



Teaching practicing surgeons what not to do: An analysis of instruction fluidity during a simulation-based continuing medical education course



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ABSTRACT

Background: Interest is growing in simulation-based continuing medical education courses for practicing surgeons. However, little research has explored the instruction employed during these courses. This study examines instruction practices used during an annual simulation-based continuing medical education course.

Methods: Audio–video data were collected from surgeon instructors ($n = 12$) who taught a simulated laparoscopic hernia repair continuing medical education course across 2 years. Surgeon learners ($n = 58$) were grouped by their self-reported laparoscopic and hernia repair experience. Instructors' transcribed dialogue was automatically coded for 5 types of responses to the following questions: anecdotes, confirming, correcting, guidance, and what not to do. Differences in these responses were measured against the progress of the simulations and across learners with different experience levels. Postcourse interviews with instructors were conducted for additional qualitative validation.

Results: Performing t tests of instructor responses revealed that they were significantly more likely to answer in forms coded as anecdotes when responding to relative experts and in forms coded as what not to do when responding to novices. Linear regressions of each code against normalized progressions of each simulation revealed a significant relationship between progression through a simulation and frequency of the what not to do code for less-experienced learners. Postcourse interviews revealed that instructors continuously assess participants throughout a session and modify their teaching strategies.

Conclusion: Instructors significantly modified the focus of their teaching as a function both of their learners' self-reported experience levels, their assessment of learner needs, and learner progression through the training sessions.

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Introduction

A commitment to lifelong learning is at the core of what it means to be a surgeon. This is seen in surgeons' participation in continuing medical education (CME) activities. It is vital that instruction of CME activities is effective so that learners meet their needs for continuing education. Participants who attend lecture-

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based CME consider presenters who identify key points to be prepared and organized and those who remain within the allotted time as more effective.^{1,2} Lecture continues to be a dominating style of CME activities; however, research has shown that interactive courses may be better at changing physician practices.^{3–5}

Interactive CME courses are defined as courses that utilize interaction among participants to facilitate learning.⁴ Examples include roleplay, case discussions, problem-based learning, small groups, skills sessions, and simulation. Teaching in an interactive setting utilizes an entirely different skill set than that of a lecture behind a lectern podium, requiring both different instruction preparation and facilitation strategies and flexibility in teaching. Simulation adds an additional layer of difficulty because the

instructor now must also incorporate the manipulation of an object into the teaching session. Although interactive, skills-based CME courses are growing in demand, there is no research examining the instruction practices used in these courses. As such, this is the first study to formally explore the instruction practices of surgical educators in a CME skills course.

Practicing surgeons who take CME courses have a wide range of surgical backgrounds. Participants include surgeons new to practice and those who have been practicing for more than 30 years. In addition, these surgeons have varying levels of experience with particular surgical equipment. For example, a surgeon new to practice may have more experience using laparoscopic equipment than one that has been in practice for many years. These learners come to the skills courses with different needs and goals; however, very little is known about how instructors navigate this complex terrain and ensure that all participants' needs are met.

This study used a mixed-methods approach to understanding how surgeons address learners' needs during a skills-based CME course utilizing simulation. The following three questions related to instructors' approaches in the course were investigated: (1) How do instructors adapt their teaching approaches when working with learners of differing skill levels?; (2) How do instructors alter their teaching approaches throughout the duration of a hands-on CME session?; and (3) How do instructors identify the learners' needs and skill level entering the course?

Methods

Setting and participants

The present study included 58 participants (5 general surgery residents and 53 practicing surgeons) who registered for a 1-day CME course on laparoscopic inguinal and ventral hernia repair at the 2015 and 2016 American College of Surgeons (ACS) Clinical Congress meetings. The course included an introductory lecture and an interactive simulation (4 hours). The simulation portion of the course was conducted in 2 sessions, each 2 hours long. Participants learned lateral ventral hernia repair in 1 session (in addition to component separation during the 2015 course) and inguinal hernia repair in the other. All procedures were taught as mesh repairs. Participants from each year were separated into 9 groups of 3 and 1 group of 2, according to similar self-reported levels of laparoscopic expertise. Each group was assigned to 1 of 10 simulator stations during each session. A total of 12 experts in laparoscopic hernia repair—1 at 8 of the stations, 2 at 2 of the stations—provided instruction using simulators developed for training in these techniques.⁶ All laparoscopic equipment and supplies necessary to repair the simulated hernias were provided. All participants consented to having their audio-recorded and video-recorded data being collected and analyzed in a deidentified manner, and the institutional review board approved the study under exempt status.

Precourse data collection

Course participants reported their experience performing 7 laparoscopic procedures using a Likert scale, where 1 is “beginner,” 3 is “competent,” and 5 is “master surgeon.” Participants' laparoscopic experience was determined by the mean of their self-rated experience with 7 laparoscopic techniques. Mean participant experience ranged from 1.71 to 4.29 (mean = 2.72, SD = 0.52).

Transcription

All simulated procedures were audio and video recorded. Cameras were placed overlooking each simulator station to provide

context for the conversations between participants and instructors. The audio recordings of 2 of the 40 sessions were corrupted and could not be reliably transcribed. Audio from the remaining 38 sessions were transcribed by a trained transcriber, and each transcription was subsequently verified by a second member of the research team. The 38 sessions consisted of 17,029 utterances, with a range of 154 to 1,252 utterances per session. These utterances were then organized in a file, including deidentified speaker identifications, group identifications, demographics, and average self-reported laparoscopic experience.

Code development and validation

To investigate how instructors responded to questions posed by learners during the lab portion of the laparoscopic hernia repair CME course, we conducted a grounded analysis⁷ of instructors' discourse during the simulated procedure. In a grounded analysis, transcripts are evaluated qualitatively to determine the presence or absence of potentially meaningful themes or patterns of behavior. Our analysis revealed five common themes: anecdotes, confirming, correcting, guidance, and what not to do. We also coded all utterances for whether they were questions posed by learners.

We developed automated coding algorithms for each of these codes. For example, to automate the code guidance, we developed an algorithm that identifies verbalizations of guidance in the discourse, using regular expressions, which searches text for patterns of words. To illustrate, the regular expression `[\\b(you)?!(\\snever)(\\swant)]` searches text for instances of the phrase “you want”—but only when the word “never” is not found between “you” and “want.” This algorithm identifies the question “You want to be farther lateral” as guidance, but not “You never want to be this far medial,” which instead constitutes an example of the code what not to do.

All 5 automated coding algorithms were validated by 2 trained human raters. For each code, the human raters and the coding algorithm independently rated a random sample of 50 utterances. Cohen's kappa was calculated between the 2 human raters and between each human rater and the coding algorithm. To determine whether the kappa values obtained for these samples could be reasonably generalized to the whole dataset, Shaffer's rho (ρ) was calculated for each kappa using the rhoR package for the R statistical software platform.⁸ The ρ can be interpreted similarly to a P value and thus allowed us to measure the significance of agreement between raters.⁹ Because kappa was greater than or equal to 0.82 and ρ was less than 0.05 for every code and all combinations of raters (Table), we used the automated coding algorithms to code all the utterances in the data set. This automation reduced the total number of utterances that would need to be coded by human raters from 17,029 to 150—a considerable reduction in labor.

Statistical approach

We used t tests to compare how instructors answered questions from learners of relatively lesser and greater experience levels in terms of the 5 types of coded responses identified in our coding scheme. Learners were grouped for statistical analysis based on their individual self-reported laparoscopic experience in upper ($n = 18$) and lower ($n = 18$) terciles.

To analyze changes in instruction approaches through time, we examined the relationship between how far along groups of learners and their instructors were in a given simulation session (ie, progress) and how frequently instructors responded to questions with certain types of coded responses. Because learners are not guaranteed to ask questions uniformly through sessions, we first performed a χ^2 test of the distribution of questions across the total utterances from each session. The results of this test indicated no

Table
Description and validation of discourse codes

Code	Definition	Example	Human 1 versus human 2		Human 1 versus computer		Human 2 versus computer	
			Kappa	Rho	Kappa	Rho	Kappa	Rho
Question	Asking a question	"Did you guys talk about defect closure?"	1	<0.01	1	<0.01	1	<0.01
Anecdotes	Describing a particular experience the instructor has encountered to help explain some part of the procedure	"That's a great question. The one time that has happened to me was a very complex adhesiolysis in a lady with multiple defects, Swiss cheese defects."	0.89	0.01	0.87	0.02	0.83	0.03
Confirming	Confirming something the learner has asked about	"Correct."	0.98	<0.01	0.84	0.03	0.84	0.02
Correcting	Correcting something the learner has asked about	"No, the vas is over here."	0.95	0.02	0.9	0.04	0.9	<0.01
Guidance	Providing instructions for how things should be done in real time	"So, again, probably the best place to start is to anchor it to your Cooper's. So, reorient yourself to where the linea alba is."	0.88	0.02	0.85	0.02	0.82	0.03
What not to do	Framing guidance in terms of actions to avoid	"The other thing is you should never put this mesh in the pelvis."	0.95	<0.01	0.92	<0.01	0.85	0.01

relationship between the distribution of questions and progress through simulations ($P = .20$).

Having established that participants asked questions uniformly throughout the simulation sessions, we normalized progress as a function of percentile session completion, wherein the first utterance in a session corresponds to 0.00% progress and the last corresponds to 100.00%. We then measured changes in the frequencies at which instructors responded to questions with responses coded as anecdotes, confirming, correcting, guidance, and what not to do, using 2 different statistical approaches: a t test of the first and latter halves of each session and a linear regression of the distances between instances of each code.

Postcourse interviews with course instructors

After the 2017 iteration of the laparoscopic hernia repair CME course, we invited instructors of the laboratory portion of the course to participate in structured phone interviews. Of the 12 instructors, 9 agreed to participate. Of these 9 instructors, 7 had taught in the simulation portion of the course at least once before. We focused our analysis of these interviews on the following: (1) the instructors' responses to questions about their appraisal of the learners' goals, needs, and skill levels; and (2) how they tailored their teaching approaches to various learners.

All phone interviews conducted with instructors were audio recorded and transcribed by a trained transcriber and verified by a second member of the research team. These transcripts were collated in a file, including deidentified speaker identifications and utterances.

Results

Analysis of instructor responses and learner experience level

Our first analysis addressed differences in how instructors responded to questions from surgeon learners with relatively lower ($n = 18$, mean self-reported experience = 2.21) and higher ($n = 18$, mean self-reported experience = 3.29) experience levels. We conducted t tests of each of our 5 codes across less-experienced and more-experienced learners that revealed 2 significant results. When more-experienced learners asked questions, instructors were more likely to respond with answers coded as anecdotes ($P = .03$). By contrast, when less-experienced learners asked questions, instructors were more likely to respond with answers coded as what not to do ($P < .001$). No significant difference was observed in the proportional rates of answers coded as confirming, correcting,

or guidance in response to questions from less-experienced versus more-experienced learners.

To provide an example of an exchange between a more-experienced learner asking a question and the instructor who replies, we look to the transcripts. In the following excerpt, Learner 1 asks a question about the use of mesh versus a primary repair. Instructor 1 responds with an anecdote about a complicated case:

- Line 1—Learner 1: *If you were to get a [inaudible] one end on these, would you use this? Or would you go in and do a primary using a suture passer...?*
- Line 2—Instructor 1: *That's a great question. The one time that has happened to me was a very complex adhesiolysis in a lady with multiple defects, Swiss cheese defects, and I fixed the bowel, I put her in the hospital on antibiotics for a week, and then I went back and I did the repair a week later. And the idea was that whatever tissue contamination there was, we took care of it. I got to observe her to make sure that the bowel, the repair of the bowel, was going to hold together and not turn into a leak. So that's what I'd do. And that's only happened to me once. Some people will say an enterotomy, a small bowel enterotomy with minimal contamination—you can fix it. You can put your non-PTFE mesh in and you'll be okay.*

In this next excerpt, a less-experienced learner, Learner 2, asks for confirmation that his technique for holding the mesh is appropriate. Instructor 2 begins by providing guidance on how to approach holding the mesh and ends his response with an example of the what not to do code:

- Line 1—Learner 2: *Can you hold that like that?*
- Line 2—Instructor 2: *Then I find the top corner, and I take the top corner with my left hand, and the way I remember it, it's my left hand, it's the up hand. If you grab the mesh with the lower hand, you'll get caught in your port all the time. You should never grab the mesh.*

Although instructors also provided anecdotes when instructing less-experienced learners, our analysis suggests that they tended to address questions from these learners by explaining which behaviors to avoid when performing a procedure. When addressing questions from more-experienced learners, however, instructors intuitively understood that the individuals with whom they were speaking possessed a higher degree of background knowledge related to the procedures being simulated. This understanding allowed instructors to address questions from these more-experienced learners with anecdote-driven responses

about their encounters with surgical complications and cases that extended beyond the basic procedural steps of a laparoscopic hernia repair.

Analysis of changes in instructor responses through time

To measure how instructors modified their instruction approaches as they proceeded through the simulation sessions, we compared changes in the rates of their response types with questions from less-experienced ($n = 18$) and more-experienced ($n = 18$) learners. Both a t test ($P = .007$) of the first versus latter halves of the sessions and a linear regression ($P = .006$) of code frequency versus progress yielded significant results for the distribution of answers coded as what not to do in response to questions posed by less-experienced learners.

Qualitative analysis of interviews with instructors

To improve our understanding of how instructors appraised and adapted to the needs of their learners and the instruction techniques they chose to use, we analyzed phone interviews that were conducted with instructors of the 2017 iteration of the simulated laparoscopic hernia repair CME course. We took both an inductive and deductive approach to analyzing the content of the interviews. Our first goal was to understand how the instructors determined the experience level of their students and their goals and learning needs because this is something that our earlier analysis did not address. Our second goal was to better understand our quantitative results by looking for instances in the interviews during which instructors described their specific instruction approaches and how they interacted with learners with varying levels of skill. In this way, the instructors' responses to these interviews provided validation and qualitative context for the findings described earlier in this report.

In terms of how they determined their students' levels of experience, all the instructors we interviewed replied to the question by stating that they simply asked their learners about their experience directly. In this first excerpt, Instructor 1 explained how starting the course off by asking his surgeon learners about their strengths, experiences, and learning objectives was the best way to serve their needs:

- Line 1—Researcher: *How did you determine the level of the experience of your students?*
- Line 2—Instructor 1: *The first thing that... I do is I ask the participants: What is their level of experience with the technique that we are working on that day? ... What are their specific goals or learning objectives for the course? Because everybody, the level of experience is different, and everybody's desires for the course are different. [In] my learner group, I had two people who... were both experienced learners and their main goals for the course that day were to pick up some additional tips and to do some things they did not necessarily do formerly, like closing the defect laparoscopically. They were looking for some pointers on, you know, mesh positioning... In years past... people have come in with very little experience doing any laparoscopic hernia repairs—some people don't do any laparoscopies—so they do not even have the ability to navigate the camera, and obviously in those circumstances what we are working on is really just the very basics of lap. hernia repair. So I ask them: What are you good at? How often do you do these things? What do you want to learn? It is easy to meet their objectives if you know what their objectives are.*

Most of the instructors we interviewed mentioned asking about what types of cases and the number of cases the learners had

performed to better understand their experience levels. Some instructors, like Instructor 2 in Line 4 of the following excerpt, also noted that observing the learners' performance during the simulation provided additional information about what the learners knew how to do and what they did not:

- Line 1—Researcher: *How did you determine the level of the experience of your students?*
- Line 2—Instructor 2: *I personally asked each of them what cases they had been doing and what cases they expected to do in the future.*
- Line 3—Researcher: *Did you make any more sort of assessments based on what you observed them doing during the actual simulation?*
- Line 4—Instructor 2: *Well yeah, I think you'd get a little bit of an idea of whether they've really been doing what they say they've been doing.*

Instructor 3 also used an initial assessment of his learners' needs and goals as a jumping-off point for instruction but noted that his instruction was subject to moving on to tangential subjects. This phenomenon shows that a CME course on one set of procedures can offer the opportunity for learners to address other related topics and procedures as well, based on their experience, learning needs, and interests:

- Line 1—Researcher: *What is your general approach to teaching the procedure?*
- Line 2—Instructor 3: *I first try to establish their level of experience... Have they had any laparoscopic training? Or have they been doing laparoscopic surgery? That allows me to kind of tailor what I am going to do to what their level of experience seems to be, and then I just ask them: What do you want to get out of this session this afternoon? Because you know, it's flexible and we can adjust things... Sometimes we kind of vary off the beaten path a little bit and get into some other things that aren't directly related to ventral hernia, other techniques that might be used in the end. For similar procedures, [I] personally asked each of them what cases they had been doing and what cases they expected to do in the future... I focus personally on what I feel their needs are, what they expressed to me their needs are.*

In this next excerpt, Instructor 4 stressed the flexibility in his approach to teaching, emphasizing how the simulation offers many opportunities to tailor instruction throughout its course. He also provided a concrete example of how he delegated tasks according to learners' varying degrees of skill and experience:

- Line 1—Researcher: *How did you tailor your teaching approach to meet the needs and goals of your students?*
- Line 2—Instructor 4: *I tried to figure out... whether a person was experienced or not, and the least experienced person, I would try to get [them] to... be the one manipulating the prosthetic and the fixation devices [rather than be the camera holder], that sort of thing. Where the more-experienced person would hold the camera, and if everything went smoothly and we had time, we would then switch over... I kept it open-ended; if they ever had questions, things they wanted to ask... I wasn't dogmatic about how we taught it. [We had] a very flexible discussion.*

In this final excerpt, Instructor 5 brought up the impact of learner awareness on teaching. For those learners who are less experienced, their understanding of their shortcomings may be more limited and thus requires a different approach than learners who have a comparatively greater fund of surgical knowledge:

- Line 1—Researcher: *How did you tailor your teaching approach to meet the needs and goals of your students?*
- Line 2—Instructor 5: *This year was pretty easy because they were very, very talkative. They just outright asked questions about how I would do this or how I would do that particular thing. When people aren't at least aware of the problems that they can have—again, this group this year, they were aware of what they were doing, they were aware of the problems that they sometimes have, and so they could ask questions about how they could get around those problems. When people are not as experienced and are having problems, oftentimes they do not recognize it, and... there is a delicate balance in correcting people who are at these higher level courses if you're highly trained surgeons, and so there is a balance in terms of how you correct them or get them moving in the right direction, so my typical line is: "When I am having the problem that you are having...", which tells them, you are having a problem, you might not know you are having a problem, but I do, and I am not going to call it anything bad, and I also acknowledge that "I sometimes have the same problem that you have, so when I have the problem that you are having right now, here are some things that I do differently." And, you know, it is a nice way to course correct somebody without telling them that like, you are doing really poorly.*

accommodate a changing set of questions and needs from their learners. These qualitative findings provide contextual insight into our quantitative analyses, which suggest that differences in instruction approach occur both across learners of different experience levels but also across learning sessions.

Discussion

This mixed-methods study is the first study to examine the instruction practices of surgical educators in a CME skills course. CME is a vital part of the profession of surgery and yet little is known about how practicing surgeons are taught in these courses. To ensure practicing surgeons are taught using the best pedagogic strategies, we must understand the instruction strategies currently being used. One of the particularly challenging aspects of teaching simulation-based CME courses is that learners possess a wide range of experience. The goal of this study was to understand how instructors assess learner level and modify their teaching in response, which is at the core of any instruction strategy utilized in a CME skills course.

We learned from our interviews with instructors of the 2017 American College of Surgeons CME course that instructors typically determined their surgeon learners' skill levels and needs by asking directly. Simulation sessions often began with the instructor requesting information about learner experience with the procedure and determining goals for the session. Based on these goals, instructors approached teaching differently when working with learners of varying experience levels. Some instructors gave learners with less experience specific roles during the simulation session or organized the session to give them increased time to practice. Also,

As illustrated in these excerpts, instructors of the simulation course acknowledged both an initial and evolving approach to assessing the needs of their learners. They initiated instruction by asking learners about their goals and needs and crafting a flight plan around those objectives from the start, but the simulated interactive environment itself also provided opportunities for them to further modify their approach in a manner flexible enough to

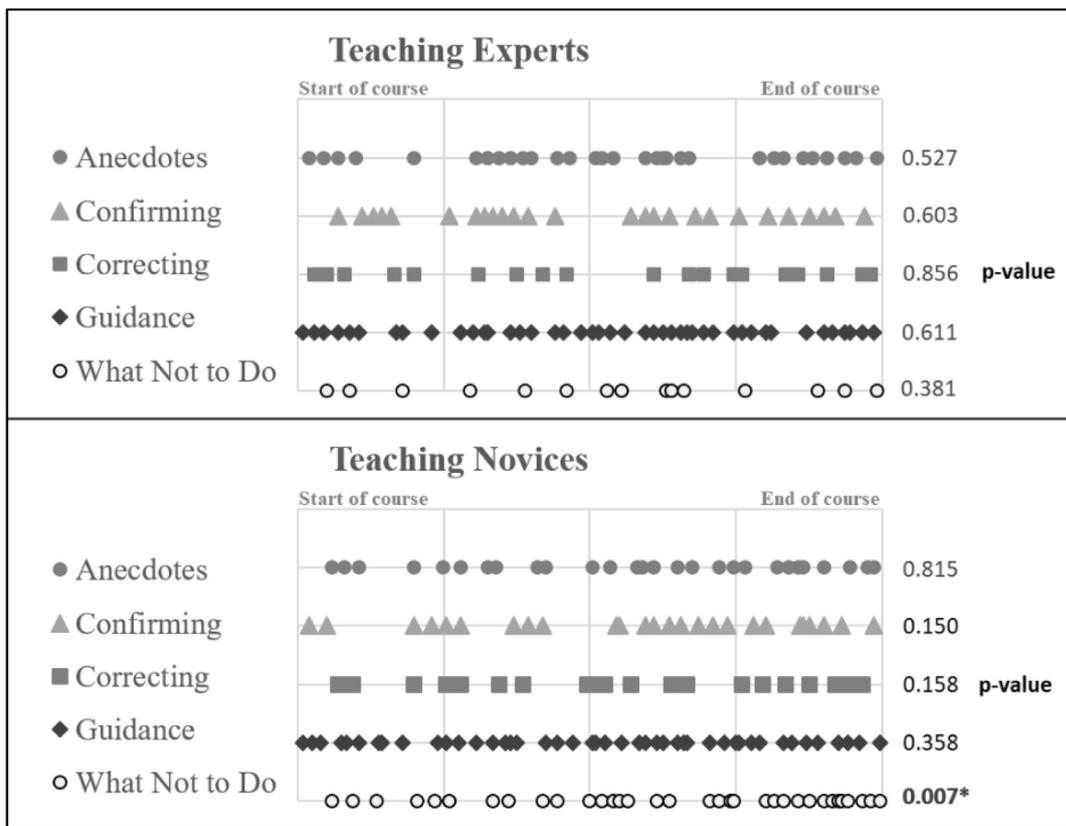


Figure 1. Distributions of instructor response codes in more versus less experienced surgeon learners. Shown above are instances of codes across simulated laparoscopic hernia repair sessions with more experienced (top) and less experienced (bottom) surgeon learners. Instructors differentially responded to questions from less experienced learners with answers coded as *What Not to Do* in the first versus latter halves of the aggregated learning sessions.

instructors answered learner questions with anecdotes more frequently when working with more-experienced learners and with what not to do when working with those less experienced.

Our study shows that instructors modified their teaching strategies throughout the duration of the simulation session. Interviews revealed that instructors monitor learner skill level throughout the course to gauge whether learners are performing at the anticipated skill level based on the introductory conversation. This monitoring throughout the sessions may prompt instructors to adjust their teaching strategies. Because instructors of simulation CME courses often have significant experience teaching residents, some have been concerned that they might struggle to adjust their teaching techniques with a more-advanced audience. However, our analyses suggest that, as simulation sessions progressed, instructors adjusted their teaching techniques. When working with less-experienced learners, instructors increasingly focused on what not to do. Instructors reported that often less-skilled learners were unaware of the errors they were making and required assistance to both identify the problem they were having and how to address it.

Just as there has been an increased interest in interactive CME, studies on instruction in other contexts like postsecondary education have shifted away from lecture toward instruction methods that more actively engage students as well. Teachers of these courses commonly use instruction strategies consistent with those used in this simulation CME course, such as guidance, confirming, correcting, and anecdotes. Changing from lecture to a more-interactive approach, like problem-based learning, has been found to substantially change the discourse between teacher and learner. In this setting, teachers focus on bringing out the knowledge currently possessed by students and further supporting that with confirmation and additional explanation.¹⁰ It has also been found that anecdotes are heavily relied on as a pedagogic strategy in math and science postsecondary teaching practices.¹¹ Similar instruction strategies are used by postsecondary educators as those utilized by instructors in this course. In postsecondary education, students' learning outcomes have been shown to improve with these types of instruction practices that promote active engagement by students.¹² CME courses that are more interactive also have been found to be more effective.⁴ The use of these instruction strategies may enhance learning in CME contexts as well.

Although it appears that guidance, confirming, correcting, and anecdotes support learning, it is less clear whether avoidant instruction, or focusing on what not to do, is an effective teaching practice. Research from sports psychology suggests that emphasizing avoidant instruction may not be an ideal approach. When given avoidant instruction individuals are less likely to perform a task as desired.^{13–16} The addition of anxiety to this avoidant instruction style worsens performance even more,¹⁴ and avoidant instruction has been found to have more deleterious effects for those at a lower skill level than for individuals at a higher skill level.¹⁵ More research is needed to determine whether similar findings hold true in surgical settings; however, based on this, it would seem that focusing on what to do rather than avoidant instruction would be a better approach, especially when working with learners of a lower skill level.

This study is not without limitations. Given that our study took place within an ongoing CME course at a large national conference, we were unable to control for the teaching experience of the instructors. Most of the surgeon instructors participated in the course for all years of the study; however, there were some new instructors each year. As new instructors, they may have been unfamiliar with the course, typical course learners, or the simulator, all of which could potentially affect their instruction in a particular

session. In addition, learners were grouped by self-assessed level of experience. An objective skills assessment may be a more-accurate way to categorize learners' skills, thus influencing instructors' strategies. Finally, our study was unable to investigate the impact of various instruction approaches on learning outcomes in the CME environment. Now that we are aware of the strategies that teachers use and how they adapt their teaching in the context of this simulation-based CME course, future research can provide direction to instructors on instruction techniques and measure their impact on learners with varying levels of skill.

Instructors significantly modified the focus of their teaching as a function both of their learners' self-reported experience levels, their assessment of learner needs, and learner progression through the training sessions. Moreover, although modifying the focus of instruction to match learners' needs is an effective strategy, additional inquiry is needed to determine whether a shift toward what not to do is more beneficial than other training techniques. Further research is needed to more fully understand how instructors approach teaching in skills-based CME courses and instruction strategies that can be effectively implemented in this context with learners of varying levels of experience.

Disclosure

The authors of this manuscript have nothing to disclose.

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