SimZones: An Organizational Innovation for Simulation Programs and Centers

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Abstract

The complexity and volume of simulation-based learning programs have increased dramatically over the last decade, presenting several major challenges for those who lead and manage simulation programs and centers. The authors present five major issues affecting the organization of simulation programs: (1) supporting both single- and double-loop learning experiences; (2) managing the training of simulation teaching faculty; (3) optimizing the participant mix, including individuals, professional groups, teams, and other role-players, to ensure learning; (4) balancing in situ, node-based, and center-based simulation delivery; and (5) organizing simulation research and measuring value. They then introduce the SimZones innovation, a system of organization for simulation-based learning, and explain how it can alleviate the problems associated with these five issues.

Simulations are divided into four zones (Zones 0–3). Zone 0 simulations include autofeedback exercises typically practiced by solitary learners, often using virtual simulation technology. Zone 1 simulations include hands-on instruction of foundational clinical skills. Zone 2 simulations include acute situational instruction, such as clinical mock codes. Zone 3 simulations involve authentic, native teams of participants and facilitate team and system development.

The authors also discuss the translation of debriefing methods from Zone 3 simulations to real patient care settings (Zone 4), and they illustrate how the SimZones approach can enable the development of longitudinal learning systems in both teaching and nonteaching hospitals. The SimZones approach was initially developed in the context of the Boston Children's Hospital Simulator Program, which the authors use to illustrate this innovation in action.

There has been tremendous growth in the use of medical simulation, as busy hospitals leverage simulation-based approaches to training clinicians and clinical teams.[1,2] Simulation-based training is commonly leveraged for the instruction and practice of basic[3,4] and complex[3,5] individual clinical skill sets, for the learning and refinement of team-based clinical care,[6,7] and increasingly for the improvement of general and crisis-related coordination[8–10] in health care teams. The diversity and volume of these purposes can create significant organizational issues and challenges for hospitals and simulation programs and centers.

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In this article, we present five major issues in the organization of simulation programs. We then introduce the SimZones innovation, a system of organization for simulation-based learning, and explain how SimZones can alleviate the problems associated with these five issues. Finally, we describe how SimZones can enable longitudinal simulation learning systems. The SimZones approach was initially developed and refined through practice and feedback in the context of the Boston Children's Hospital (BCH) Simulator Program. Today hospitals across four continents use this approach to organize their simulation programs. Here, we present SimZones as an approach that can benefit any hospital or simulation program, regardless of size.

Major Issues in the Organization of Simulation Programs and Centers

Several common but significant issues affect the organization of learning within simulation programs and centers. These include challenges associated with (1) supporting both single- and double-loop learning experiences with limited resources[11,12]; (2) managing the training of simulation teaching faculty[12–14]; (3) optimizing the participant mix and other necessary players to ensure learning[15–17]; (4) balancing in situ, node-based, and center-based simulation delivery[18,19]; and (5) organizing research and measuring return on investment and other tangible sources of value.[20]

Issue 1: Supporting both single- and double-loop learning experiences

Argyris[21] originally coined the terms "single-loop learning" and "double-loop learning" in his work as an organizational psychologist (see Figure 1). Single-loop learning describes the acquisition and mastery of known skill sets (e.g., bag mask ventilation, IV insertion). Learners correct developmental gaps by comparing their behavior with practice standards. In double-loop learning, learners (with skilled facilitation) attempt to "learn how the very way they go about defining and solving problems can be a source of problems in its own right."[21] For example, a team-focused simulation and (expertly facilitated) debrief may enable cardiologists and internists to uncover significant disparities, rooted in professional and experiential differences, in their perceptions of a patient's condition and the optimal interventions she or he needs.[22,23] Through this process, the team

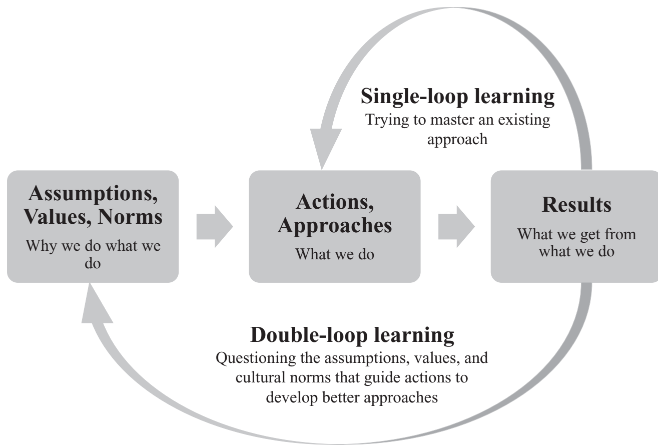

Figure 1 Differences between single- and double-loop learning processes. Model adapted from Argyris.[21]

can develop new understandings and practices that improve future efforts.

Codeveloping, with clinical partners, and delivering both single- and double-loop learning experiences presents challenges to simulation program leaders, as curricular approaches, technology, and staffing should vary across learning types. Table 1 illustrates the differences in simulation delivery requirements, approaches, and focus for single- versus double-loop learning. Single-loop learning involves skill acquisition and mastery, and it relies on the efficient transfer of knowledge from master instructors to less proficient learners. The technology (e.g., manikins, software) used in single-loop learning enables learners to perform simulated tasks that closely resemble reality. In contrast, double-loop learning is focused on the development of shared understanding within the team in preparation for creating new work approaches. Technology is employed to increase team member engagement by closely simulating real environments and patients. Unlike single-loop instructors, double-loop facilitators are trained in debriefing techniques to discover[24] and leverage these shared understandings to initiate positive change.

Structured debriefing after any simulation is a careful practice that should be guided by trained instructors and facilitators.[24–26] Debriefing approaches are numerous and should align with learners' needs and the goals of the simulation.[12] Many simulation-based courses have hybrid learning goals that require multiple debriefing approaches.

Issue 2: Managing the training of simulation teaching faculty

Simulation faculty may be full-time employees of a simulation program or drop-in teachers of particular courses. Broadly, this group delivers specialized courses to diverse learners, yet approaches to training faculty members often remain undifferentiated.[12–14] For example, faculty leading clinical skills workshops may engage in the same training as those facilitating complex team training and development experiences.

Issue 3: Optimizing participant mix to ensure learning

There are many options and constraints (e.g., limited funding, availability) in assembling participants and various simulation and debriefing role-players.[15–17] While certain participant mix choices can optimize learning, others may reinforce negative behaviors or limit learning (e.g., when portrayals conform to stigma or stereotype or when team training lacks real teams).

Issue 4: Balancing in situ, node-based, and center-based simulation delivery

Simulation can occur in actual clinical environments ("in situ"),[27] in dedicated spaces within a hospital ("sim nodes"), or in centers located outside a hospital.[18,19] Given this diversity of locales, simulation leaders must decide which simulations should occur in each environment (where there is choice) and which environments should be supported with limited funds.

Issue 5: Organizing simulation research and measuring value

A pressing question for simulation program leaders concerns how to best discover, describe, and document the various forms of value, using academic research or otherwise, that simulation provides to the hospital, practitioners, and directly to patients.[20] Clear understanding and documentation of this return on investment is needed to guide efforts and secure funding for growth.

SimZones: An Organizational Innovation

SimZones, a system for matching simulation development and delivery

Table 1
Differences in Supporting Single- and Double-Loop Learning Using Simulation

Simulation characteristic	Single-loop learning	Double-loop learning
Learning goal focus	(Clinical) skills acquisition	• Team and system development • Behavioral understanding, efficiency
Learning mechanism	Transferring procedural knowledge, approaches	Sharing assumptions, exploring root causes of team (dys)function
Examples	• Procedural skills workshops • Mock codes	• Crisis team training and development • Cross-specialty crisis training • Surgical team training and development
Faculty type	Instructor (master) of clinical or other domain	• Facilitator (developer) • Optional: Human factors specialist, individual/team/process change specialist
Debriefing perspective	Domain specialist	Change agent, insider/outsider, guide
Faculty development mechanism	Workshop on course direction, teaching procedural (clinical) skills through simulation	Workshop on course direction, facilitation to encourage positive individual and team development
Technology focus	• Haptic accuracy • Enables clinical skills practice, transfer to reality	• Enables gestalt of clinical moment • Enables authentic team-behavioral engagement

approaches to specific learning needs, offers simulation leaders an organizational solution to the five issues presented above. Figure 2 illustrates the SimZones framework that guides all course development and delivery at the BCH Simulator Program. The figure depicts the intentional packaging of features, resources, and approaches into distinct SimZones (Zones 0–3) along with a zone representing reality (Zone 4), with each zone prescribing optimal simulation design and delivery for a particular learning audience and goal(s). In the sections that follow, we detail how the zones differ in participants and learning goals, approaches to clinical and contextual complexity, fluidity of action, and debrief/feedback approaches. Finally, we explain how the zones address the five issues presented above by facilitating goal planning, resource allocation, curriculum development, location, and faculty development activities.

Of note, in the literature on communication transmission,[28] signal indicates the desired information, and noise indicates anything that inhibits recognition. Here, we use signal to indicate the key clinical information (e.g., more signal = more authentic, clinical complexity) and noise to indicate the degree of purposeful distraction in the simulation environment.

Zones 0–2: Simulation for Single-Loop Learning

Zone 0 simulations

Zone 0, or autofeedback, simulations currently represent only 6% of BCH Simulator Program courses (24 of 432 in 2015) (see Table 2) and typically involve the use of virtual reality training tools.

Participants and learning goals. Participants are typically individuals in need of deliberate practice with a skill set. Goals involve learning and practicing how to do something according to standard practice. An example of a Zone 0 learning objective is “Demonstrate proficiency with suturing and knot tying skills utilizing LapSim technology.”

Signal and noise. Zone 0 simulations have clear, focused clinical content and no noise (e.g., collegial interactions, competing clinical tasks or symptoms), which encourages a singular focus on specific skill mastery.

Action and debrief. An instructor is not present, so the learner interacts with an automatic-feedback training tool.

Zone 1 simulations

Zone 1 simulations, typically employed in the instruction of foundational clinical skill sets, represent 35% of BCH Simulator Program courses (152 of 432 in 2015) (see Table 2). These are instructor-led “how to” sessions.

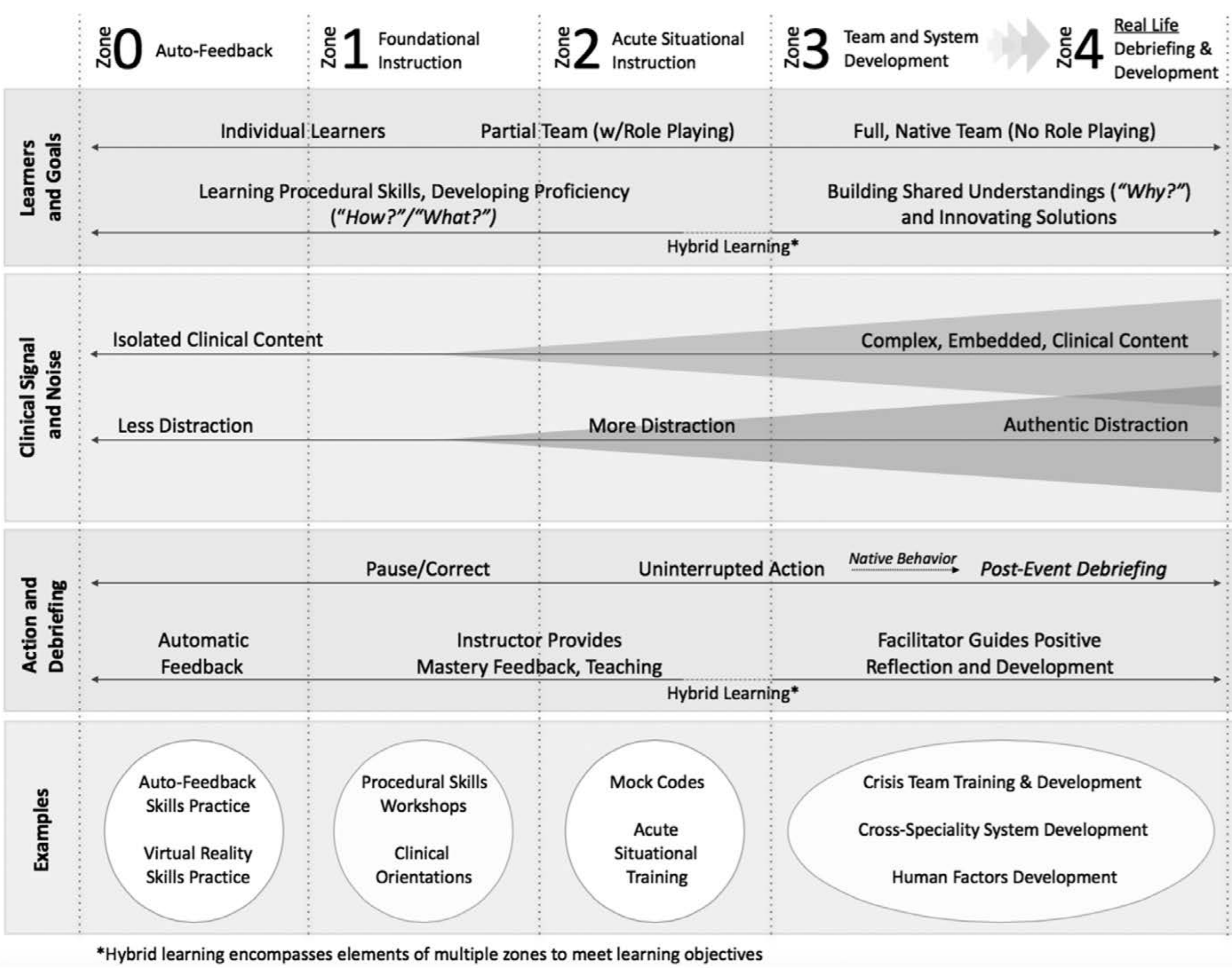

Figure 2 SimZones framework that guides all course development and delivery at the Boston Children’s Hospital Simulator Program, 2015–present.

Table 2

Examples of Simulation Courses Offered at the Boston Children's Hospital Simulator Program by Zone, 2015

Zone	Courses
0	Mimic da Vinci surgery system and LapSim training, Urology
	LapSim for postgraduate year 2 gynecology residents
	Medical student general surgical skills training
1	New graduate registered nurse orientation (skills training)
	Medical-surgical intensive care unit resident skills training
	Emergency department faculty skills training
2	Emergency department fellows medical mock codes
	Medical-surgical intensive care unit fellowship mock codes
	Neonatal intensive care unit acute situational training
3	Orthopedic surgery interprofessional team training
	Medical intensive care unit interprofessional crisis team training
	Cross-specialty crisis team training

Participants and learning goals. Typical participants in Zone 1 simulations are partial teams, trainee practitioners, and groups of specialized learners, including PAs, nurses, NPs, residents, and fellows from all medical and surgical specialties. Goals involve learning and practicing how, and occasionally what and when, to do something according to standard practice. An example of a Zone 1 learning objective is "To recognize the signs and symptoms of sepsis in the pediatric patient."

Signal and noise. There is a clear, focused clinical emphasis and little orchestrated distraction. Minor noise elements may include audible signals from equipment and interpersonal interactions.

Action and debrief. Zone 1 simulations can be organized into multiple scenario experiences or involve a single simulation and debrief (often in a one-hour format) for busy clinicians. Instructors explain what to do and when/how to do it, then use the pause principle to guide learning. As participants demonstrate greater skill, the instructor may allow for longer periods of uninterrupted action—this itself is a form of (positive) feedback for learners. In postsimulation debriefing, the instructor may use a plus-delta (+/Δ) approach, organized around what went well and what could be improved questioning, followed by directive feedback to guide development. Zone 1 simulations can be embedded into larger training programs (e.g., clinical orientations) and may involve rotating stations.

Zone 2 simulations

Often called mock codes and typically employed for acute situational instruction, Zone 2 simulations represent 31% of BCH Simulator Program courses (136 of 432 in 2015) (see Table 2). Although both Zone 1 and Zone 2 simulations promote the mastery of known skill sets, there is a logical progression for many learners from Zone 1 to Zone 2 experiences.

Participants and learning goals. Zone 2 simulations involve partial or full clinical teams of all skill levels (although most commonly groups of trainees). Learning goals involve contextualized clinical skill building. An example of a Zone 2 learning goal is "To utilize the septic shock protocol to manage and treat the pediatric patient in septic shock." There is often role-playing in Zone 2 simulations involving confederates (e.g., a nurse role-playing as a physician) who create the appropriate learning context.

Signal and noise. In Zone 2, there is greater complexity concerning what to do and when/how to do it. Zone 2 simulations have significant noise, including equipment, competing stimuli, and human interactions, and typically occur in real patient rooms or close simulations. Actors may be used to portray family members.

Action and debrief. Zone 2 simulations feature uninterrupted action. Participants should be engaged in a realistic fashion (e.g., called into a patient room) and then exposed to the simulation until the preplanned stimuli, (re)actions, and responses have played out to the instructors' satisfaction. Then "the curtain is lowered" and the entire group transitions to the debriefing (typically, plus-delta). At BCH, Zone 2 courses may be embedded in longitudinal learning programs (e.g., structured resident- or fellow-oriented development); clinical orientations; or multiple-scenario, multiple-debrief training experiences. Zone 2 training also can be offered in single-scenario, single-debrief formats. On-site simulation nodes or dedicated simulation spaces allow trainings to be offered with minimal disruption to clinical schedules.

Zone 3: Team-Based Simulation for Double-Loop Learning

Zone 3 simulations

Zone 3 simulations, employed for the purpose of team and system development, represent 28% of BCH Simulator Program courses (120 of 432 in 2015) (see Table 2). Zone 3 simulations are core curricular elements in the crisis management training of all clinical teams and some nonclinical teams.

Participants and learning goals. Zone 3 participants should be native, intact teams, rather than partial teams or groups of individual learners. There is generally no clinical role-playing in Zone 3 simulations. Learning goals promote (1) an understanding of the team's behavior and its causes and (2) positive change. An example of a Zone 3 learning goal, from a cross-specialty team training course in the BCH Cardiac Intensive Care Unit (CICU), is "To describe personal plans for improving communication and team coordination during Stat Calls in the CICU."

Signal and noise. Significant noise, including equipment difficulties and failures, human factors (including family/actors), and competing clinical indicators, may obscure the most pressing clinical signals in Zone 3.

Action and debrief. Zone 3 simulations run uninterrupted until "the curtain is lowered" by the facilitator and debriefing begins in a nearby room. Debriefing is guided by a trained facilitator and intended to provoke the discovery of the assumptions and values that guided the team's behavior.[21,24] Accordingly, Zone 3 simulations must elicit authentic behaviors as the "raw material" for the subsequent debriefing, which is carefully guided to encourage participants to reflect on the action and to share openly any explanations for their behavior. These explanations help the team understand, and eventually treat, the root causes of team-based performance issues. Of particular interest are the behaviors that appear incongruent, inefficient, ineffective, confusing, or otherwise notable and worthy of investigation. Finally, the facilitator directs the conversation toward discussion of the positive changes the team can make and to solutions to the identified issues. The principles of such revealing and productive conversations are well described in the literature.[12,25,26]

To meet the learning goals, Zone 3 simulations often involve multiple stages, two to three scenarios, changing locations (or approximations of such), and corresponding debriefings. For example, a surgical Zone 3 simulation may begin in the intensive care unit (Scenario 1) and then progress to the operating room (Scenario 2), where significant bleeding is encountered and managed (Scenario 3).

Using Zone 4 to Bridge Simulation and Real Patient Care

In the BCH Simulator Program, we use the concept of Zone 4 to refer to the debriefing and development associated with real patient care (i.e., not simulation). In several cases at BCH, the debriefing methods used in Zone 3 simulations are also used for team debriefings after real patient events (Zone 4). Likewise, real events become subject material for Zone 3 simulation scenarios, creating a perpetual system of timely, targeted development for the hospital.

Approaches to Hybrid Learning

Although courses typically fit in a single zone, course developers may want to address both single- and double-loop learning goals in a single experience. Our approach to such hybrid learning is to clearly divide debriefing activities into corresponding phases. There are three important steps to this process: (1) alerting learners to the upcoming two phases, (2) initiating a clear transition between phases, and (3) transitioning debriefing approaches (and facilitators, if needed) to shift the focus.

Occasionally, the nature of learning goals may require a laddering approach in a two-scenario course, where the first scenario is a Zone 1 simulation and the second is a Zone 2 simulation. This approach may be used when learners enter the simulation with skill awareness or proficiency but not mastery. We recently used laddering in a fire/evacuation simulation—the protocol was first learned and practiced with a pause-principle exercise (Zone 1), then it was performed in an uninterrupted fire drill (Zone 2).

How the SimZones Model Addresses the Five Major Issues

Issue 1: Zones support and differentiate multiple types of learning

The greatest complaint associated with learning through simulations relates to mismatches between learning needs and instructional approaches.[25] Experienced clinical instructors may offer advice during team training that inadvertently reinforces the traditional health care hierarchy. In contrast, a trained facilitator is skilled in the use of inquiry to explore assumptions and encourage the team to understand and move beyond traditional limitations. SimZones clearly differentiates between mastery and exploratory approaches. Within mastery approaches (Zones 1 and 2), SimZones also creates clear distinctions between hands-on instruction (Zone 1) and more empowering approaches better suited to advanced learners (Zone 2).

Issue 2: Zones guide the organization of simulation faculty training

We noticed that approximately two-thirds of simulation faculty at the BCH Simulator Program behave as instructors, promoting clinical skill acquisition and mastery (Zones 1 and 2). The remaining faculty work as facilitators, promoting team-based reflection and improvement in coordination and crisis response (Zone 3).

To match this reality, we developed two separate, zone-based, train-the-trainer courses. Because Zone 1 and Zone 2 simulations require a mastery-oriented, single-loop learning stance from instructors, a unique, single-day instructor training course was developed. An appropriately longer (three-day) course was developed for those faculty who planned to develop, direct, and facilitate Zone 3 simulations. The longer course focuses on human factors fundamentals and inquiry-based debriefing methods.

Issue 3: Zones create clarity around assembling participants

Decisions about how to recruit participants—and when and how to incorporate actors—are influenced by budget, time constraints, availability, and consideration of the learning objectives. SimZones can clarify such decisions. For the recruitment of participants, Zone 3 offers a simple formula—assemble the entire native team when possible. Team training with the intention of double-loop learning (i.e., Zone 3) revolves around the work of an authentic team. Otherwise, participants will have difficulty engaging in the authentic behaviors that are required to fuel productive reflection and planning for change. In both Zone 1 and Zone 2, the guidelines are less restrictive, in that role-playing can encourage progress toward the learning objectives. For example, emergency medicine fellows may practice acute clinical situations with their instructor acting as a bedside nurse. To complete the learning moment (e.g., mastering an algorithm), the absence of a genuine nurse may ease simulation scheduling challenges and allow the group to focus exclusively on one particular skill.

Although we typically do not employ actors to play clinician roles (and never in Zone 3 simulations), this practice can be used successfully when role behaviors are well defined. We caution clinicians who are playing other roles in Zone 1 and Zone 2 simulations to avoid reinforcing stereotypes and dysfunction. When hiring (or arranging for) actors to play parents, siblings, or patients, SimZones provides guidance around the required actor skill level, flexibility, and preparation to achieve the learning objectives. At a minimum, Zone 3 simulations demand that actors understand the background and behavioral range of their characters. Such actors then can keep up with the dynamic action of a Zone 3 simulation. Although skilled actors are generally preferred for parent/family/patient roles, less experienced actors can handle the reduced range required by most Zone 1 and Zone 2 simulations.

Issue 4: Zones clarify the conditions under which high-fidelity locations and resources are most valuable

The availability of sophisticated manikins and other technology has alerted many to the concept of high fidelity, in which fidelity represents how closely a simulated situation or aspect of the simulation (e.g., manikin, equipment, environment) resembles reality.[29] However, comparisons of learning outcomes do not always favor high-fidelity approaches.[30]

Table 3
Simulation Research Questions by Zone Informed by the SimZones Approach to Simulation Program Organization

Research topic area	Zones 0 and 1	Zone 2	Zone 3
Return on investment	What are specific financial benefits associated with fewer errors and reduced training times?		What are the financial benefits associated with team/system development?
Training reach/efficiency	How many clinicians/teams are trained and at what cost? Does simulation-based training reduce the time required to prepare providers?		
Clinical outcomes	Does simulation-based skills training reduce task-based medical errors?	Does mock code training improve the time to a differential diagnosis and intervention?	Does team training identify latent safety threats?
Cultural outcomes	Does cross-functional skills training decrease interprofessional gaps in understanding?	Does mock code training improve clinical confidence and job satisfaction?	Does team training improve psychological safety?

SimZones align to simulation fidelity in the following ways. In Zones 0 and 1, where skill acquisition is the focus, fidelity matters in the focused area of the task and not in the surrounding context. For example, a Zone 1 intubation course requires high-fidelity airway trainers and intubation equipment but not a realistic clinical environment. In Zone 2, where clinical performance in context is the focus, greater fidelity in contextual elements (e.g., beeping machines, parents, team member interactions) contributes to learning. In Zone 3, where double-loop learning and system (re)invention are the focus, high fidelity in equipment, in facilities, and in the simulated patient encourages authentic behavior in preparation for reflective learning.

Issue 5: Zones guide simulation research

Researchers recommend organizing a simulation research agenda according to Kirkpatrick's four levels of training evaluation—reaction, learning, behavior, results.[5] SimZones can further inform research planning and design. Clinical partners want to understand how Zone 1 clinical skills training impacts how quickly new trainees are prepared to provide care, how efficiently and broadly training is delivered, and how many lives (and dollars) are saved through the resulting improvements in skill-based competencies. For example, surgical residents can learn how to avoid cast saw burns during cast removal through simulation training.[31] Table 3 organizes simulation research questions by SimZone.

Supporting Longitudinal Simulation Learning Systems

Simulation centers, and the hospitals they serve, may appreciate tools for defining longitudinal, postgraduate, professional learning programs. Both teaching and other hospitals are interested in offering continuing education for their clinicians.

Teaching hospitals function as postgraduate medical programs, requiring clinicians to complete longitudinal curricula to advance to senior positions. The SimZones model serves an organizing function for those aspects of postgraduate medical education that can be addressed by simulation. For example, the following is a list of simulation curricula in a neonatal intensive care unit, with college-like course numbers that include the relevant department and zone: NICU.101–NICU Nursing Orientation (Zone 1), NICU.120–NICU Fellowship Bootcamp (Zone 1, 2), NICU.201–NICU Nursing Mock Code (Zone 2), NICU.202–NICU Fellowship Mock Code (Zone 2), and NICU.301–NICU High Reliability Crisis Team Training (Zone 3).

Other hospitals are also concerned with continuing education and could create similar developmental programs. For example, each department could have its own simulation learning progression, in which those acquiring new skills spend significant time in Zone 1, then transition to Zone 2 offerings to rehearse clinical skills in context. Finally, teams with solid clinical fundamentals come together for progressive training and development in Zone 3.

Limitations

Along with clear benefits, several potential limitations of the SimZones model have emerged throughout the program's development, including the possibility of mismatching zones with learners' needs and faculty members' teaching methods, issues with combining zones with novel curricula, and the need to learn the language in transitioning from previous simulation approaches. Our development of hybrid and laddered approaches, however, were flexible responses to combining zones in simulations and have been instrumental in enabling the successful adoption of SimZones at BCH and other organizations.

The Future of SimZones

As simulation becomes a universal preparatory tool for training responsible health care providers, those who direct simulation programs and centers will be faced with challenges related to the volume, growth, diversity, funding, and innovation of their organizations, all while having to support high-quality learning and patient care. The SimZones approach, already invaluable at the BCH Simulator Program and several of our international partners, is a powerful enabler of organization and quality for large and small simulation programs and the communities that they support. Using SimZones across simulation organizations will enable rapid, high-quality resource sharing and boost curricular innovation. However, entering into an increasingly Internet-based era of education, SimZones will require flexible development to accommodate dispersed teaching methods, technologies, teams, and organizations.

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