarching term given to a range of theories: e.g. complexity theory; cultural historical activity theory; actor network theory; spatial, and practice theories (Fenwick, Edwards & Sawchuck, 2001). While these differ in foci and are expressed in different forms and intensities, they share an emphasis on the *relational* (e.g. between humans, as well as between humans and things, knowledges, and/or spaces etc): i.e. decentering the human. The focus of sociomaterial accounts are necessarily multiple, and interest is on how humans, things, knowledges and spaces assemble, and how they work *on*, *with* and *against* one another. By way of example, Nerland & Jenson (2012) investigate the interplay between practices and objects in their exploration of professional work. In doing so, they draw attention to “the role of epistemic objects in the processes of knowing, and, in this respect, to their transformative as well as stabilising effects upon practice” (ibid, p. 106).

As its name suggests, the unit of analysis of the ‘practice turn’ are practices (Schatzki et al., 2001; Schatzki, 2002; Gheradi, 2015; Hager 2014). This ‘turn’ is invigorating pre-service professional education research with new and interesting ideas concerning what it means to prepare novices for professional practice (e.g. Dall’Alba 2009; Kemmis et al., 2014; Mahon et al., 2017). In simulation pre-service education ,Nyström et al. (2016a) use practice theory to problematise interprofessional knowings and enactments as a fluid movement between bodily positioning in and out of synchrony in relation to the sociomaterial arrangements of simulation.

Spatial theories challenge the notion of ‘context’ in ways that refute innocuous understandings: context is *not* merely a stage on which human actions are performed. Spatial theorists see spaces as *performed*, *peopled* and/or *practiced* – thus they look for how spaces are made *practically intelligible* (Schatzki, 2002). Soja (2010) advocates for spatial perspectives that identify “consequential spatiality” (p.193) and his exploration of bus riders in Los Angeles highlights vast inequalities in the distribution of things, systems, opportunities and power. Similarly, in education, spatial theories can help draw attention to how learning spaces are assembled “in ways that enable or inhibit learning, create inequalities or exclusions, open or limit possibilities for new practices and knowledge” (Fenwick, Edwards & Sawchuck, 2011 p.129). Furthermore, Massey (1993) reminds us that “space is not static (i.e. time-less), nor time space-less” (p.155): thus connecting space with time.

We make use of these ideas to open up new questions about simulation learning spaces, pedagogical practices and learning. This approach helps us to tease out relationships between activities, things and spaces that might otherwise go unnoticed, as well as identify how the spatial open ups or closes down possibilities for students and learning.

### **Outline of research studies**

This paper emerges from ‘research in progress’ carried out by two qualitative studies being carried out by two interdisciplinary teams primarily interested in simulation: one in Australia, the other in Sweden. While each study is independent, similar methodologies and conceptual developments are enabling respective research teams to collaborate on various aspects (e.g. Abrandt Dahlgren et al., 2016; Lindh Falk et. al., 2017), including this paper.

Both the Australian and Swedish studies adopt ethnographic methodologies that are appropriate for sociomaterial studies (Fenwick et al., 2011, p. 153). Specifically, research methods of both studies include non-participant observation, where multiple researchers observe and make unstructured field notes from various locations across the simulation space (e.g. bedside, control room), as well as locations where student observations, briefing and debriefing phases are carried out. In addition, multiple locations of simulation space are video and/or audio recorded. Where possible, recordings are transcribed, and in some cases Swedish transcripts are translated. Subject documents, including educator and/or student guides are used in desktop research to complement other data. The combination of methods results in both studies having rich sets of data which facilitate the combined case study presented below.

In terms of breadth, the combined sample from across both studies consists of 45 simulation cycles (e.g. briefing, simulation and debriefing) involving 11 educators and around 350 students. Cycles lasted between one and two hours, which typically included briefing and debriefing phases of around 12 to 30 minutes. Scenarios in both Sweden and Australia depicted variations of an acute emergency and/or a deteriorating patient condition.

### **Disrupting homogenous simulation spaces**

In addition to the students who are actively engaged in the simulation action, there other human players involved. One important group are the students who act as observers. In all the simulation classes we observed as part of the research there were student observers involved. In the Australian study there were around 25-30 pre-service nursing students (in each of the cohorts we studied) enrolled in a final year unit focused on ’critical care’. The semster long unit made use of simulation in some of its 2 hour classes. When simulation was used, 4-6 students were assigned acting roles and the remainder observed. It was possible for students to complete the unit without ever taking an acting role in simulation – although they would likely take acting roles in other units. The Swedish study differed in that it involved a range of undergraduate health professionals (e.g. medical students, nurses etc.) involved in full day simulations with a focus on interprofessional work. Students were asigned to an interprofessional team of 8-10 students that worked together over the day. Multiple simulations occured throughout the day and each involved 4-6 acting roles while remaining team members observed. The acting/observer roles were rotated among team members.

For a number of reasons, not least of all larger cohorts, the observer role is now commonplace in simulation classrooms (Kelly et al., 2016; Nyström et al., 2016b; Rochester et al., 2012). However, despite growing numbers of students observing (rather than acting) in simulations, the observer role is overlooked in the literature. There is, however, some agreement that observation needs to be an active process (Chi et al., 2008) and active observation can be supported in different ways: by the use of instructional support through individual observational guides (Stegmann et al., 2012); by the use of collaborative scripts and peer feedback where different roles and tasks are distributed between the active and the observing students (Chi et al., 2008; Zottmann et al., 2006); and/or by arranging observers into small groups each with a different focus (Kelly et al., 2016).

Returning to our understanding of space then, we revise the material space of simulation to include the entirety of physical space(s) in which simulation is enacted. This means that not only the space where students perform CPR is included but also the spaces where observers are located. In addition, we include the space where the technologies underpinning the simulated action are located. To avoid confusion, forthwith we treat these various (sub)spaces as ‘zones’ of the simulation space (in its entirety).

In our respective studies the simulation spaces are situated in three higher education institutions. While the material arrangements of how simulation is enacted differed slightly across sites, they all could be divided into three zones: an *active* zone; a *control* zone and an *observer* zone. The active zone is where simulated action takes place; students taking acting roles in the simulation are located here. This zone includes hospital beds, medical equipment and at least one life-sized high-tech manikin with capacity for a ‘pulse’ and a chest that rises and falls as she/he ‘breathes’. The manikin is also able to ‘speak’ with the help of a human and equipment located in the *control* room (the control zone). Humans located in a control room can see the simulation action via one-way windows. It is here that a technician controls the technology enabling changes in the manikin as well as the video equipment that the relays the video into the observer zone where student observers are located. The observer zone is either a separate room altogether, or in the same room as the active zone but separated by a partition. In any case, the observer zone is typically furnished with student seating and a video screen. Thus, we now say the simulation space consists of the entanglement of multiple yet interdependent materialities, humans, activities and *zones* that coproduce the simulation laboratory. Acting students move across the various zones during various phases of the simulation cycle. All the Australian, and *some* Swedish, observers remain in the observer zone and watch videoed simulation action relayed to a screen. Some other Swedish observers observe through a one-way window from the control zone.

## Layer 2: Pedagogy enacted in the simulation space

Having provided background, this section turns to empirical data to illustrate pedagogy. Our empirical illustration follows the phases of simulation enacted across the various zones. We begin with the briefing phase where the educators’ pedagogical interventions prepare the students for the ensuing experience – or to use Boud and Walkers’ (1990) words, how students are “introduced to the learning situation” and what, if any, relevant aspects are “pointed to” (p. 73). Adhering to the general rythm of the simulation cycle (seen in Layer 1), each simulation began with a briefing phase where the scenario was introduced to the class before the acting or observing roles were assigned. Once assigned, some students moved into their respective zones. Role cards provided acting students with information about their role and then a technical briefing further prepared them by providing information about the functionality of the manikins and where they could locate particular medical equipment and other objects they might require (e.g. phones to call doctors). In most cases, acting students were also provided with clothing items (e.g. uniforms, hats, other accessories) to help them ‘get into character’.

Toward the end of the briefing phase attention was redirected toward observers. We noted various ways the observing students were invited to engage in the forthcoming happenings. In most cases, very short instructions were given, for example, “So while [the simulation] is happening the rest of you are going to sit here quietly and watch the simulation on the screen.” This briefing exemplifies the limited activities expected of observers: sitting quietly and watching. That said, there were some observer briefings where the educator justified the observer role and framed it as a learning opportunity.

Observer briefings did not always include verbal instructions about what to notice. However, when there were, observers were directed to notice how teams of acting students worked together; team leadership; or how clinical skills were performed. Implied was an expectation that observers would provide feedback to their acting peers. While written observation guides were available their use was varied. In some instances, the educator distributed these during the briefing without providing instructions about how they should be used. In other instances, they were available electronically before the class with an assumption that students would print them and bring them to class. Verbal briefings of observers sometimes included instructions about what was expected of them in the forthcoming debriefing phase:

[After the simulated action], we’re going to gather back together as a group and the people that have participated are going to get a chance to talk about the experience. Then the observers are going to have a chance to then make some comments.

With the briefing complete, the actual simulation phase began. Those in the active zones now made decisions about the unfolding clinical situation, decided on and performed various clinical skills, and communicated with other ‘actors’ (i.e. team members, the ‘patient’ and the patient’s ‘family’). It was common for the educator to be part of the acting team too (e.g. taking the role of doctor). The ‘doctor’ often narrated what was occurring: e.g. “So he’s got bruising on the left side of his chest […] and he’s got burns to his right arm.” These sorts of narrations were audible to both acting and observing students alike as was the talk between acting students/nurses.

As simulated activity ramped up in the acting zone, activies in the observer zone were more relaxed and largely confined to (sanctioned) sitting quietly and watching the screen. A few observation guides were on desks or laps, but were rarely used. When observers were working in small groups there was some pointing to the screen and whispering, which suggested students were discussing some aspect of what they were observing. Unsanctioned activities were also noted when observers were not accompanied by an educator: e.g. using mobile phones, grooming, and sleeping. Where the observers were accompanied by an educator (i.e. when they were located in the control zone), educator questioning prompted discussions around some aspect of what was being observed.

Once the scenario came to an end, the third phase of simulation (debriefing) began. Here the initial setting up of the briefing phase more or less came to fruition. The cohorts ‘gathered back together’; Australain acting students re-entered the observer zone; Swedish students re-entered the observer zone or a larger room where the briefing was held.

Once the cohort was reassembled, ‘the people that participated got a chance to talk about the experience’. Educator-led debriefing phases began by focusing on the acting students’ experiences. Debriefings exemplified the various debriefing steps seen in the established simulation literature: e.g. (1) reflecting, (2) noticing, (3) interpreting, (4) responding, and (5) reflecting (Lusk & Fater, 2013, p. 18). Following this, observers ‘got a chance to comment’ with the educator generally asking questions such as “What do you think?”, “Thoughts?”, and “How do you think that went?”. Such questions typically generated short responses such as “Good” or a brief comment about what an acting students did well. It was not uncommon for just one or two observing students to speak during each debriefing. The example below shows an observers’ contribution being folded into the debriefing:

Facilitator: *How do you think that went?*

Acting Student: *I lost track of time.*

Facilitator: *You think it was quick?*

Acting Student: *Yes*.

Facilitator: *Now, those who were observing, how did you think the time sequence went?*

Observing student: *Slow*

[Facilitator expands on this point …]

Facilitator: *So we need to wrap up very quickly…*

These contrasting experiences of time across the zones and phases of the simulation cycle provide a helpful segue to consider snapshots of some typical students’ experiences in the simulation spaces we investigated:

Student A arrives at her class in the simulation laboratory. The educator gives the entire class a broad introduction to what will be happening. Student A is relocated to the acting zone where she is briefed in more detail about what is expected of her in the forthcoming activity. The student carries out the activity which requires her to perform a number of practices, and apply a number of concepts, that she has been learning about in a scenario of professional practice. When the activity is complete she re-joins her classmates where she is prompted to describe, reflect on, and learn from, her experience through a 20-minute educator led debriefing phase. Class is dismissed.

Student B arrives at her class in the simulation laboratory. The educator gives the entire class a broad introduction to what will be happening. Student B is then directed to ‘sit quietly and watch [the video screen]’ in the observer zone. The educator disappears for around 40 minutes. During this time Student B fumbles through her bag, checks her mobile, and talks softly with her classmates. Once a video appears on the screen she sporadically watches it while continuing her earlier activities. The educators’ reappearance marks the beginning of the debriefing phase, consisting of a 20-minute discussion with a group of her peers. Finally, the educator asks Student B and the other observers ”what did you think?” One student (not Student B) says ”good”. Class is dismissed.

Student C arrives at her class in the simulation laboratory. The educator gives the entire class a broad introduction to what will be happening. Student C is allocated to an interdisciplinary team: i.e. a group of students she will work with over the day. Student C’s first experience of the simulation cycle is similar to Student B’s located in either the observer zone or the control/oberserver zone. In the next cycle her experience is similar to Student A’s. This ‘cycle of simulation cycles’ continues until the class is dismissed.

These typical enactments of the simulation zones and phases highlight important differences in the overall simulation space. Folding in this empirical layer, we shift our understanding of the simulation space yet again - to one of ‘spaces of difference’.

# Layer 3: Spaces of difference

Several features of the simulation learning space are likely to be shared by all students. For instance, the students may have similar desires (e.g. to become health or medical practitioners), their professional education is more or less similar, and they share the overarching experience of being students in a nursing or medical pre-service program that includes being enrolled in a unit that makes use of simulation pedagogy. Both acting students and oberservers also share having their learning shaped by the same scenario/script that has been designed for the simulated activity. But as the snapshots above illustrate, there are some important differences for learning that are afforded by the zones in which students are positioned during the simulation cycle.

Despite learning being the object for all students in the simulation classroom, the spatial affordances of various zones result in differences in terms of roles and relationships, proximities, materialities, activities and time. While both the acting students and the observing students are embedded in social roles and relationships and physically engage with the materiality of the zone they are located within, their proximities to the simulated action (the locus of learning) are different.

The available roles for students in the acting zone are as nurses, patients, patient family members (while simultaneously students) and this also means being entangled in multiple social and professional relationships. Entangled with these roles and relationships is the materiality of the active zone - resembling that found in a professional settings and yet nested in the broader educational institution. Available roles in the observer zone are as students, limiting the social relationships to one of peers (and student/educator for some observers). Entangled within these roles and relationships is the materiality of observer zone – resembling the educational setting found more broadly in the educational institution in which the observer zone is nested. In some cases the control zone makes available roles of student observers and, in some cases observers accompanied by educators. The materiality of the control zone, and in particular the technologies, also makes available roles of *disembodied* patients and doctors.

Proximity and the sociomaterial arrangements of each zone also “open up or limit” the kinds of activities posible (Fenwick, Edwards & Sawchuck, 2011, p. 129). For instance, while all can physically touch the material setting of the zones they are located within, visceral engagement with the locus of learning (the unfolding simulation and its materiality) is only ’opened up’ for students bodily embeded in acting zones. Further interrogation of possible activities across the zones can also shed light on how and why certain activities become practically intelligible: i.e. more or less likely to happen (Schatzki, 2002). The human activities in the acting zone resemble those from professional settings (e.g. monitoring blood pressure, performing CPR), whereas human activities in observer zones resemble those found in typical educational settings (e.g. note-taking, listening to an educator, being stimulated by some form of content). Note how blood pressure machines, manikins, note-pads and video technologies are agentic in opening up possibilities for activities to happen.

Activities are shaped not only by objects within the zone, but also by mediating objects that infuse and circulate across multiple zones. For instance, the scenario/script and observation guides. Both are products of curriculum design with the purpose of bringing about learning, and as such they embody the learning outcomes for the entire class. The scenario/script manifests in various objects (e.g. ‘role cards’, handover scripts, patient history records) made physically available to acting students who use them to enact the performance that is to be observed by students in other zones. These scenario/scripts embody some sort of medical situation presupposing how acting students might notice and intervene. That is, it shapes acting students’ actions in order that all students learn. This means they are informed by both professional *and* educational practice. The focus of observers is typically to “evaluate” acting students’ performances. Observation guides generally manifest as student handouts or electronic documents made available to observing students. Their purpose is to direct what observers are to notice and to bring about learning (e.g. Chi et al., 2008). While the content of observation guides is professional practice, its design is primarily informed by education practices. Notwithstanding instances where an additional educator accompanies observers, the observation guide acts as proxies for absent pedagogues. While observer guides have potential to circulate across the multiple zones, and influence activities in various simulation phases, this is not generally realised. Additional curriculum objects (e.g. the simulation plan for a patient’s deteriorating condition) are made available to educators or control-room technicians. They impact both the active and observer zones but in different ways. For instance, they trigger particular events (e.g. a drop in the manikin’s blood pressure signifying cardiac arrest) that acting students must notice and respond to (e.g. perform CPR) – a performance that is to be observed by others in another zone. We emphasis though, that *opening up* opportunities so that particular activities might happen, is not the same as *making* them happen.

In the simulation cycles we studied there were also examples where prescribed activities did not ensue in the presupposed manner. Pedagogical interventions were used to direct and *re*direct student activities. These interventions impact students in different ways as well. For instance, many educators appear to “notice out aloud” (Rooney & Boud, forthcoming) during the simulation phase. This involves educators (in their doctor role) narrating an unfolding situation – to use an example mentioned earlier –“So he’s got bruising on the left side of his chest, […] and he’s got burns to his right arm.”Both acting and observing students can hear this narration thus be (re)directed to notice some pivotal clinical moment arising in the simulation requiring them to act. Students in the acting zone must notice this moment in the midst of ’practice’ and use their developing clinical judgment to respond to the situation unfolding in the here and now. Observers, on the other hand, may be prompted by the naration to notice this moment and (perhaps) project themselves into similar future situations to imagine how best to intervene if a similar situation were to arise for them.

Again this draws attention to the *temporal differences* between the zones and their precariousness. Like all spaces, the acting zone is only performed for the duation of the simulation phase, and at other moments becoming a fancy bit of kit. Acting students temporarily position their activities within the professional practice they are training for (if only for the duration of the simulation) and act ‘as if’ they are already practitioners, whereas for observers the professional practice is in the future. Some cross between zones in the same lesson speeding up or slowing down action at different moments. For some, alternate roles are postponed until other times. The arrangements of the units involved can mean students may, at another time, be assigned a different role in another zone. However, there are no guarentees that this is the case either. We conceed a liklihood that other units of study provide students with opportunities to take on acting or observing roles – but what might this mean for learning ‘interpersonal communication’ and ‘critical care’?

By way of moving to concluding then, we understand simulation laboratory as spaces of difference. As such we tentatively consider ‘spatial injustices’ (Soja, 2010) – admittedly, hardly on the same scale as bus riders in LA. As we may observe more broadly though, where there are differences there are also inequalities. But how are these differences to be understood, let alone resolved? Do spatial injustices limit learning opportunities for students in the observing zone? Does the overwhelming focus on the learning of students in the active zone overshadow that of the observers? In response to these questions we might, on the one hand, conclude that observers are being short-changed. For example, our layers of simulation pedagogies may appear to illustrate how the majority of the teachers’ time in the simulation laboratory is devoted to the students delegated active roles, while observers appear overlooked. On the other hand, we might construct a different argument, where it is the students in the active zone that are subject to injustice. After all, it is the performance of the small group of students in the acting zone that provide the locus for observers’ learning. Does simulation pedagogy only appear to be about the actors’ learning when, in fact, the actors are merely proxies so that the observers might learn? These are all interesting perspectives, but ones we do not reconcile. What we can see, however, is that the standarisation of learning becomes inplausible and that there is value in asking new questions about simulation pedagogies.

# Concluding discussion – complex spaces

Our accounts of the simulation laboratory present it as a space of flux. Role cards, scenarios and various clothing items transform students into ‘real’ professionals (albeit temporarily). Educators transform into doctors who manage patient conditions and orchestrate attending nurses, yet they simultaneously remain educators who direct observing students’ focus at pivotal moments. It is not only a space where humans transform but where humans and human activity transforms the space as well. Time speeds up for some and down for others in the very same space. Once briefed and dressed, student/nurses performing CPR on a manikin/patient transform the ostensible educational space into a hospital ward (or at least a version of one) before debriefing returns nurses to students, and doctors to educators. Yet even these roles are unstable. When observers enter the control zone with disembodied students there is a merger of zones for the duration of the simulation. But it is not only the humans and activities that shape the simulation space. Our layered accounts illustrate how objects have agency too - as Fenwick, Edwards & Sawchuck (2001) rightly insist: e.g. observation guides, scenario/scripts, medical equiptment, desks etc. each shape possible actions as well as confirm (or deny) temporary subjectivities and/or relationships. Transformations are assisted by the materiality of technologies and objects endemic in both the professional and educational domains. As Fenwick (2010) would say, ‘stuff matters’ - yet it is often overshadowed in research accounts by the preoccupations of understanding human activity and meaning making.

In contrast to the homogeneous perceptions of simulation laboratories seen in much of the health sciences literature, our layering of the simulation space, informed through a sociomaterial lens, sees it as more complex. We have illustrated how the multiple nature of the simulation space (zones) must work together to open up possibilities for learning in the simulation laboratory. In contrast to exant literature that often focuses on one zone in isolation, we suggest it more helpful to consider the entanglement of roles, relationships, activities and materialities across *all* zones. This multiple focus is complex for researchers as well as for simulation educators.

This returns us to the role of pedagogy. A sociomaterial understanding of interdependent learning zones in the simulation spaces draws attention to differences for all involved: including educators. These are complex educational spaces. But then how might space and pedagogy align when these precarious simulation spaces are understood as complex? What ‘designable elements’ (Carvalhoa & Yeoman, 2018, p. 5) might support learning? Teaching in these spaces is demanding for educators who must have multiple foci if they are to support all students’ learning. However, we propose that a deeper understanding of the simulation space may help educators develop pedagogical interventions, that further open up opportunies for all student learning, by raising questions about simulation that have hitherto gone unasked. Aligning these complex simulation spaces with pedagogies is likely to require complex pedagogies generated by more complex questions. We do not pose these here, but as Zygmunt Bauman (2005) so poignantly suggested, we see merit in not arriving at definitive answers, but by remaining open to asking new sorts of questions. However, this layered account of the simulation space presented here may provide impetus for others to do so.

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