Chapter 7
Teaching with Simulation

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The role of simulation in medical education continues to expand. It is used across the spectrum of medical education, including in medical school curricula, residency education and fellowship programs, and can be used in all health care disciplines. Applying and integrating our working knowledge of pedagogy, medical education, and medical simulation is important to both the educational and patient care missions of medical schools. Used effectively, simulation provides an environment for experiential learning toward enhancing the learner's critical thinking, problem solving, and decision-making skills. It provides opportunities to assimilate the basic and clinical sciences and to apply that knowledge in realistic, yet low risk situations. It can also improve teamwork skills and reflection.

This chapter will present information on how simulation can be optimally used to enhance the teaching and learning experience in medical education curricula. Moreover, it will offer perspectives on how simulation can re-energize teaching and learning.

What Is Simulation?

This chapter will define simulation as "a training and feedback method in which learners practice tasks and processes in life-like [face-to-face] circumstances, with feedback from observers [and] peers. . .to assist improvement in skills"; it is an interactive approach to teaching and learning which provides experiences that reproduce real situations (Gaba, 2004, p. i2). Simulation offers opportunities to observe learners' performance in a realistic but risk-free, controlled environment.

What Are Medical Simulators?

A "simulator" is a device that represents "a simulated patient (or part of a patient) and interacts appropriately with the actions taken by the [learner]" (Gaba, 2004,

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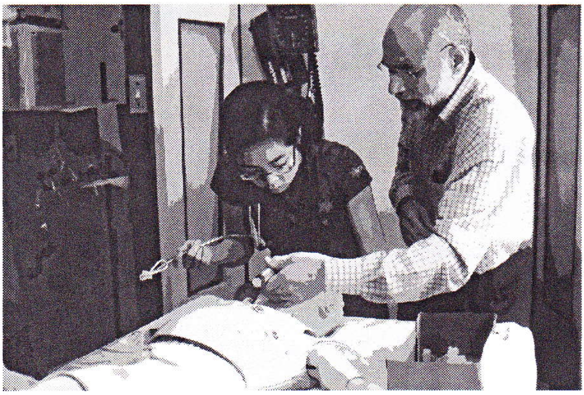


p. i2). Simulators vary from relatively simple multimedia, to various types of task trainers, to human patient simulators. Though medical simulation represents a range of technologies, the term "simulator" is generally used to refer to technologies that are used to imitate tasks. Simulators permit learners to practice procedures as often as required to reach proficiency without harm to a patient. A task trainer is a device that replicates limited aspects of a task. Though this chapter will not go into currently used simulation technologies that support teaching and learning in medical education, a snapshot of simulation technology is provided in Table 7.1 (Ziv et al., 2003, p. 784).

Table 7.1 Simulation tools and approaches used in simulation-based medical education

Tools or approach	Description
Low-tech simulators	Models or mannequins used to practice simple physical maneuvers or procedures
Simulated/standardized patients	Actors trained to role-play patients, for training and assessment of history taking physicals, and communication skills
Screens-based computer simulators	Programs to train and assess clinical knowledge and decision making, e.g., preoperative critical incident management, problem-based learning, physical diagnosis in cardiology, acute cardiology, acute cardiac life support
Complex task trainers	High-fidelity visual, audio, touch cues and actual tools that are integrated with computers. Virtual reality devices and simulators that replicate a clinical setting, e.g., ultrasound, bronchoscopy, cardiology, laparoscopic, surgery, arthroscopy, sigmoidoscopy, dentistry.
Realistic patient simulators	Computer-driven, full-length mannequins. Simulated anatomy and physiology that allow handling of complex and high risk settings, including team training and integration of multiple simulation devices.

Why Teach with Simulation: The Benefits

Learning is facilitated through experience (Kolb, 1984), and simulation has the potential to provide that experience and learning if used in keeping with basic principles of educational theory.

Simulation provides an effective vehicle for the integration of the basic and clinical sciences, and can be effectively used in curricula across the continuum of medical education and practice to make the curricular material come to life. Medical students cite critical thinking, as facilitated by experiential learning, as an important benefit of learning through simulation.

Simulation has been shown to improve the acquisition and retention of new knowledge compared with traditional lectures. Participants in the 2005 Millennium Conference on Medical Simulation agreed that "simulation offers a conducive environment for focused reflection and critical thought" (Huang et al., 2007, p. 88). The Conference report concluded that "medical simulation represents a powerful technique that has the potential to revolutionize medical education ... and to enhance current curriculum by integrating basic and complex concepts [through] reflective practice" (Huang et al., 2007, p. 93). It further reported that simulation should be used to enhance currently used methods of medical education. Gordon et al. (2001, p. 472), noted that students "felt that the [simulation] experience promoted critical thinking and active learning, and that it allowed them to build confidence and practice skills in a supportive environment." Those same students believed that the simulator helped them integrate basic and clinical sciences toward preparing for residency.

Key Principles for Teaching and Learning with Simulation

Teaching

As with any teaching effort, teaching with simulation needs to begin with an analysis of what the learners need instead of what the technology can offer. Curricula and use of simulation based on the level and needs of the learner is paramount toward helping learners build on prior knowledge and skills. When beginning to consider integrating simulation into any curricula, it is often helpful to talk with faculty development professionals and other faculty who are familiar with the use of simulation in medical education. It is helpful to collaboratively explore opportunities for utilizing simulation; advantages of using simulation; and challenges to its implementation. An appropriate educational approach would be to consider what you want to teach, and then to consider the most appropriate way in which to teach it and whether simulation will assist the learner in achieving the learning objective. As is always the case in teaching, it is essential to establish goals and learning objectives, to determine the teaching strategies for meeting those objectives, and to determine whether the teaching and learning will be enhanced by the use of simulation; if and in what way simulation will support the teaching and learning; how simulation will be integrated into the teaching; and how its effectiveness (i.e., achievement of goals and objectives) will be evaluated. All are fundamental elements for teaching with simulation.

For example, consider whether it will help the learners move beyond memorization, help them to apply the new knowledge, and then transfer the information learned to real-life situations. As with the use of any technology, simulation is only a tool for teaching, it is not the curriculum. Gaba (2004) noted that the use of simulation can be categorized by 11 dimensions. Seven of these must be considered when designing and implementing any simulation experience, and are key to the effectiveness of the experience:

1. purpose of the simulation
2. unit of participation (e.g., individual, group, team)
3. level of the learner
4. healthcare discipline
5. type of simulation technology
6. degree of participation in the simulation
7. method of feedback.

Learning

As noted earlier in this chapter, simulation offers the learner opportunities to become engaged in experiential learning. Experiential learning "involves reflective thought, and influences subsequent actions and personal development" (Dunn, 2004, p. 18).

As described by Kolb (1984) (Fig. 7.1) experiential learning consists of four related components: concrete experience, reflective observation, abstract conceptualization, and active experimentation.

Figure 7.2 illustrates an adaptation of Kolb's (1984) model of experiential learning by Dunn (2004, p. 17), which identifies five points in the experiential learning cycle.

Dunn adds a fifth point to the cycle, that of "planning for implementation" – examination of what will be done differently in the next implementation. Thus, in Dunn's model, the learner moves from a concrete experience (an event), to reflection (what happened), to abstract (what was learned), to planning for implementation (what will be done differently), to active experimentation (what is done differently), and back to the concrete experience, thus completing the experiential and feedback loops.

Teaching and learning with simulation can use both the cognitive and psychomotor domains. Students move from acquisition of knowledge to demonstrating their ability to synthesize the information, and apply it to simulated and patient-based psychomotor experiences. Experiential learning operates with the principle that "experience imprints knowledge more readily than didactic or online presentations alone" (Dunn, 2004, p. 17).

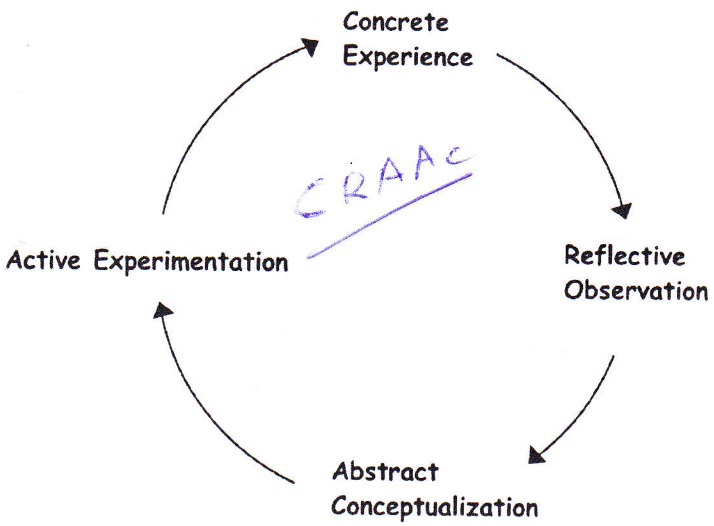


Fig. 7.1 Kolb's model of experiential learning (1984)

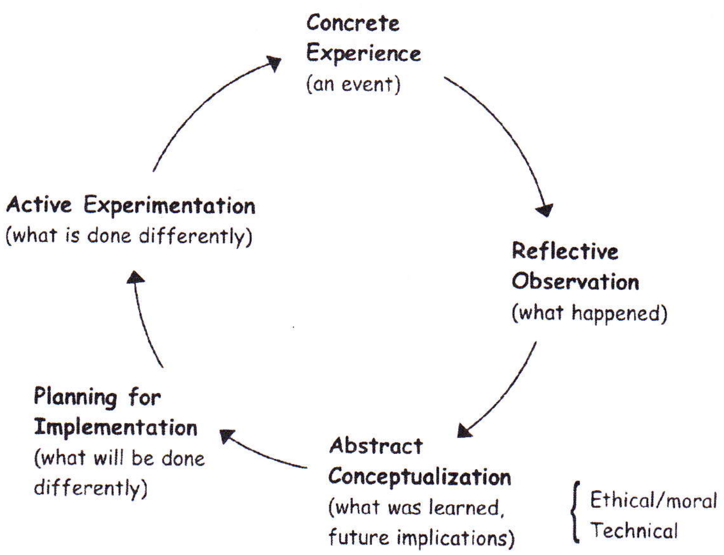


Fig. 7.2 Dunn's adapted model of experiential learning

Experiential learning offers the learner the opportunity to build knowledge and skills within the cognitive and psychomotor domains of learning. Bloom's (1956) hierarchy of learning in the cognitive domain has six levels of increasing difficulty or depth. Those six levels are:

1. knowledge
2. understanding (e.g., putting the knowledge into one's own words)
3. application (e.g., applying the knowledge)
4. analysis (e.g., calling upon relevant information)
5. synthesis (e.g., putting it all together to come up with a plan)
6. evaluation (e.g., comparing and evaluating plans).

Dave (1970) lists behaviors in the psychomotor domain, from the simplest to most complex:

1. imitation (e.g., patterning behavior after someone)
2. manipulation (e.g., performing actions with instructions)
3. precision (e.g., refining)
4. articulation (e.g., coordinating actions, achieving consistency)
5. naturalization (e.g., high level, natural performance)

Learning to apply previously acquired knowledge and skills to new contexts requires practice and feedback. Simulation provides teaching opportunities for integrating the basic and clinical sciences using problem solving and critical thinking, with the added benefit of facilitated reflection after the simulation experience, which, in simulation is referred to as debriefing. This will be addressed later in this chapter.

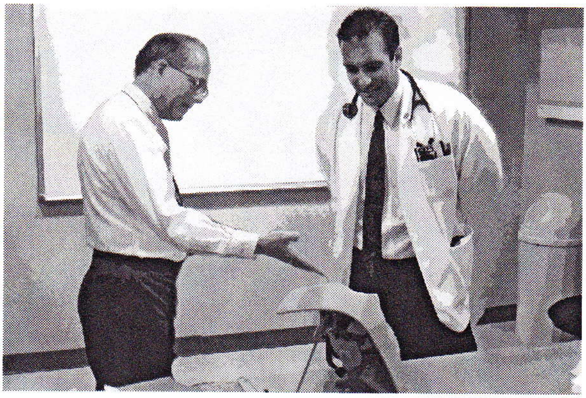
Building a Scenario

When building a scenario, it is important to keep the above detailed learning hierarchies in mind, and how they will be incorporated into the simulation scenario in order to optimally meet the needs of the learner. It will vary, depending on the stage of the learner. For example:

- Students learning facts and applying those facts to a new situation, such as might be the case in a foundational sciences curriculum in the early years of medical school.
- Residents learning a new procedure.
- Learners working on synthesizing information to develop a treatment plan, and evaluating that plan in light of other options.

In summary, one must be mindful of the level of the learner and the cognitive level the scenario is aimed at.

Simulation has the potential to bring life to teaching cases for learners at all levels of medical education. When developing a scenario, it is best to base the scenario on real cases and events, as they add robustness – as is true anytime one is teaching with cases. This is true whether developing a new scenario or adapting one for use in the simulation. It is important to design the scenario and develop teaching strategies



keeping the teaching goals and objectives at the forefront, so that confusing or non-pertinent content does not take away from the learning objectives. Additionally, it is important that every scenario have a clear take-home message, and includes an evaluation of learning.

Simulation technology can also be used in conjunction with standardized patients. Since many physical conditions cannot be replicated by standardized patients, simulation technology combined with the use of standardized patients is an approach for assessing learner performance and competence in some examination and other high-stakes testing situations. Integration of the two can also provide a more robust and realistic representation of clinical situations.

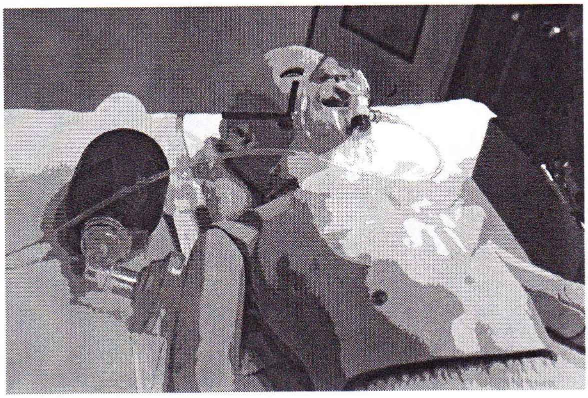
Components of an Effective Simulation Session

It is helpful to include four specific key components in every simulation session. Those components are: an introduction or briefing to the simulation session; the simulation itself; the debriefing; and an evaluation.

During the briefing, it is important that the faculty begin to create a climate of support and trust. It is also during this briefing component that the faculty share the purpose of the simulation, the basic elements involved, its goals and objectives, and what is involved in the debriefing process. It is also the time during which the ground rules for the simulation experience are set, as well as what is expected of the learners.

Key considerations for an effective simulation session include the following:

- select a limited number of educational points for each session
- take into account the level of learner and learning
- identify the resources needed
- prepare for the unexpected
- decide whether a co-facilitator for the debriefing is needed
- do a dry run prior to the actual simulation.



Debriefing and Fundamentals for Doing It Effectively

Debriefing is considered to be the essence of the simulation experience and is essential for the learning process. Debriefing occurs following the simulation and in a separate room from the simulation. The debriefing examines what happened (e.g., what was done well and what needs improvement), what was learned, and what will be done differently next time. It helps to identify and address gaps in knowledge; involves decisions about, and reflection on, the simulation, and often involves the viewing of a video recording of the simulation itself. Debriefing should be an interactive experience and beneficial to the learners, as well as the faculty.

When debriefing, it is important to keep in mind the goals and objectives of the simulation being debriefed; as well as the debriefing strategies. For example, will there be co-facilitators and what will their roles be? What will the strategy be for feedback and reflection? If video of the simulation was recorded, when and how will the video be used during the debriefing? The viewing of the video can be integrated into the debriefing in a few ways, but two frequently used methods are viewing the video prior to discussion and reflection, or viewing the video interspersed in the discussion and reflection for the purpose of emphasizing key learning points. Though review of video during the debriefing can allow learners to see what they actually did versus perception of what actually occurred, lengthy use of video can detract from the purpose and benefit of the debriefing component. The debriefing is facilitated by the faculty, but can also be co-facilitated by a learner whose role was observer of the simulation itself.

The established goals and learning objectives for the session are particularly key in helping the learner during the reflective aspect of debriefing. However, reflection on, and analysis of, an event is the foundation of experiential learning and within the process of experiential learning, debriefing is facilitated reflection. Reflective practice is a key factor in improving future practice.

To ensure an optimal debriefing experience for the learner(s), it is important that faculty conduct this component of the simulation keeping in mind the key elements of an effective debriefing, as well as those that detract from the debriefing process, as listed below (Dunn, 2004).

Elements of a successful debriefing:

1. create a friendly and confidential learning environment
2. provide pre-simulation expectations (e.g., simulator use and limitations, simulation principles, ground-rules)
3. encourage questions supportive of self-critique while fostering discussion
4. reinforce principles, correcting a limited number of errors
5. avoid excess correction, criticism
6. stress a key number of educational points
7. use visual aids, including the use of video, to review concepts or actions
8. avoid creating an excessively long debriefing.

Factors that detract from the debriefing process are as follows:

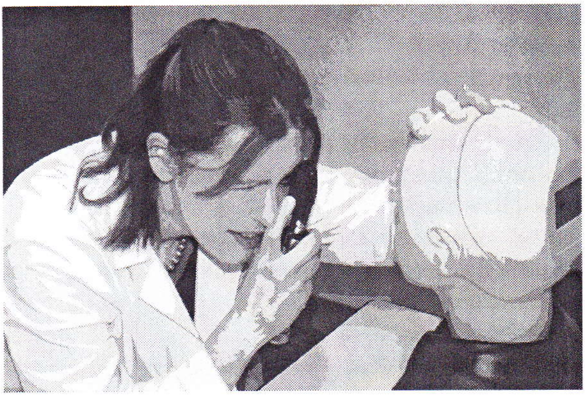
1. lack of an initial explanation of purpose, objective(s), orientation (e.g., of simulator)
2. excessive instruction discussion
3. closed questions and excessive criticism or negativism of learner's performance
4. consuming excessive time on medical issues
5. highlighting too many key teaching points
6. underestimation of trainee emotions
7. autocratic attitude of debriefer
8. allowing discussion to focus on the limitations of simulation.

The depth and length of debriefing needed in a simulation depends on factors such as the objectives of the simulation, the complexity, level of the learner, learner experience with simulation, time available, role of simulation in the curriculum, and relationship between the learners. It is particularly helpful when the debriefer critiques and challenges the learner while preserving a supportive, trusting relationship.

Faculty Development Considerations

Faculty development is an important component of any simulation program. Some basic skills needed include curriculum development (to include goals and objectives), teaching methods, scenario development, evaluation methods (including critical action checklists and other evaluation tools as needed), knowledge of simulation technologies, computer literacy, and debriefing.

Considering the importance of debriefing in teaching with simulation, as noted earlier in this chapter, it is critically important that faculty receive faculty development in debriefing methods and consider initially pairing with, or at least observing, an experienced facilitator.



It is vital to the success of the simulation program to make faculty development and on-going support on teaching with simulation available to faculty via face-to-face and online programs. Such an approach provides an efficient and effective way to continually enhance faculty involvement in teaching with simulation and incorporate their feedback toward revising programming efforts. Moreover, it can potentially satisfy risk management continuing education requirements of health care professionals.

Faculty development is key toward helping faculty think about innovative and effective ways of teaching with simulation, and furthering the integration of simulation technology and effective learning. Moreover, it will advance the effective use of simulation as an existing and emerging instructional technology tool, and advance the assessment of technology-mediated student learning outcomes.

Summary

It is hoped that readers will be challenged to identify opportunities and potential applications of simulation in their curricula in ways that support teaching and learning; recognize benefits of using simulation; and begin to overcome any challenges to sound educational implementation. Teaching with simulation holds the ability to effectively help learners integrate the basic and clinical sciences, apply and integrate medical knowledge in a real-time and safe learning environment, practice without risk, and expand inter-professional communication and cooperation among healthcare professionals and throughout the medical school community.

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Huang GC, Gordon JA, Schwartzstein RM (2007) Millennium Conference 2005 on Medical Simulation: A summary report. Simulation in Healthcare 2(2): 88–95.

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For Further Reading

Dunn WF (Ed.) (2004) Simulators in critical care and beyond. Society of Critical Care Medicine, Des Plaines, IL.

This text is a robust and valuable collection of a spectrum of information and resources for those seeking to learn more about simulation in healthcare. Information ranges from program development to skills development and beyond.

Fanning RM, Gaba DM (2007) The role of debriefing in simulation-based learning. Simulation in Healthcare 2(2): 118.

This article offers the reader a review of literature on debriefing in simulator-based learning, as well as lessons learned from experienced facilitators. Though a useful resource for anyone involved in facilitating the debriefing process, it is particularly useful for those interested in enhancing their skills in this area.

Huang GC, Gordon JA, Schwartzstein RM (2007) Millennium Conference 2005 on Medical Simulation: A summary report. Simulation in Healthcare 2(2): 88–95.

This article provides readers with results of a 2005 inventory on virtual patient simulation activities at U.S. and Canadian medical schools.

Gordon JA, Oriol NE, Cooper JB (2004) Bringing good teaching cases "to life": A simulator-based medical education service. Academic Medicine 79(1): 23–27.

This article describes the development of an undergraduate medical education simulator program, including curriculum development and integration, and is an informative resource for readers seeking information in that regard.