Next Time Won't You Play With Me:

Scalability of Simulation-Based Learning at Northwestern University

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June 2015

Research Question

What variables of scale contribute to achieving stated outcomes of simulation-based medical education at the Feinberg School of Medicine and how do they compare to the variables of scale proposed for other types of game-based learning innovations?

Data Interpretation

This study aimed to examine the rich and complex question of scalability for simulation-based medical education, looking specifically at the characteristics which make simulation-based medical education a worthwhile learning initiative and how these characteristics are created, maintained, and supported. The data gathered through artifact analysis, interviews, and observations examined the relationship of the simulation-based learning to institutional characteristics of technology-enhanced education, to characteristics of simulation-based medical education, and to variables of scale for other types of game-based learning proposed by other researchers (Clarke & Dede, 2009; Epper, Derryberry, & Jackson, 2012; Issenberg & Scalese, 2008). Specifically, this study assessed Feinberg's simulation-based learning against the five categories of variables of scale proposed by Clarke and Dede (2009) for technology-driven game-based learning initiatives: (1) student level variables, (2) teacher level variables, (3) technology infrastructure conditions, (4) school/class level variables, and (5) administrative/school level culture variables. The data gathered from this study supports these variables for simulation-based medical education in many cases and not in others. The data are interpreted in relation to four key findings: (1) simulations are developed and supported institutionally, (2) faculty expertise and roles vary greatly, (3) fidelity drives simulations, and (4) technology supports simulations but is not necessary. Following from these four findings, a new framework for assessing scalability of simulation-based medical education is proposed by the researcher in the conclusions section. The interpretation of the data starts by examining the fundamental characteristics of simulations at Feinberg which have been developed and supported institutionally to create a successful program.

Simulations Developed and Supported Institutionally

The findings of this study generally support the argument from the literature for using an institutional perspective when adopting and developing technology-enhanced game-based learning strategies (Epper et al., 2012). A level of institutional support is also present in many of the variables of scale proposed by Clarke and Dede (2009) and the data clearly suggest several variables including those related to support for teachers from an administrator and support related to the innovation were important for simulation-based learning at Feinberg. For example, all three interview participants described a high level of support from the administration and other teachers at Feinberg as well as the individual departments in which they worked. Artifact analysis also showed a great deal of resource support provided to simulation-based medical education at Feinberg with significant space and technology allocation.

The allocation of resources and support for instructors at Feinberg had a clear correlation to the assessment of standards and creation of content that contributed significantly to the education of medical students. Northwestern simulations closely resembled best practices of game-based learning programs researched by others (Ke, 2009; Randel, Morris, Wetzel, & Whitehill, 1992; Sitzmann, 2011; Vogel et al., 2006). For example, all three interview participants described the development of content standards that fit into the larger curriculum of medical school education. This follows closely with what Sitzmann (2011) and others have argued about the need for simulations to be embedded within a larger curriculum to be successful. As described by interview participants, the Feinberg simulations have been developed holistically to allow students to participate in simulations regularly throughout medical school. All three interview participants described how more exposure to simulations over time caused students to be able to be more invested in the simulation and accept the fidelity of the learning environment more completely without questioning it. This finding strongly supports what the literature has previously established about increased cognitive gains when students have access to simulations repeatedly over time (Ke, 2009; Sitzmann, 2011) and also to the variable of student comfort level and familiarity with the innovation from Clarke and Dede's (2009) framework of scale.

Faculty readiness and development was also supported holistically at Feinberg based on the results of this study. Two out of the three interview participants had undergone significant training related to simulation-based learning and all three described the importance of such advanced, specialized training in developing simulation sessions. In particular, all three interview participants described the importance of supporting the development of faculty who are able to provide appropriate feedback to establish the right environment for learning within simulations. Will in particular, discussed how having the capacity to develop sufficient training for feedback within an organization was central to the success of simulation-based medical education and should, as such, be central to the question of scalability for such programs. In similar fashion to established literature in the field, Dan described the need for feedback in terms of the cognitive load of students who need to learn the task being simulated and not how to interact with the simulation. This finding thus closely supports previous research on simulation-based education in which others have found that without proper feedback and guidance, using game- and simulation-based learning strategies tended to teach students more how to use the game than how to learn the task being replicated (Ke, 2009). Ultimately, the goal described by all three interview participants was to create an environment in which students were completely engaged in simulations to the point that those students treat it as real as if they were in the real task environment instead of a simulation. This is substantially similar to creation of a flow state from the literature in which participants get completely focused on an activity to the exclusion of everything else around them as described by Ryan et al. (2006) and others. It also relates to the importance of establishing psychological fidelity of the simulation environment among participants described heavily in simulation-based medical education literature (Issenberg & Scalese, 2008; Kneebone, 2003).

In different situations, the creation of psychological fidelity was done differently, but all three interview participants described a collective institutional effort in establishing this important characteristic. For example, Mary described the selection and training that standardized patient actors go through in order for them to be able to support students appropriately within simulation sessions. The faculty facilitator on the second day of observed simulations similarly described the amount of support that goes into simulations behind the scenes. For example, he described how lab technicians sitting in control rooms were instructed to move simulations along so that the facilitators in the rooms could focus on providing feedback and support to students and not on timing and logistics. This importance of fidelity of the simulation is discussed in more detail later in the discussion of how fidelity drives simulations. Additionally, all three interview participants made an important distinction in level of training required between those who create simulations and those who facilitate them. That distinction, not present in Clarke and Dede's (2009) variables of scale, is discussed in more detail in the next section.

Faculty Expertise and Roles Vary Greatly

Clarke and Dede (2009) only conceived variables for one level of teachers. For them, game-based learning initiatives were created and designed by researchers and then implemented in the classroom by teachers who probably never met the game designers (Clarke & Dede, 2009).

The challenge for them was in design a system which could stand on its own for teachers in the classroom without those who designed the game-based learning platform as part of that process. As the data show, this presumption is fundamentally different for simulation-based medical education at Feinberg. All three interview participants described multiple types of roles for teachers depending on the circumstance and the type of simulation. For example, Dan described a pyramid structure for how simulations are run and supported. There are faculty members at the top who design simulations which others then teach. Will similarly distinguished between teaching scenarios and designing or writing scenarios in many of his answers to questions targeted at teacher level variables. These ideas were supported in the observation as well where there was one “teacher” (in the sense of being a faculty member in Feinberg) who actually did very little teaching; instead, the faculty member coordinated the activities of multiple facilitators who actually supported the learning of students in the simulation sessions. The importance of the expertise of teachers thus varied greatly depending on the role of the teacher and the level of support provided to that teacher.

The most obvious example of this is in the level of technology familiarity and fluency highlighted by Clarke and Dede (2009). As described by Dan, the pyramid structure is such that those at the top, who can build and develop the content of the simulations, require a high level of technology familiarity and fluency, but those towards the bottom who focus on facilitating simulations designed by others do not require much or any technology familiarity and fluency. This is also true for background characteristics of teachers described by Carke and Dede (2009) such as professional development and academic specialization. Those who design simulations require a good deal of additional academic specialization but those who facilitate other’s simulations do not. For instance, in the observed session, the faculty leader spent time with each of the individual room facilitators before students arrived, orienting them to the session and what would happen. In this way, the facilitators, who were themselves older students, did not have any specialized training because they only supported the learning within a simulation session designed by the faculty member who had advanced training. These medical residents were, of course, familiar with simulations and medical education, having gone through the process themselves as students, but were not as familiar with the technology and the teaching skills. In relation to Clarke and Dede’s (2009) variables, then, the teacher’s level of comfort and familiarity with the innovation is important while the teacher’s level of comfort with technology was generally of little importance. Mary described a similar situation for standardized patient simulations where fourth year medical residents help facilitate simulations designed by her and others with more expertise. Dan emphasized at several points that a great deal more work is put into simulations ahead of time. In the observed session, for instance, it was clear the content and the interactions had been meticulously mapped out and prepared ahead of time so that the session itself could run smoothly with little intervention by the faculty coordinator. In thinking about scale, this curriculum development time and expertise aligns closely to what Issenberg and Scalase (2010) describe. For Issenberg and Scalase (2010), many of the most important factors for simulation-based medical education involve the complexity of simulated learning environments based on realism to an actual clinical scenario. Creating complex learning opportunities which involve high fidelity and repetition of basic tasks requires time and expertise in simulation design and development as well as time and resources for testing (Issenberg & Scalese, 2008). Teachers who are developing the curriculum and the content of simulations thus have to be experts or have a high level of support from others who are experts.

Ultimately, in making a distinction between teachers who are content developers and teachers who are facilitators, simulation-based medical education as observed in this study does not follow the model described by Clarke and Dede's (2009) variables of scale. To relate the data collected from the simulation-based medical education at Feinberg back to Clarke and Dede's (2009) variables of scale, many of the variables identified by the authors are very important for teachers who are developing content, but not at all important for teachers who are simply facilitators, including the teacher's comfort level using innovation, the teacher's technology familiarity and fluency, and variables related to the background, training, expertise, and years of teaching experience. The level of expertise teachers demonstrate in simulation-based medical education supports the creation of simulations which have a high level of fidelity and thus support the cognitive gains of students in developing psychomotor and clinical skills as described by the literature (Issenberg & Scalese, 2008; Maran & Glavin, 2003). The importance of fidelity from the data collected on the development and support of simulations at scale is described in detail in the next section.

Fidelity Drives Simulations

Clarke and Dede's (2009) variables of scale discuss the importance of training students on using technology required for game-based learning. Their model does not, however, describe a need for other types of student level understanding and comfort with the innovation, as was a prominent finding from the data collected on simulation-based medical education in this study. When asking about the importance of technology and the reliability of that technology, for example, all three interview participants described the variability in the amount of technology used and the importance of that technology to the learning outcomes of the simulation based on the fidelity needing to be replicating. Will, for instance, described how certain characteristics of the learning environment have to feel and act real for the simulation to be successful, but what those characteristics are and how they are created using technology or not depends on the learning objective of the simulation session. This relates closely to Issenberg and Scalase's (2010) finding that several components related to the realism and interaction of students in the environment are important to the success of simulations, including that "the simulation and the behavior it provokes should approximate the clinical challenges that occur in genuine patient care contexts" (p. 35). The authors also describe the requirement for simulations to take place in a controlled environment where learners are able to be the central active participants in the session (Issenberg & Scalese, 2008). These features describe the importance of creating the appropriate environment which fosters learning within simulation sessions and are strongly supported by the data on simulations at Feinberg.

All three interview participants described the importance of creating the right environment for simulations to take place. Will strongly emphasized this when he asked: "how do [learners] engage in an environment where the environment is limited and how do they still perceive it to be real? And to what extent do you need to orient people to the simulated learning environment so they can engage?" This quote is a clear example of the need to situate learners within the simulated learning space in order to create a safe environment in which to engage with simulated learning. Mary described something similar when she discussed the selection of standardized patient actors. She emphasized that the standardized patient actors have to buy into the education mission and they have to want to create a realistic and supportive environment in which students can practice, fail, and learn. The idea of creating safe spaces for learning was central in the observed sessions as well with all of the simulation sessions beginning with an overview of the rules of simulations, including a strong emphasis on confidentiality and the importance of failing for learning. However, in the observed sessions, there was also an emphasis placed on the need to actively participate. The grade was contingent not on performance, but on participation and effort.

In some ways, these observed environmental characteristics tie in with Clarke and Dede's (2009) student level variables related to collaboration skills and affective measures like engagement and self-efficacy. These were important characteristics in observed simulation sessions and all three interview participants described how learning was collaborative in simulated environments. Dan described how different sessions with different types of learners could be better with greater or fewer people. Earlier learners, for example, need larger groups for more "brain power" while more experienced groups of learners need to be smaller with more opportunity for individual learners to be actively involved in the simulated case. However, Clarke and Dede's (2009) variables fall short of providing an adequate framework to assess the overall comfort students have in engaging with the simulated environment and thus the creation of fidelity within a simulation. For example, all three interview participants discussed how nervous students are when they first participate in simulations and are nervous about performing in front of others. Creating the environment where it is safe to make mistakes and the extent to which learners were comfortable within the simulation environment was a central theme discussed throughout the interviews.

Related to this establishing of a comfortable environment, several of the interview participants emphasized the need to have trained personnel who can establish a supportive environment. One way this was emphasized in the interviews was in the ways feedback is provided. Will, in particular emphasized that feedback is one of the most difficult and important pieces of an effective simulation session. He explained for example how "having capacity in people who are trained to deliver simulation and also provide performance feedback and debrief that's aligned with what the learning objectives are is an incredibly important thing.” Mary described how students involved in simulations watch recordings of their sessions and provide peer and self-assessments of their performance within the sessions regularly. In observations, feedback for sessions was central to the learning process in simulations. Feedback often took more time than was spent simulating the actual clinical scenario. This emphasis is very similar to the way Issenberg and Scalase (2010) and others have described how “Feedback provided during the learning experience is the most important feature of simulation-based education to promote effective learning” (p. 35). As discussed earlier as well, when thinking about scale the presence of quality feedback in order to establish the fidelity of an environment should be of central concern for simulation-based education.

Related to this question is the level of technology required for simulations. In every case, interview participants emphasized that the learning objectives of the simulation drive the determination of what fidelity should be replicated and how. As such, the students’ technology familiarity and fluency was definitively not important. All three interview participants distinguished a need to provide background and training for students before participating in simulation-based education but not in the use of technology specifically. Two of the three interviews specifically discussed how the technology used is the same as would be found in all hospital rooms, which served the dual purpose of replicating the fidelity of a hospital environment and also providing training on the technology required to work as a professional in medicine. Similarly, the observed simulations did not show any signs of difficulty for students in using any technology. This does not mean no technology was used for simulations. The ways in which technology is used to support simulations is discussed more below.

Technology: Supportive, but not Necessary

Much of the literature on simulation-based medical education discusses the variations in types of simulations based on fidelity of the simulation, which, in turn, is based on the learning objectives of the simulation session (Issenberg & Scalese, 2008; Maran & Glavin, 2003; Rehmann, Mitman, & Reynolds, 1995). For example, some simulations use high technology simulator mannequins, while others use human actors as patients. This is different from other types of game-based learning which typically involve a single game platform in which the level of technology required is static, such as the multi-user virtual environment “River City MUVE” project studied by Clarke and Dede (2009). Not all game-based learning is high technology, but most other types of game-based learning involve the same level of technology infrastructure and comfort level using the technology no matter when or where it is used. Clarke and Dede (2009) defined their variables of scale with this assumption, thus describing technology conditions as a key variable for scale. The data from this study suggest that simulation-based medical education does not fundamentally require any technology to be effective, but is often supported or enhanced by the use of technology. In mapping the technology used for simulations at Feinberg to Clarke and Dede’s (2009) variables of scale, in most cases the importance of the variable depends highly on the type of simulation and goals of the session.

The focus on learning objectives first and technology used second was a central theme supported by all three interview participants. Will, for example, emphasized the question: “How much technology do I need to augment what I have in front of me? Whether that's a simple doll, so that people are engaged and feel something, that's what promotes learning: the emotional engagement—makes them feel like that's real.” All three interview participants said that the technology used should be aligned with learning objectives. In this way, if a task doesn’t require high technology mannequin simulators, then those high-technology techniques should not be used. For simulations which do not require lots of technology, the technology infrastructure condition variables required for that simulation are therefore not important. However, as Dan explained, the technology required for high-tech simulations often pushes the boundaries of technological capability. For example, Dan described bringing an interactive student response program to a lecture class to create a simulation with a patient in a large setting that failed because the school's wireless network could not support the number of user connections on the platform. In that case, the technology infrastructure condition variables from Clarke and Dede (2009) could be considered very important as well as other variables related to support from technology experts and the comfort level of teachers in using the technology.

All three interview participants discussed how one of the most difficult parts of designing simulations is in deciding how much or how little technology is required. Dan for example described how it is important in deciding how to use technology to figure out what technology will support learning versus what will detract from that learning. He described how if a student is focused too much on how to interact with the technology and make the technology function correctly, then learning can be inhibited by that use of technology—an idea that is supported by pervious literature as well (Ke, 2009; Vogel et al., 2006). Dan also emphasized that generally students are comfortable with the technology but sometimes when students aren't, and they struggle with basic interactions with iPads for example, then sometimes using more technology is not preferable for helping learning. Given this, the emphasis for determining scale for simulations should first be placed on defining learning outcomes which determines the necessary fidelity of the simulation before finally deciding the extent to which technology can support those outcomes. This flips Clarke and Dede's (2009) conception of scale, which emphasized having the technology infrastructure in place first then training and supporting students and teachers on how to use that technology.

Ultimately, the data from this study supports the conclusion that simulations at Feinberg have been supported and developed holistically in a manner consistent with best practices for cognitive gains from previous research on game- and simulation-based learning (Ke, 2009; Ryan et al., 2006; Sitzmann, 2011; Vogel et al., 2006). Also, while the variables of scale for game-based learning innovations from Clarke and Dede (2009) capture some of the important characteristics of scale for simulation-based medical education, they do not capture all of the complexity specific to simulations. The findings presented here from this study all support a conclusion that a new framework is necessary in order to accurately assess the scalability of simulation-based medical education. The following conclusions section will discuss what a new framework could look like based on the literature, the data gathered from this study, and ultimately the relationship to Coburn's (2003) dimensions of scale for education innovations broadly.