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Case study 7.
Authentic learning experiences through technology-enabled simulations

Summary

This case study describes how computer-based simulation is used to enhance practice-based teaching and learning. Students participate in physical and computer-enhanced simulation activities to highlight deficiencies in skills and knowledge. Simulations offer a number of advantages for students including:

- Holistic realistic experiences: Learners experience an accurate, continuing simulation of a realistic medical event interspersed with relevant workshops and seminars.
- Multidisciplinary team approach: Students from many disciplines participate in simulations to represent the multidisciplinary approach in solving complex problems. To date, students from medicine, nursing and pharmacy have participated. In future, more disciplines will be involved in the simulation activities.
- Use of technology to support simulation: From the use of a computer-controlled high –fidelity simulation mannequin, video recorded observations and use of adaptive release of information in the learning management system (LMS), web-based patient care modules and reflective blogging are used to manage and extend the learning experience.

Keywords

Simulations; computer-based simulations; medical simulations; multidisciplinary simulation

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What worked?

Senior medical students have extensive clinical exposure, but are seldom called upon to make their own clinical decisions and experience the consequences while they are on practical experience. Therefore, many commencing doctors are ill prepared to face the multitude of responsibilities of being a doctor (Wall, Bolshaw & Carolan, 2006; Cave, Goldacre, Lambert, Woolf, Jones & Dacre, 2007; Gome, Paltridge & Inder, 2008; Goldacre, Taylor & Lambert, 2010). The students are ill prepared in terms of,

- Management of emergencies (Wall et al., 2006; Gome et al., 2008; Goldacre et al., 2010)
- Ability to communicate difficult news (Gome et al., 2008)
- Knowledge of how to make clinical decisions (Wall et al., 2006; Gome et al., 2008)
- Performance of practical procedures (Wall et al., 2006; Goldacre et al., 2010)
- Prescribing of drugs (Hilmer, Searle, Le Couteur, Crampton & Liddle, 2009)

The greatest challenge in making decisions for patient care is for the safety of the patients themselves (Rogers, McConnell, Jones de Rooy, Ellem & Lombard, 2014). The lecturer in this case study suggested that harm can be done from prescribing the wrong dose of a drug or not communicating with the patient effectively. A mistake in handling an emergency or an overdose of medication will have detrimental effects for a patient. Therefore, students need opportunities to learn where they can make patient care decisions and learn from the consequences. Using learning simulation methodologies, the risk of injury to patients can be minimised while allowing students the opportunity to practice without fear of harm.

This case study discusses how an extended live-action simulation is delivered using a variety of technologies to enhance the simulation experience. These include the use of a computer-controlled high–fidelity simulation mannequin, video recorded observations, adaptive release of information in the LMS, web-based patient care modules, and blogging in the LMS.

Learning through extended medical simulation

Beginning as a pilot in 2009, and now offered to all third and fourth year graduate entry medical students, students participate in a week-long simulation as their only on-campus experience while they are on placements in hospital clinical settings. As part of the week-long series of activities, “learners experience an accurate, continuing simulation of a realistic clinical story from the likely future professional minds, interspersed with more traditional seminars and workshops raised by the simulation” (Rogers et al., p. 2). The goal of the simulation is to make learners aware of where there are gaps in their knowledge; this provides strong immediate motivation for them to attend to and engage with the related workshops and seminars (Rogers et al., 2014). A lecturer interviewed for this case study explains the importance of the simulation,

> *It's really their only opportunity to make decisions for themselves…they never really get to make their own decisions and then see the consequences. (Lecturer)*

Students are randomly allocated to a clinical team of four to five students. One member is chosen to be the leader (registrar) while the others play the role of junior doctor (intern). In Year 3 of their program of study, the clinical teams manage one simulated patient over the week, while in Year 4, they manage a total of 8 simulated patients with interconnecting stories, in real time over the course of the week (Rogers et al., 2014).

The Year 3 students manage a live, trained simulated patient, who has been in a traffic accident. During the week-long duration of the simulation, doctors order tests on the documentation they will use in hospital practice and results are returned in a realistic time after tests ordered. The simulated patient's medical record is constructed including "medical charts, fluid orders and case notes as they would in a real clinical setting" (Rogers et al., 2014, p.3). As the simulation progresses, the simulated patient is played at times by a digital controlled, high-fidelity simulation mannequin while at other times the team facilitator provides information. Students work through various care decisions in their clinical team while students from other areas call in at various times to play their part in the wider story. Most of the patient care story is told in real-time but time lapses are built into the program to enable a wider story to be told over the week.

Participating, observing and assessing the clinical practice are facilitators who progress the story through the week and provide feedback to students. Each team is allocated a facilitator who works with the students for the full duration of the week. The facilitator is an experienced practitioner who ensures the simulation follows the plan and also guides the students in the right direction by questioning students about the decision they make. A student commented about the importance of the simulation,

> *I guess the other things that I found out is that knowing how you can do something doesn't necessarily mean that you can actually do that when it comes to doing it. As we've found out, it sort of doesn't work that way all of the time. So practice is very very good. (Student)*

To aid in developing communication skills, professional actors are deployed to play the part of the simulated patient's relative. At various times the actor is used to obtain feedback about the simulated patient's progress thus testing the student's ability to give feedback about the care of the patient. Sometimes the actor slips out of role to provide feedback to the students about how they have managed the doctor-relative communication process.

During the week, the simulated patient 'unexpectedly' becomes acutely unwell. Each team undertakes the management of this event in succession with the simulation mannequin. Each team is advised of a medical emergency and rushed to the simulated patient to perform an emergency procedure. Each team enters the room with the relative

(professional actor) to provide emergency care for the simulated patient. They have to manage the emergency response and deal with the relative at the same time. A student explained that they appreciated the hands on experience,

> *You actually pickup very little in the hospital by observing a resus [resuscitation] because…you don't really have a role as a student…so often you are on the outskirts observing the situation…there is so much going on, you're not paying attention to actually each individual's role, so you're not learning…you are just seeing in front of you…I think those are very different processes, seeing and doing, and that's the advantage I think of the simulation. (Student)*

The simulation is conducted with as much accuracy to real life processes as possible to ensure the students experience the full effect of the process. A lecturer interviewed for this case study commented,

> *The key conceptual requirement, I think, is authenticity. It absolutely has to be as realistic and as authentic as you can make it in order for the students to suspend their disbelief and actually put themselves in there. It doesn't work if they don't. (Lecturer)*

A student reported that they felt less fearful of making a mistake,

> *It's not a real patient so it gives you an opportunity to learn by mistakes and learn for next time but not have to worry about repercussions that you would face if it was over in a hospital and … an actual patient. (Student)*

The facilitator and the simulated mannequin computer controller observe what is happening from a separate observation room. The simulated patient vital statistics are managed on a computer screen as the clinical team progress through the emergency without the assistance of the facilitator. The routine of the event is previously determined to ensure the process occurs in a suitable timeframe. The whole event is video recorded by another observer for later discussion. The students are not aware of the type of medical emergency they will encounter. The students are informed at the beginning of the week that they will be recorded but with the stress of the medical emergency most students are surprised to find out they were recorded. The objective of the medical emergency is to put the students into a stressful medical emergency where they have to make quick decisions as a team about the simulated patient's medical care. For most students, they have only observed what happens while on hospital clinical settings. A student commented on the unpredictable nature of the experience,

> *But that's the whole point…is to go into the morning and not know how the day is going to pan out. Because it sort of puts you on the spot. (Student)*

Teams are on-call over the week when one member receives an emergency message about the simulated patient's health. As their response, the student needs to access especially

designed in-house patient learning modules through the LMS to manage the simulated patient virtually. The lecturer explains,

> *Things like the x-rays come up on the [learning management system] at that time to release at the right moment… [The learning management system] points the students to a module, which is how they do an interactive assessment of the patient. When they answer the first series of questions, they get more information according to their answers. (Lecturer)*

Each morning the on-call team member reports back and explains their reasoning as justification for their clinical decisions. Students are required to complete online journals when they reflect on their experiences in simulation. The lecturer explains,

> *They do 300 words a night and then at the end of the week they do 500 words on the Friday. (Lecturer)*

Students are recorded as part of the emergency event and that video is viewed at a debriefing and reflection feedback session later in the day. During the week, students attend workshops and seminars to develop new knowledge and skills that are identified as part of the simulation. At the end of the week, students participate in the wrap-up session where they can discuss the key decision points in the patient story to clarify and optimise their learning. A student commented on the effectiveness of the tool,

> *I find the most effective learning I do is in the hospital with real patients. This is probably the closest you get outside of the hospitals. (Student)*

During the week, other trainee medical students who can assist in the care of the simulated patient are incorporated into the simulation. The lecturer describes this as *inter-professional learning* where students learn to work with students from other medical areas. During the observed emergency event, a first year nursing student participated and at other times students from pharmacy have been involved. It is planned in the next round of scheduled simulations in 2015 that students from other medical disciplines will participate in the simulation. At this stage, the simulation is well supported and funded to continue into the future. Other medical schools from around Australia have expressed interest in this simulated approach to learning.

Why it worked

Enablers

There are a variety of factors that enabled the use of simulations in this case. This section attempts to highlight important factors that have emerged from the data or been observed by the researchers in compiling this case. The following factors are intended to provide guidance for other higher education institutions to assist in enabling TEL.

Supportive team approach: Multidisciplinary school support and approach for simulation. A whole school belief that the simulation experience benefits students of multiple disciplines and is an important part of learning.

Realistic simulation space and minimised risk: Computer controlled mannequin, hospital space and actual medical equipment provide a realistic feel for the simulation. A multi-disciplinary approach, where students from many disciplines work together to simulate typical medical work team practices. The simulation is placed away from real practice where students can fail without real-life consequences.

Interactive online learning to support practice: The LMS and the in-house developed patient learning modules support the delivery of information to the clinical teams. Data is submitted and automatically made available through the LMS.

Affective dimensions of teaching and learning approach: The students are scheduled to participate in a medical scenario where there is a high possibility of failure. The experience is used to remind students of what they do not know in order to prepare for specialised learning. The second medical scenario is conducted where students are able to demonstrate their newly acquired learning with a successful outcome. The approach emphasises the affective dimensions of learning to improve the student experience.

Student confidence and participation: Students believed that the simulation helped them prepare for emergency situations where they were able to confidently make decisions regarding patient care. Students were able to prepare, watch, practice and reflect on where all processes were built in the assessment approach for the simulation.

Challenges

There are several challenges in relation to the use of simulations. This section aims to highlight specific challenges that were reported by participants, or observed by the researchers, to have a direct implication for the enactment of the TEL and which may be relevant for other institutions to consider in deciding to use computer-based simulations.

Limitations to simulating reality: The simulation mannequin cannot offer the real feel, physiology, verbal responses and mental processing of a human being. In an emergency event, there are many physical complex signs that a human can physically display that a mannequin cannot. Validity issues relate to building scenarios that emulate real life practice that students may or may not have experienced while on work-integrated learning. The students only considered the simulation activities as valid when it was incorporated into assessment.

Dedicated space and cost of the simulation: A dedicated space is required for the simulation that enables students to participate in a realistic experience but allows for others to observe and/or manipulate the variables to control the simulation. There are considerable costs to set up and conduct the simulation, including the staff costs to manage, facilitate and perform the simulation, purchase high fidelity simulation mannequin, and the cost for setting up a dedicated hospital looking space.

Student availability and simulation opportunities: The week of the simulation is the only week that each group of students is on campus for the year. The simulation needs to run successfully to ensure the students benefit from the experience. Due to the cost and time to set up for each simulation, the simulation scenario was repeated for each week. Reliance was placed on the students to not advise future students about the simulation scenario.

What the research literature says

The use of simulations for learning is not new and has been used for decades in many disciplines including health. With the affordances of technology, simulations have been able to move from paper to screen and now, with gaming, they have moved into personalised, interactive, game experiences that are very realistic. Gaba (2004) defined simulation as a technique that uses real life experiences to enhance learning. The benefit of simulation is that it provides a safe learning environment for students to practice, where they are free to make mistakes, correct them, and improve the processes of care (Kenaszchuk, MacMillan, van Soeren, & Reeves, 2011). Simulation offers students the opportunity to put theory into practice in a simulated protected environment.

For higher education, the 2014 Higher Education Edition of the NMC Horizon Report highlighted that games or gamification (defined to include simulations) have a two to three year time for adoption (Johnson, Adams Becker, Estrada & Freeman, 2014). The report suggests that "digital simulations are another method being used widely to reinforce conceptual applications in mock real world scenarios" (Johnson et al., 2014, p.43). Simulations provide,

> *These game-like environments [that] transform assignments into exciting challenges, reward students for dedication and efficiency and offer a space for leaders to naturally emerge… Educational gameplay has proven to foster engagement in critical thinking, creative problem-solving and teamwork – skills that lead to solutions for complex social and environmental dilemmas (p.42).*

For simulation in medical studies, Okuda and colleagues (2009) reviewed more than 100 medical research papers on simulations to determine that medical simulations traditionally cover a "particular set of skills or the management of a particular condition and utilise short, isolated clinical scenarios or sometime disembodied part-task trainers" (Rogers et al., 2014, p. 2). This covers many core elements of being a doctor but is run in isolation of each other.

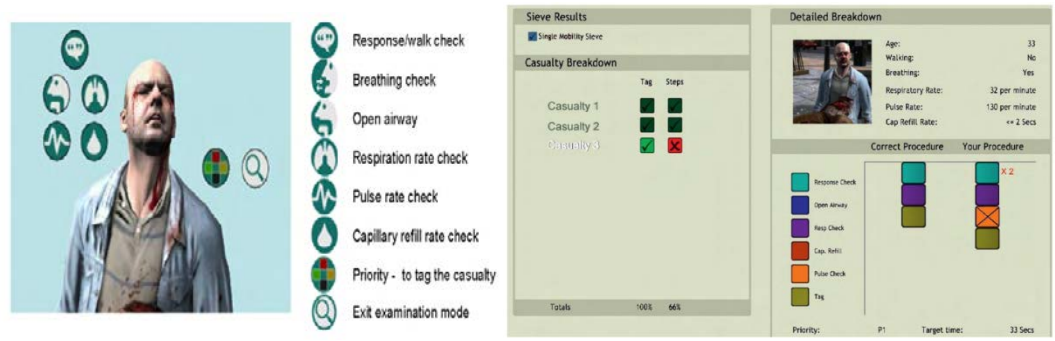

Figure 1:Triage Trainer – Two screens (Knight et al, 2010)

From another perspective of using gamification, Knight and colleagues (2010) found that a serious game *Triage Trainer* "demonstrated that serious gaming technology can be used to teach major incident triage, that it improves the accuracy of the triage process" (p. 1178). This game simulates a major incident where a bomb has exploded in a busy urban street and the player has to identify and assess a number of casualties (see left image in Figure 1) located around the scene. Players move through the game scene assessing casualties using a mouse. When all casualties have been prioritised, a summary of the results are shown (see right image in Figure 1). This simulation is a totally synthetic environment where players are motivated and engaged to complete the task. Due to the nature of the simulation scenario in this case study, and the investment required in setting up and running this scenario in a realistic physical format, there would not be many opportunities for students to participate in this type of experience. Therefore, synthetic simulations offer students the opportunity to participate in unusual scenarios that could not be simulated via the approach in this case. This area of serious gaming in health is increasing at a fast pace with over 432 games (including *Triage Trainer*) available on the *Centre for Digital Games Research* website (http://www.healthgamesresearch.org) (Note: this website is no longer being updated). There are many areas of health education that could benefit from the use of gamification.

A systematic review by Issenberg's group (2012) identified the features of gaming that best facilitate learning to include: providing feedback; curriculum immigration; capturing clinical variation; and providing a controlled environment. Extended live action simulation was developed to entail all of these features to prepare the third and fourth year graduate entry students to be better doctors.

Johannesson (2012) proposed an 'onion model' of layers showing the conditions for learning skills training though simulation. This model was developed for nursing but is applicable for medical students as well. The student is at the core with the condition for student learning including their motivation, confidence and the meaningfulness of learning. The next layer highlights what the student learns in the simulation from skills, how to perform, and professional behaviour. The next layer explains how the student learns by: preparing, watching, practicing, and reflecting. The next layer describes the conditions for learning starting with variation, realism, feedback and reflection.

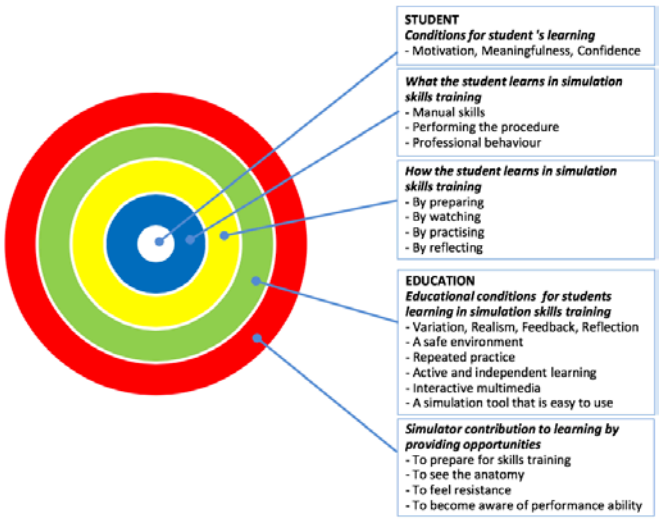

Figure 2: The "onion model" of layers showing conditions for learning (Johannesson, 2012)

It is essential that students are allowed to learn in a safe environment where they can repeat practices to improve skills and knowledge. The environment needs to allow for active and independent learning with interactive multimedia and a simulation tool that is easy to use. The final layer talks about the physicality of learning where students learn to prepare for learning, see the anatomy, feel the resistance of performing medical procedures, and become aware of their performance ability. At the core is the individual student where the outer layer describes the educational support that enhances the learning process. This model provides a useful view of the enablers that facilitate learning from simulations. As a weakness, Johannesson's model describes using multimedia to aid in delivering the simulation but multimedia is a limiting term when describing technology. As seen in the serious games work, perhaps a better way to describe this would be to use the term visual technologies, as this would accommodate multimedia through to serious games.

Moving forwards

Participant advice

The students advocated several key 'methods of success', that could be considered when thinking of using computer-based simulations:

New skill set - a new set of skills are required by lecturers to understand the affordances of computer-based simulation learning.

Automate - use technology to automate the experience so that all students experience the same scenario.

Assessment - build assessment into the computer-based simulation activity. Assessment should include many aspects of the computer-based simulation and

assess students on their work within the simulation scenario. Assessment should also include the affective experiences of the students. Experienced facilitators with suitable real life experience should make judgments about performance and use technology to capture the evidence for assessment.

Need a dedicated simulation space - a simulation environment that emulates real life practice to offer a more authentic learning experience.

Cost – consider the cost of setting up and then running the computer-based simulation.

Share simulation experiences - provide support to peers by sharing experiences. Publish research to build a knowledge base for computer-based simulations.

Institutions moving forward

- Institutions need to acknowledge that students need learning experiences that emulate their future workplaces; computer-based simulation can give students enhanced learning opportunities. Develop computer-based simulation scenarios that build in success and failure so that students get to experience the complexities of real life work environments. As in this case study, move students from failure to success to enhance the learning experience. Ensure students are supported through failure so there are no negative consequences. By developing physical and virtual computer based simulation learning spaces, students can feel safe to try without fear of the repercussions of failure.

- Institutions need to create spaces that allow lecturers and other students to discuss, negotiate, and collaborate to enhance the learning experience. Run the simulation experience over a designated time that incorporates on and off campus activities.

- Develop potential in staff to teach using computer-based simulation. Implement a professional development approach where lecturers share their computer-based simulation teaching and learning experiences with other staff. Acknowledge that lecturers may need to attend conferences, or other professional development, to learn and share how computer-based simulation can be successfully implemented in higher education, this sharing of knowledge needs to be captured and presented in multiple forms of knowledge from simple documents to video explanations that can be easily found and viewed on a range of devices. These materials need to be designed in a way that caters for multiple types of users.

Resources for exploring

The following simulation examples are available. This list is not comprehensive as gaming/simulations are evolving at a fast pace. This list is not an endorsement, as each

organisation needs to determine which site best meets their needs in terms of access requirements, cost and location.

SICKO	The Stanford University School of Medicine's SICKO is a web-based simulation game in which students manage three virtual patients simultaneously and must make critical decisions in the operating room. URL: go.nmc.org/sick
World Trade Game	Griffith University have developed a multiplayer online global trading game with a focus on economic and environmental impacts. URL: go.nmc.org/wtgame
SimSchool	Curtin University has developed a virtual environment and trainee teachers are able to interact with simulated students. URL: go.nmc.org/simschool
Online Business Simulations	Pedagogy, Assessment, Learning - 2013 OLT- Enhancing student learning outcomes with simulation-based pedagogies project with University of Queensland, Griffith University, La Trobe University, University of South Australia and the William Angliss Institute. URL: http://www.bizsims.edu.au

Guides, Cases and Readings

The following resources from the *NMC Horizon Report 2014 Higher Education Edition* (Johnson, Adams-Becker, Estrada and Freeman, 2014) are recommended to further explore how gaming or simulations can be used in higher education.

- The power of gamification in higher education (Tara E. Buck, EdTech Magazine, 18, October, 2013.
  URL: go.nmc.org/awesome
- Gamification of Tertiary Courses: An exploratory study of learning and engagement (Varina Paisley, 30th Ascilite Conference, December 2013)
- The role of gamification and game-based learning in authentic assessment (Lincoln C. Wood et al., 36th HERDSA Annual International Conference, July 2013)
  URL: go.nmc.org/herdsa

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