Medical Simulation:

Guided Observation versus Active Participation: Is There a Difference in Learning Outcomes?

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Abstract

Learning outcomes are the expected results of learners participating in any educational activity. Medical simulation is an educational technique that is increasingly utilized for the training of healthcare professionals to achieve these desired learning outcomes. Different simulation techniques include manikin-based team training, procedural skills training, use of standardized patients to facilitate teaching communication, and virtual reality trainers or screen-based simulation. The application of simulation has grown substantially over the years.

Simulation-based education has been shown to improve learning and patient outcomes. It may even be ‘cost-effective’ when considering the benefit to patient care. The use of simulation as an educational technique, however, requires dedicated space and facilitators and often requires sophisticated manikins, medical equipment, and recording and monitoring technologies. These requirements can serve as barriers to the implementation of simulation-based education. Therefore, simulation is likely underutilized in health profession education due to the financial constraints or limitations in the number of instructors.

Vicarious learning (learning by observing) could theoretically present an interesting alternative to active participation in simulation when resources are limited. The lack of evidence regarding observers’ learning outcomes (LO), especially in the context of case-based scenarios focused on team training, has perhaps led educators to underutilize this method of instruction. This study uses a prospective randomized control study of third-year medical students to explore the degree of learning of active participation in team-based simulation training to those who learned vicariously through guided observation and participation in the debriefing session.

Keywords

Medical simulation, education, case-based scenarios, participation, guided observation, vicarious learning, learning outcomes, crisis recourse management.

Résumé

Les résultats d'apprentissage sont les résultats attendus des apprenants qui participent à toute activité éducative. La simulation médicale est une technique éducative qui est de plus en plus utilisée pour la formation des professionnels de la santé afin de rencontrer les apprentissages attendus. Différentes simulations techniques inclues la formation d'équipe sur un mannequin, les habiletés procédurales de formation, l'utilisation de patients standardisés afin de faciliter l'enseignement des communications, ainsi que des formateurs en réalité virtuelle ou en simulation à l'écran. L'utilisation de la simulation a considérablement augmenté au cours des années.

L'utilisation de la simulation en éducation a démontré qu'elle améliorait l'apprentissage et les résultats des patients. Il peut même être « rentable » quand nous considérons la prestation des soins aux patients. L'utilisation de la simulation comme technique d'enseignement exige, cependant, un endroit dédié à celle-ci ainsi que des facilitateurs et nécessite souvent des mannequins sophistiqués, du matériel médical et de la technologie d'enregistrement et de surveillance. Ces exigences peuvent servir d'obstacles à la mise en œuvre à l'enseignement basée sur la simulation. Par conséquent, la simulation est probablement sous-utilisée dans l'enseignement des professions de la santé en raison des contraintes financières ou des limites dans le nombre d'instructeurs.

L'apprentissage indirect (apprentissage par observation) peut théoriquement présenter une alternative intéressante à une participation active en simulation lorsque les ressources sont limitées. Le manque de preuves concernant les résultats d'apprentissage des observateurs (RA), surtout dans les scénarios pour la formation en équipe, a peut-être conduit les formateurs à sous-utiliser cette méthode d'enseignement. Cette étude utilise une étude prospective randomisée contrôlée d'étudiants de troisième année en médecine afin d'explorer le degré d'apprentissage de la participation active dans la formation de la simulation en l'équipe par rapport à ceux qui ont appris indirectement à travers l'observation guidée et en participant à la séance de compte-rendu.

Mots-clés

Simulation médicale, éducation, scénarios basés sur des cas, participation, observation guidée, apprentissage indirect, résultats d'apprentissage, recours à gestion de crise.

Introduction

Learning outcomes are the expected results of learners participating in any educational activity. Medical simulation is an educational technique that is utilized increasingly often for the training of healthcare professionals that allows the learner to practice patient care away from the clinical bedside. According to McGaghie,

> In broad, simple terms, a simulation is a person, device, or set of conditions, which attempts to present [education and] evaluation problems authentically. The student or trainee is required to respond to the problems as he or she would under natural circumstances. Frequently the trainee receives performance feedback as if he or she were in the real situation. (1999, p. 9)

This controlled and safe environment allows for deliberate practice and self-reflection on the part of the learner (Gaba, 2004). The role of simulation as an educational technique has been demonstrated to improve learning (Cook et al., 2011) and patient outcomes (Cook, Brydges, Zendejas, Hamstra, & Hatala, 2013) and perhaps even to be cost-effective when considering the benefit to patient care (Cohen et al., 2010). Simulation-based instruction is resource intensive and may be costly; therefore, there are a limited (but growing) number of simulation centers in existence, thus restricting access to this form of instruction for learners (Kunkler, 2006).

During resuscitation-based scenarios, some simulation centers may divide learners into participants and observers, particularly when they have high learner-to-instructor ratios. The simulation cases or scenarios are run by the participant group (hands on), and the observer group watches from the outside, either through live-video feeds or through one-way mirrors and headsets to enable them to hear the conversation inside the room. Often the roles are reversed for subsequent scenarios so that participants become observers and observers become participants in an attempt to give them equal opportunities to participate. Bandura (1962) initially described learning behaviors by observing and explored this approach of observing or vicarious learning. In the context of this study, vicarious learning is referred to as an instructional method in which observers don't interact directly with the participants or the participants' instruction (PSLC, 2016). Observers may learn effectively as they actively participate in debriefing. This method of instruction has recently been studied and found potentially to be as effective as active participation with respect to learning outcomes (Stegmann, Pilz, Siebeck, & Fischer, 2012).

Eppich et al. (2015) define debriefing as an informal interactive discussion or conversation to reflect on a performance. During this period, learners and instructors meet after the event (case scenario) to discuss why or why not certain actions or decisions were made. It is believed that debriefing is the when the majority of learning from simulation-based scenarios occurs (Savoldelli et al., 2006). Lin and Cheng (2015) also recently published their current perspectives on the role of simulation and highlighted the powerful role debriefing plays, both on knowledge improvement and behavior performance. For an optimal learning experience, debriefing must follow simulation. Without it, simulation cannot guarantee improvement in performance or learning outcomes (Khan, Pattison, & Sherwood, 2011; Savoldelli et al., 2006; Welke et al., 2009). Debriefing offers the opportunity for analysis, discussion, and elaboration of why or why not specific actions were completed.

Self-efficacy, defined by Bandura (1995), is the belief in one's capabilities to organize and execute a course of action required to manage specific prospective situations. This definition differs from self-confidence, which is the more general belief in the person's likelihood to succeed (Pajares, 1996). Multiple studies have demonstrated that self-efficacy beliefs improve among medical trainees with training (Blok et al., 2004; Mason & Ellershaw, 2004; Katz, Feigenbaum, Pasternak, & Vinker, 2005). Turner and colleagues (2009) established that self-efficacy is a useful predictor of the application of learning in the pediatric resuscitation setting. Little is known about the self-efficacy of active and vicarious participants in simulation-based education. It is important to determine whether active participation results in greater self-efficacy, as such a result would support the importance of participation, even if objective measures of learning showed no difference between active participation and students' learning through vicarious methods.

Experiential learning, or learning through experience, has dominated the culture of medical education for a significant period, raising a safety concern for patients (Gordon et al., 2006), as learners or junior medical personnel perform their first procedure on real patients without previous practice in a simulated setting. Literature from the education psychology field indicates that information is easily recalled if taught under conditions that approximate reality or environments similar to those of the work place (Bransford, 1999).

In terms of the focus of the health care system – the patients – it is reported that approximately 10% of hospital admissions are associated with adverse events (Institute of Medicine Committee on Quality of Health Care, 2000). These events are not necessarily related to the patients' underlying medical condition (Gillon et al., 2012), but more significantly to issues related to poor communication, which can be improved by deliberate practice in controlled and safe settings.

Simulation is the imitation of a real-world process or system over time. It is a technique, not a tool, used to train and evaluate high-risk domains, such as medicine (Beaubien & Baker, 2003). If used and integrated into the healthcare system, it could improve patient safety and quality of care (Cook et al., 2011). The use of simulation can span the curriculum from the pre-clinical medical student to the continuing professional development (CPD) of physicians in practice, as participation in CPD courses has resulted in improved outcomes (Wenghofer et al., 2015). Simulation-based education can be optimized when considering all eleven dimensions that represent the diverse applications of simulation. These dimensions are the aims and purposes of the simulation activity; unit of participation; experience level of participants; health care domain; professional discipline of participants; type of knowledge, skill, attitudes, or behaviors addressed; the simulated patient's age; technology applicable or required; site of simulation; extent of direct participation; and method of feedback used (Gaba, 2004). Complementing other forms of medical education with medical simulation appears to have the potential to serve as a step towards a solution to patient safety and quality-of-care issues. A guide to effective learning from medical simulation was published as a Best Evidence Medical Education (BEME) systematic review and included the features of providing feedback, repetitive practice, curriculum integration, range of difficulty, multiple learning strategies, capturing clinical variation, controlled environment, individualized learning, defining the outcomes, and simulator validity (Issenberg, McGaghie, Petrusa, Lee Gordon, & Scalese, 2005). These features were taken into consideration in the cases we developed in order to optimize the educational experience. Feedback was provided during the debriefing, learners were given an additional opportunity to practice, the level of difficulty of the cases was adjusted to the knowledge and skill level of third-year medical students, and the setting involved a controlled environment.

Medical simulation, as described by Meller (1997), can be passive, active, or interactive. When passive, it only enhances the setting to approach realism, leading to ease of recall. Active simulation provokes a reaction from the learner. Interactive simulation, on the other hand, changes in response to a decision made by the learner (Issenberg et al., 2005; Meller, 1997). Depending on the level of learners and the objective of simulation, any level of

Bloom's Taxonomy "learning in action" can be used or applied (Figure 1).

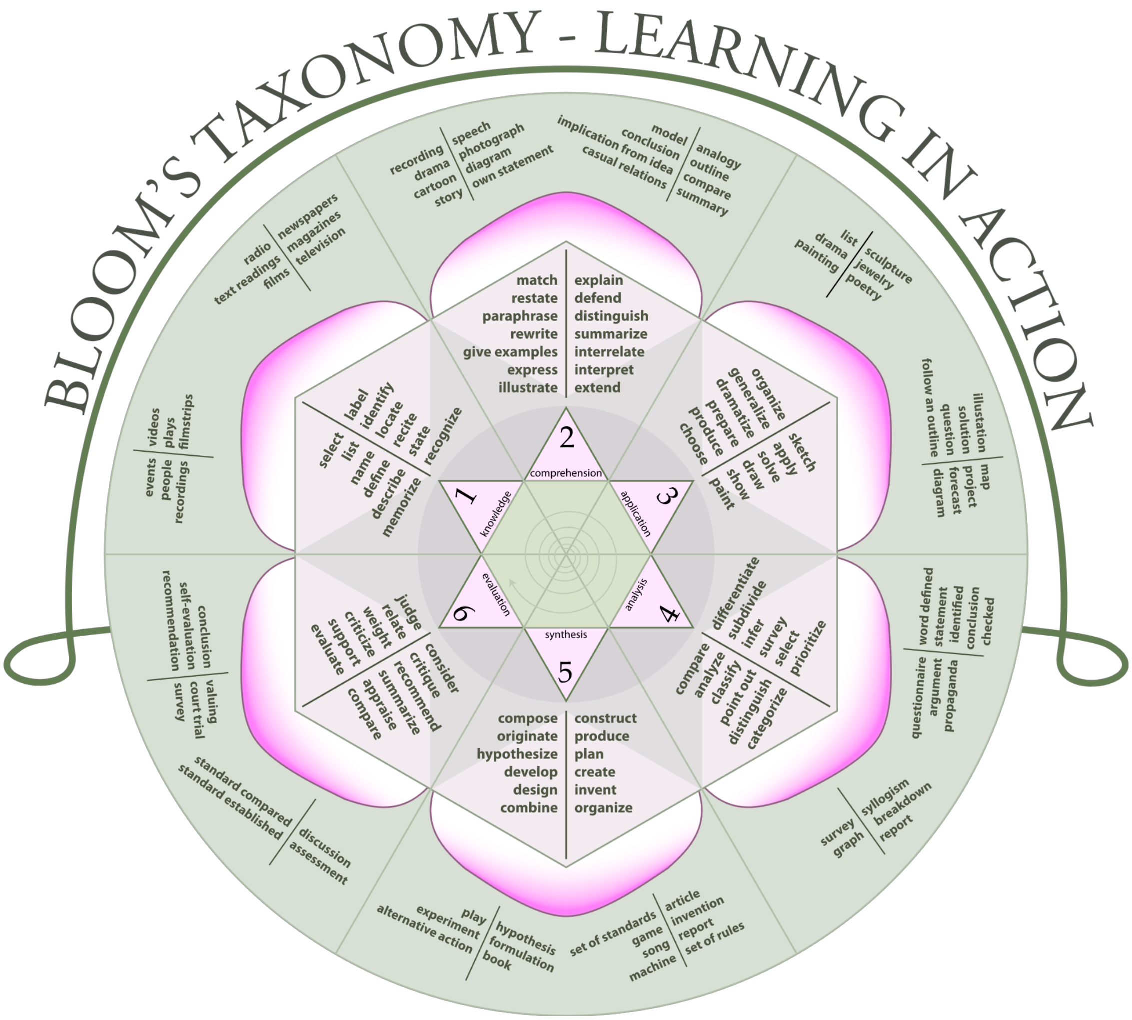

Figure 1. Bloom's Taxonomy. By K. Aainsqatsi (https://en.wikipedia.org/wiki/Bloom%27s_taxonomy#/media/File:Blooms_rose.svg).

Bloom's taxonomy is divided into three domains, which can be used to guide the creation of educational objectives and assessment methods. The three domains are the cognitive, affective, and psychomotor domains. Each domain is further divided into levels moving from the lowest to the highest. The lower the level, the more a traditional method of education may be warranted (list, define, and mention), and the higher the level, the more applicable it is to real-life situations (analyse, critique, and recommend) where simulation may have a greater role. Medical simulation has been used more frequently over the past few years, particularly based on an increased focus on patient safety and quality of care and on providing educational opportunities for health care learners (Issenberg et al., 2005). It has also been used recently to accelerate or replace clinical training and as a solution to the rising number of learners as well as the limited exposure to specific or rare clinical scenarios (Richardson, Goldsamt, Simmons, Gilmartin, & Jeffries, 2014; Singer et al., 2013).

Literature Review

Simulation appears to be a promising solution to the increasing demand for a safe, reliable educational environment that can facilitate a change in learning outcomes and performance, especially in technical skills and procedures. However, simulation-based education requires a large investment in high-fidelity manikins, medical equipment, monitoring devices, computers, audio-video recordings, and (perhaps most importantly) instructor time. The benefits of these aspects are hard to measure. Learning outcomes are a fairly easily obtainable immediate measure, but long-term benefits such as a persistent change in performance or a decrease in patients' adverse events are critical to seek. These are the outcomes stakeholders are most interested in, and research in this area should also include them. Given the limited (but growing) number of simulation centers in existence that therefore 'restrict' access to this form of instruction for learners (Kunkler, 2006), some simulation centers may divide learners into participants and observers, particularly when they have high learner-to-teacher ratios in order to maximize instructor time. These roles may be switched if multiple scenarios are run in an attempt to provide all participants an equal opportunities for learning. It is as if instructors assume that observers are not learning or are learning less, compared to participants. The literature search for this study did not uncover any studies comparing the learning outcomes of participants and observers in simulation-based education, making it an interesting area for further research.

Vicarious learning happens through one or any combination of three different components, observing an act (visual input), overhearing (auditory input) and observing a behavior or interaction (dialogue), or discussing the dialogue with others. Earlier studies suggested that the most important of these is the auditory component. Recent studies conclude that learning happens less during the monologues (visual or auditory inputs) and more during the dialogue (Chi, Roy, & Hausmann, 2008). Thus, if learning does occur by observing and the dialogue is the most important factor for learning, then the debriefing post-event may theoretically provide participants with similar learning outcomes as those of participation in the simulation. The literature for requirements regarding observation to guarantee or optimize the effect suggests that active observing is superior to passive observation (Chi et al., 2008). Thus, the students in the current study were provided with guided observation sheets in an attempt to maximize their learning outcomes. This would provide the learners with cues regarding what to look for while observing, instead of observing blindly without a clear objective, thereby allowing them to participate in the dialogue during the debriefing. Since most of the learning occurs during the debriefing, learning outcomes may approach those of active participants in the scenario.

Apprenticeship has been a method of teaching clinical skills for decades, but not as much, if any, for case-based scenarios or teaching of other human skills, such as communication, empathy, and professionalism (Lave & Wenger, 1991; Collins and Kapur, 2014). It would be interesting to witness students/residents shadowing an expert, to observe and learn those non-technical skills, and then to debrief the event to create a dialogue on how the activity went. Increasing the time spent in apprenticeships was suggested as a solution to face the demanding needs of training in combination with frequent high-fidelity medical simulation (Khan et al., 2011).

Purpose of the Study

The study seeks to determine whether there is a difference in learning outcomes between the different roles the learner could have in a team-based simulation activity (observer or participant) in an attempt to evaluate the current educational practice and perhaps optimize the use of simulation centre resources in the future.

Research Question

Guided Observation versus Active Participation: Is There a Difference in Learning Outcomes?

Hypothesis

The current research project aims to determine if there are differences in learning outcomes between the active participant and observer groups (both of whom will participate in debriefing) in simulation-based education.

Hypothesis 1: Active participation followed by debriefing will result in improved learning outcomes (objective measures and self-efficacy) compared to guided observation followed by debriefing.

This study will also evaluate whether the subgroup of team leaders differs from other active participants.

Hypothesis 2: Team leaders will demonstrate larger improvements in learning outcomes compared to other team members, as they are not only actively participating but also guiding and observing team members.

Methods

Participants

A convenience sample of 40 third-year medical students were approached during their pediatric rotation at the Montreal Children's Hospital (MCH) and invited to participate in the study. Participation was entirely voluntary. Recruitment occurred from March 2015 to April 2016. Third-year medical students were chosen for this study, as they are new to the clinical environment and are less likely to have had previous CRM training. No compensation was provided for participating.

Procedure

During the pediatric rotation at the MCH, third-year medical students were offered a two-hour Crisis Recourse Management (CRM) workshop. An explanation of the training program and the research project was provided in advance of the workshop by the principal investigator, who is not a teacher or evaluator of the students. Questions regarding the assigned pre-reading (sent one week prior to the workshop to all students who registered for the workshop and covering the medical content of the cases; i.e., pediatric resuscitation, not CRM content) were answered. The administrative assistant at the Simulation Centre, who had no supervisory role to the students, obtained written informed consent at the time of the CRM workshop.

After signing the informed consent form, the students completed the baseline demographic questionnaire and were randomly assigned by drawing a number from a bucket. Each number corresponded to the assignment of either participant or observer by a computer-based randomizer. All research participants (scenario participants and observers) completed a CRM error identification exercise using a 5-minute video with scripted errors portrayed by a medical team. This video with 12 CRM scripted errors was created by a group of experts. To confirm that no additional CRM errors existed in the video, 3 Master instructors in Pediatric Advanced Life Support (PALS) were asked to individually identify the errors, and then they compared their answers to what the authors had scripted. Previous research (Bank, Snell, & Bhanji, 2014) using this video demonstrated a significant change between the data collected before and after a CRM workshop (from 3/12 to 7/12) regarding the ability to detect CRM errors. After completing the video exercise scenario, participants were then actively involved in an objectives-based CRM case (hands on), and the observers watched the participant group with a "guided" worksheet through a live-video feed recording or through a window with an audio connection. After this 10-minute scenario, both groups were gathered together for a 20-minute debriefing session to review and discuss important learning points from the session. The discussion during the debriefing was focused mainly on the CRM issues the team faced, with little emphasis on the clinical issues. A second case followed, with the students in their same roles (Figure 2). In an attempt to standardize the process, one instructor taught all 6 sessions (40 students in total).

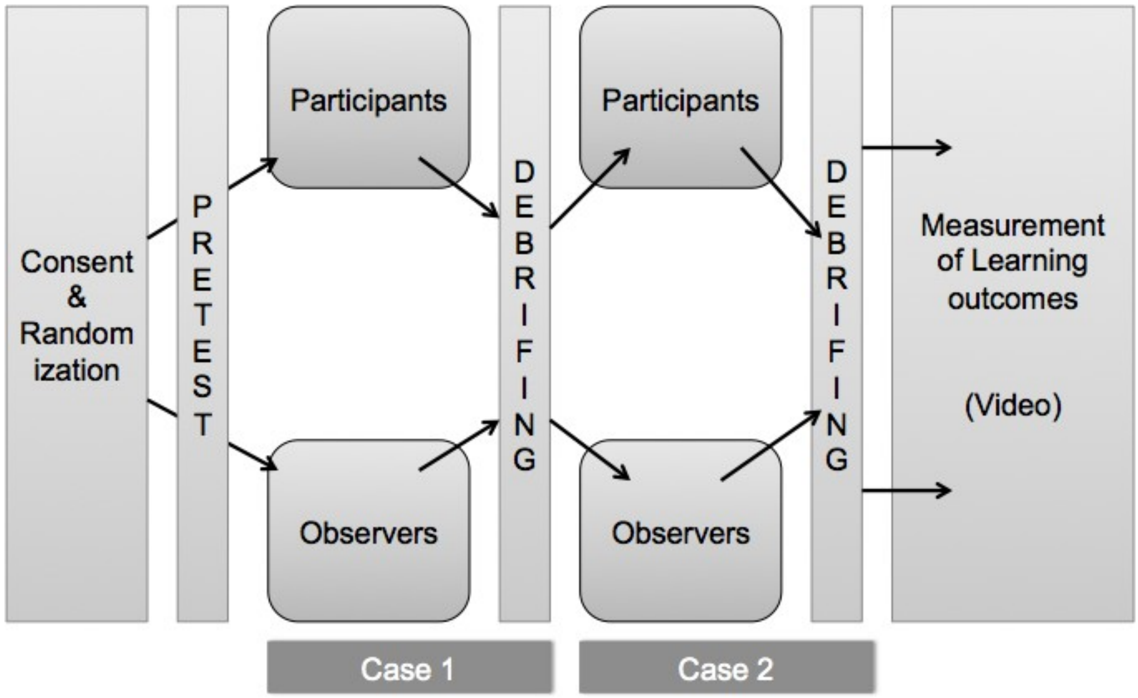

Figure 2. Thematic representation of the research procedure.

After the second debriefing session, all students repeated the CRM error identification exercise. This previously used assessment exercise demonstrated face/content validity based on a review by three research independent experts in pediatric resuscitation (Bank et al., 2014). The tool demonstrated an improvement in its scores with training, implying that it measures the construct of interest. A formal review of the tool using more modern validity frameworks (Hatala, Cook, Brydges, & Hawkins, 2015) was unfortunately beyond the scope of this particular study.

In addition to the objective test, this study applied a retrospective pre-/post- (RPP) survey using a 5-point Likert scale to evaluate the learners' perception of their understanding of CRM, team leader (TL) role, and team member (TM) role. The RPP was felt to be preferable to the traditional pre/post format in this context, as it eliminates the response-shift bias and it limits sensitizing the learners to the topic prior to the experience - in addition to its ease of development and use, as it is completed at one point in time (Bhanji, Gottesman, de Grave, Steinert, & Winer, 2012).

There was also a post-test questionnaire assessing the students' self-efficacy in CRM skills based on a validated self-efficacy tool specifically designed for CRM (Plant, van Schaik, Sliwka, Boscardin, & O'Sullivan, 2011).

Analysis

The distributions of all variables considered in the study were compared in the participant, observer, and leader groups in order to ascertain whether the randomization was successful. For continuous variables, a one-way analysis of variance (ANOVA) was performed, with each variable as the outcome of a single ANOVA test. For categorical variables, a chi-squared test for independence was performed between each variable and the participation group variable. A significant p-value indicates imbalance of a variable between the different participation groups.

Next, the post-workshop scores were compared using the Mann-Whitney test, during which observers were compared to participants/leaders (grouped into a single category). Descriptive statistics of each of the score types were also calculated in these two categories.

A chi-squared test of independence was used to check whether a subject's preferred role happened to be the role that he/she received.

Finally, another set of Mann-Whitney tests was used to test the differences in self-efficacy measures between the observer and participant/leader groups. The Mann-Whitney test was also used to compare the same self-efficacy scores between participants and leaders.

All statistical analyses were performed using the R programming language using the packages “CreateTableOne” and “xtable”.

Human Subjects Ethics Approval

Ethics approval was granted by the Faculty of Medical Institutional Review Board at McGill University, Study # A03-E24-13B. Participation in the study was voluntary. There were no foreseeable harms or risks to participation and participants. Data collected during this simulation session was anonymous and was not used for grading or assessing the students in any manner. Written informed consent was obtained from all participants prior to the workshop.

Results

A comparison of the distributions of baseline variables from the different experimental groups was conducted. Table 1 shows these differences. Inspection shows that these baseline characteristics were equally distributed between the two groups (participants/leaders and observers), indicating that the randomization of the experimental groups was successful. The table also demonstrates the pre-course measures, both objective (video score pre) and subjective (self recording of their understanding of CRM, TL, and TM roles).

		Participants	Observers	Leaders
N		14	20	6
Age (mean (sd))		24.21 (2.91)	26.20 (4.27)	26.83 (3.97)
Sex (%)	Male	3 (21.4)	9 (45.0)	2 (33.3)
	Female	11 (78.6)	11 (55.0)	4 (66.7)
Prev. life support course (%)	Yes	14 (100.0)	20 (100.0)	6 (100.0)
Courses taken (%)	ACLS	14 (100.0)	18 (90.0)	5 (83.3)
	ACLS+ATLS	0 (0.0)	2 (10.0)	1 (16.7)
Time since last course (%)	3-6 mo	5 (35.7)	8 (40.0)	3 (50.0)
	6-12 mo	9 (64.3)	12 (60.0)	3 (50.0)
Prev. CRM course (%)	Yes	1 (7.1)	4 (20.0)	0 (0.0)
	No	13 (92.9)	16 (80.0)	6 (100.0)
Motivation to learn CRM (%)	Not at all	0 (0.0)	1 (5.0)	0 (0.0)
	Slightly	1 (7.1)	1 (5.0)	1 (16.7)
	Moderately	4 (28.6)	6 (30.0)	3 (50.0)
	Very	7 (50.0)	11 (55.0)	2 (33.3)
	Extremely	2 (14.3)	1 (5.0)	0 (0.0)
Score pre (mean (sd))		2.64 (1.91)	2.60 (1.39)	2.17 (1.47)
CRM understanding pre (mean (sd))		2.21 (0.58)	2.65 (0.75)	2.17 (1.17)
TL understanding pre (mean (sd))		3.50 (0.94)	3.15 (0.93)	3.67 (0.82)
TM understanding pre (mean (sd))		3.21 (1.12)	3.35 (0.93)	3.83 (0.75)

Table 1. Summary of baseline variables in the three experimental groups.

Next, the clinical rotations that individuals have already completed in addition to plans for residency were examined. Table 2 demonstrates the completed rotations and residency plans for individuals in the three experimental groups. Once again, a balance is evident between the groups.

Rotation	Completed	Participants	Observers	Leaders	p
N		14	20	6	
Anesthesia (%)	Yes	6 (42.9)	8 (40.0)	3 (50.0)	0.909
	No	8 (57.1)	12 (60.0)	3 (50.0)	
IC (%)	Yes	1 (7.1)	0 (0.0)	0 (0.0)	0.386
	No	13 (92.9)	20 (100.0)	6 (100.0)	
Family med (%)	Yes	14 (100.0)	20 (100.0)	6 (100.0)	
	No	0 (0.0)	0 (0.0)	0 (0.0)	
Ped subspecialty (%)	Yes	10 (71.4)	9 (45.0)	4 (66.7)	0.273
	No	4 (28.6)	11 (55.0)	2 (33.3)	
Med subspecialty (%)	Yes	13 (92.9)	20 (100.0)	6 (100.0)	0.386
	No	1 (7.1)	0 (0.0)	0 (0.0)	
Surg subspecialty (%)	Yes	12 (85.7)	20 (100.0)	6 (100.0)	0.142
	No	2 (14.3)	0 (0.0)	0 (0.0)	
OBGYN (%)	Yes	7 (50.0)	10 (50.0)	3 (50.0)	1.000
	No	7 (50.0)	10 (50.0)	3 (50.0)	
Psychiatry (%)	Yes	14 (100.0)	20 (100.0)	6 (100.0)	
	No	0 (0.0)	0 (0.0)	0 (0.0)	
Other (%)	Yes	1 (7.1)	2 (10.0)	0 (0.0)	0.716
	No	13 (92.9)	18 (90.0)	6 (100.0)	
Residency	**Planned**	**Participants**	**Observers**	**Leaders**	p
Emergency Med (%)	Yes	1 (7.1)	2 (10.0)	1 (16.7)	0.809
	No	13 (92.9)	18 (90.0)	5 (83.3)	
Anesthesia (%)	Yes	2 (14.3)	1 (5.0)	0 (0.0)	0.450
	No	12 (85.7)	19 (95.0)	6 (100.0)	
IC (%)	Yes	3 (21.4)	2 (10.0)	0 (0.0)	0.369
	No	11 (78.6)	18 (90.0)	6 (100.0)	
Family med (%)	Yes	3 (21.4)	10 (50.0)	4 (66.7)	0.109
	No	11 (78.6)	10 (50.0)	2 (33.3)	
Ped subspecialty (%)	Yes	3 (21.4)	5 (25.0)	1 (16.7)	0.906
	No	11 (78.6)	15 (75.0)	5 (83.3)	
Med subspecialty (%)	Yes	4 (28.6)	11 (55.0)	2 (33.3)	0.273
	No	10 (71.4)	9 (45.0)	4 (66.7)	
Surg subspecialty (%)	Yes	2 (14.3)	3 (15.0)	1 (16.7)	0.991
	No	12 (85.7)	17 (85.0)	5 (83.3)	
OBGYN (%)	Yes	0 (0.0)	2 (10.0)	1 (16.7)	0.360
	No	14 (100.0)	18 (90.0)	5 (83.3)	
Psychiatry (%)	Yes	2 (14.3)	4 (20.0)	1 (16.7)	0.910
	No	12 (85.7)	16 (80.0)	5 (83.3)	
Unsure (%)	Yes	4 (28.6)	1 (5.0)	0 (0.0)	0.075
	No	10 (71.4)	19 (95.0)	6 (100.0)	
Other (%)	Yes	0 (0.0)	3 (15.0)	1 (16.7)	0.300
	No	14 (100.0)	17 (85.0)	5 (83.3)	

Table 2. Summary of clinical rotations completed and future residency plans.

After completing the CRM workshop, four post-workshop measures were examined: video score (objective), CRM understanding, TL understanding, and TM understanding (subjective). Table 3 presents the summary statistics and results from a Mann-Whitney test comparing the observers and the participants/leaders. Table 4 shows the same results but compares the participants with the leaders. Again, these comparisons did not show any significant differences between the groups being considered for these four post-workshop measures.

Measure	Group	Mean	Median	SD	Test-stat/p-val
Score	Observers	5.25	5.50	1.68	234/0.35
	Participants/Leaders	4.80	5.00	1.47	
CRM	Observers	3.90	4.00	0.64	194/0.86
	Participants/Leaders	3.90	4.00	0.72	
TL	Observers	4.25	4.00	0.72	179.5/0.55
	Participants/Leaders	4.40	4.00	0.60	
TM	Observers	4.40	4.00	0.60	213.5/0.68
	Participants/Leaders	4.35	4.00	0.49	

Table 3. Summary statistics for the post-workshop measures comparing observers to participants/leaders. Significance was determined via the Mann-Whitney test.

Measure	Group	Mean	Median	SD	Test-stat/p-val
Score	Participants	4.71	4.50	1.64	34.5/.55
	Leaders	5.00	5.00	1.10	
CRM	Participants	3.86	4.00	0.77	39/0.81
	Leaders	4.00	4.00	0.63	
TL	Participants	4.36	4.00	0.63	37.5/0.71
	Leaders	4.50	4.50	0.55	
TM	Participants	4.29	4.00	0.47	33/0.40
	Leaders	4.50	4.50	0.55	

Table 4. Summary statistics for the post-workshop measures comparing participants to leaders.

Significance was determined via the Mann-Whitney test.

This study also evaluated the number of individuals in each category who stated a preference for being in either the observer or participant/leader group. It is clear that individuals tended to develop a preference for the group to which they were assigned. A chi-square test for independence was performed and suggested a relationship between these two variables. The results can be seen in Table 5.

	Prefer Observer	Prefer Participant/Leader
Observers	14	6
Participants/Leaders	2	18

Table 5. Counts of individuals preferring to be observers or participants/leaders against what was assigned. Chi-square test for independence =12.604, p –value < 0.001

Finally, the results of the post-workshop self-efficacy measures are presented. The Mann-Whitney test was performed to test for differences in answers between groups. Table 6 shows the results from the Mann-Whitney test for comparisons both between the observers and participants/leaders and between the participants and leaders. Most of these variables did not differ significantly between the tested groups. The one exception is Question 1(c): “In dealing with sick children, I am confident in my ability to plan how to handle such events." This difference was observed in the participants-to-leaders comparison, with the leaders scoring higher. It should be noted that, if an adjustment for multiple comparisons were made, this variable would no longer be considered significant.

Question	MW stat	p-value	MW stat (P vs. L)	p-value (P vs. L)
1(a) Recog clincial deterioration	180.000	0.514	33.500	0.414
1(b) Anticipate events	189.000	0.757	27.000	0.186
1(c) Plan handle	198.500	0.977	18.500	0.039
2(a) Gather info	149.000	0.090	39.000	0.798
2(b) Access resources	191.000	0.753	41.500	1.000
2(c) Take charge	163.500	0.300	24.000	0.124
3(a) Make decisions	128.500	0.043	20.000	0.054
3(b) Big picture	189.500	0.770	31.000	0.337
3(c) Identify interventions	180.000	0.561	45.000	0.813
3(d) Decide interventions	166.000	0.320	26.000	0.146
3(e) Prioritize interventions	171.500	0.594	39.500	0.860
3(f) Reevaluate situation	205.000	0.897	33.000	0.451
3(g) Delgate tasks	173.500	0.397	50.000	0.444
3(h) Coordinate team	177.500	0.509	27.000	0.183
3(i) Identify skills	194.000	0.866	38.500	0.778
3(j) Instruct/correct team	180.500	0.588	33.000	0.459
3(k) Communicate plan	227.000	0.406	38.500	0.778
3(l) Ensure taken place	185.500	0.655	42.000	1.000
3(m) Provide reassurance	187.000	0.699	36.500	0.639
3(n) Create calm atmosphere	213.000	0.715	43.000	0.964

Table 6. Results from performing the Mann-Whitney test to compare post-workshop self-efficacy measures. The first two columns show the test statistic and p-value for the observers vs. participants/leaders comparison, and the second two columns show these values for the leaders' vs. participants' comparison.

Discussion

The results demonstrate no statistically significant difference between participation and active observation with regard to students' learning outcomes (ability to identify CRM scripted errors) in a simulation-based education learning activity. Reproduction of the results of this pilot study in future studies could help optimize the use of simulation centers. All learners do not necessarily need to be actively involved, and educators can feel comfortable that the observers are also learning. This may help to optimize instructor time and allow a variety of cases and scenarios to be conducted in a limited time (as opposed to running cases multiple times with different groups of learners).

A convenience sample of 40 students was used.

In the baseline data, information on previous life support courses was collected (in which CRM concepts are sometimes taught), and the study sought explicitly to determine if they had attended any additional CRM courses. All 40 students were Advanced Cardiac Life Support (ACLS) certified with the majority earning this certification more than six months ago. Five out of the 40 students indicated that they received CRM training, but when they were asked to elaborate, they mentioned that it was part of their ACLS course. The rotations completed and future residency training interest were observed, assuming that certain specialties require particular CRM skills, and although it was early in their training, the students could have been more oriented or exposed to CRM. All baseline data was well balanced between groups, indicating adequate randomization.

Learning outcomes were measured in two ways: first, the study analyzed the objective ability to identify CRM errors on a scripted video that has been previously utilized in research (Bank et al., 2014). The second was a subjective score using a RPP on a subjective 5-point Likert scale to detect students' perceived improvement in understanding of CRM, TL, and TM roles. The RPP was selected over the traditional pre/post (TPP), as it has the following advantages: it counteracts the response shift bias, learners are not sensitized to the topic with a pre-training questionnaire which may negatively affect learning, and it is completed at one point in time after the objectives of the simulation have been experienced (Bhanji et al., 2012).

There was no significant difference in learning outcome between participants and observers. The subgroup analysis between types of participation (participant vs. TL) again showed no significant difference in LO. Retrospectively (post workshop), each student was asked their preferred method of participation when involved in such learning experiences;

perhaps surprisingly, observers didn't express the feeling that they had missed a learning opportunity. A chi-square test for independence was performed, and the results suggested a relationship between these two variables.

In addition to the objective learning outcomes, a self-efficacy measure was included. The issue with self-efficacy scales is that they have to be very specific and tailored to a particular task for a better predictive value and less ambiguity. Items must be phrased in a way that emphasizes capability and not intention (*can* is preferred over *will*). If measured appropriately, self-efficacy was found to be a major determinant of intention (Bandura, 2006). A recently published article containing a self-efficacy instrument designed and validated for CRM skills was utilized (Plant et al., 2011).

There are different forms of debriefing; e.g., team-led and instructor-led, with or without video assistance, and using a variety of debriefing techniques. There appears to be no significant difference between approaches as long as debriefing does occur and it is objective oriented (Beaubien & Baker, 2003) (Savoldelli et al., 2006). Comparing different forms of feedback/debriefing, it was found that post-event/simulation debriefing pertains most to mastery learning goals (Eppich, Hunt, Duval-Arnould, Siddall, & Cheng, 2015). Since the examined learners were fairly inexperienced, an instructor-led debriefing with video assistance was used to provide them concrete examples of expert performance and to close the gap between desired and actual performance.

Limitations

This study was conducted among students at McGill University who volunteered to be part of the CRM training and study. As such, they may reflect a select group whose members have an interest in resuscitation and are motivated to learn maximally from the experience. The results from this group may not be generalizable to the wider student population.

Our learning outcome is the students' ability to identify errors, not their ability to perform effectively as a team leader or member. Participants were also tested immediately, so retention of information and long-term learning remain unclear. Additionally, the validity evidence for the video review tool used in the study is limited. Further studies may be needed before results can be widely accepted.

Relevance

This study demonstrates equivalent learning for active participants and guided observers in simulated CRM scenarios. If reproduced, these findings may justify a reduction in the simulation time with more learners engaged vicariously in the scenario and actively in the debrief. Educators can feel comfortable that the guided observers are also learning.

Conclusions

The results of this study indicate that there is no significant difference in learning outcomes between participants and guided observers or in self-efficacy measures as a potential indicator of future capability. The sample size of this study is small, and future studies are required to explore this concept further. If it is confirmed that observers learn as much as participants when observing case-based scenarios, it possibly opens a door for a new teaching strategy—apprenticeship for non-technical skills.

Future Research Directives

Our study explores a fairly new concept in simulation-based education; therefore, future study should approach learning outcomes that include performance on a larger scale in the context of different settings. Perhaps broader results can lead to the creation of generalizations with regard to guided observation.

GUIDED OBSERVATION VERSUS ACTIVE PARTICIPATION

Apprenticeship as a teaching method for non-technical skills is a very interesting field to explore, with regard to both exports and learners.

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Appendix A

Pre/Post Questionnaire

Project to evaluate the current practice of teaching CRM Skills
Pre-Workshop Questionnaire
Study #:
Date:

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1. Age:__________yrs.

2. Sex:

□ Male □ Female

3. Previous life support courses; please indicate month and year course was taken:

□ None
□ ACLS □ ATLS □ PALS
When: When: When:

4. Previous training in Crisis Resource Management at the Simulation Center:

□ Yes; Please describe

□ No

5. I have completed the following clinical rotations prior to the start of this study (Please check all that apply)

□ Emergency Medicine
□ Anesthesia
□ Intensive Care
□ Family medicine
□ Pediatrics/Subspecialty
□ Medicine/Subspecialty
□ Surgery/Subspecialty
□ Obs-Gyn
□ Psychiatry
□ Other, please specify

6. I plan to pursue the following specialty(ies) in my residency training (Please check all that apply):

□ Emergency Medicine
□ Anesthesia
□ Intensive Care
□ Family medicine
□ Pediatrics/Subspecialty
□ Medicine/Subspecialty
□ Surgery/Subspecialty
□ Obs-Gyn
□ Psychiatry
□ Other, please specify
□ Unsure

7. How would you rate your motivation to learn CRM skills?

□ Not at all motivated
□ Slightly motivated
□ Moderately motivated
□ Very motivated
□ Extremely motivated

GUIDED OBSERVATION VERSUS ACTIVE PARTICIPATION

Project to evaluate the current practice of teaching CRM Skills
Post-Workshop Questionnaire
Study #:
Date:

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1. In such a training session where learners are divided into observers or participants, what role do you prefer?

□ Participating
□ Observing

2. Please fill the table below:

My understanding of…	**Before Workshop**	**After Workshop**
	Low *High*	*Low* *High*
Crisis Resource Management	1-----2-----3-----4-----5	1-----2-----3-----4-----5
The role of a team leader	1-----2-----3-----4-----5	1-----2-----3-----4-----5
The role of a team member	1-----2-----3-----4-----5	1-----2-----3-----4-----5

GUIDED OBSERVATION VERSUS ACTIVE PARTICIPATION

3. Please rate your level of agreement with the following statements by circling the response that most closely represents how you currently judge yourself in these areas
Ratings: SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree

1. In dealing with sick children, I am confident in my ability to:					
a. Recognize clinical deterioration	SD	D	N	A	SA
b. Anticipate events	SD	D	N	A	SA
c. Plan how to handle such events	SD	D	N	A	SA
2. When called to a pediatric emergency situation or code, I am confident in my ability to:					
a. Gather information about the situation effectively	SD	D	N	A	SA
b. Access additional resources (other health care professionals) for additional help.	SD	D	N	A	SA
c. Take charge as the team leader	SD	D	N	A	SA
3. As a team leader in a pediatric emergency situation or code, I am confident in my ability to:					

GUIDED OBSERVATION VERSUS ACTIVE PARTICIPATION

a. Make decisions	SD	D	N	A	SA
b. See the big picture	SD	D	N	A	SA
c. Identify a number of different possible interventions	SD	D	N	A	SA
d. Decide on the most appropriate interventions	SD	D	N	A	SA
e. Prioritize the necessary interventions	SD	D	N	A	SA
f. Re-evaluate the situation & change plans as needed	SD	D	N	A	SA
g. Delegate tasks appropriately	SD	D	N	A	SA
h. Coordinate all team members (other MDs, RNs, pharmacy, social work, RTs)	SD	D	N	A	SA
i. Identify & utilize the skills of the team members	SD	D	N	A	SA
j. Instruct & correct team members regarding their performance	SD	D	N	A	SA
k. Communicate my plan clearly to the team	SD	D	N	A	SA
l. Ensure that my requested interventions have taken place	SD	D	N	A	SA
m. Provide reassurance & encouragement to the rest of the team	SD	D	N	A	SA
n. Create & maintain a calm atmosphere among the team	SD	D	N	A	SA

Appendix B

Scoring Sheet

Project to evaluate the current practice of teaching CRM Skills
Scoring Sheet (Pre-Workshop)
Study #:
Date:

‘ **The following video contains multiple crisis resource management errors; please list the errors you identify below:**

Appendix C

Guided Observation Sheet

Project to evaluate the current practice of teaching CRM Skills

Guided Observation Sheet

The Team Leader/Team Member…

- Clearly identifies that he/she will lead the resuscitation
- Delegates roles and responsibilities to team members
- Maintains control of leading the resuscitation
  - Manages distractions
  - Avoids allowing others to give orders
  - Controls noise and crowd
- Uses effective closed-loop communication
  - Gives questions and orders clearly and assertively
  - Speaks to and identifies members by name or other clear method
  - Ensures team members have heard and understood (e.g. through members' responses to questions or by asking for verbal confirmation once order is completed)
- Manages team resources and distributes workload appropriately
  - Avoids overloading or underloading team members
  - Avoids giving multiple orders at once
  - Prioritizes multiple orders when several are needed
- Verbalizes thoughts and summarizes progress periodically for the benefit of the team (shares situational awareness and mental models)
  - Describes events so far
  - States suspected diagnosis as well as other possibilities
- Asks for and acknowledges input for team members
  - Asks for other ideas

    - Asks for confirmation of suspected diagnosis
    - Incorporates ideas from team when appropriate

- Reassesses and re-evaluates situation frequently

    - Verbally identifies changes in patient status in a timely fashion
    - Acknowledges changes in status identified by team members

- Avoids fixation errors (getting "stuck" on a particular issue)

    - Acknowledges information that is inconsistent with interpretation
    - Uses new information or changes in status as an opportunity to reconsider other diagnosis
    - Reassesses situation when interventions not producing desired effect

- Refrains if possible from active participation (hands-off); applies to Team Leader only

- Shows anticipation of future events by asking for preparation of equipment or medication not yet needed

    - Asks for X-ray to be called ahead of when ready
    - Asks for infusions to be mixed up before needed

- Asks for appropriate help early and shows awareness of own limitations

    - Asks for additional personnel/extra hands
    - Asks for consultations to be called for advice