Qualities and Methods of Highly Effective Surgical Educators: A Grounded Theory Model

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OBJECTIVE: To identify personal qualities and teaching methods of highly effective surgical educators using a novel research design.

DESIGN: In this qualitative study, surgical residents were sent an electronic survey soliciting nominations for faculty perceived as highly effective surgical educators. In-depth, semistructured interviews were conducted with surgeons receiving the most nominations. Grounded theory methodology identified themes for analysis.

SETTING: General, vascular, and plastic surgery residents and faculty at the University of Pennsylvania Health System.

PARTICIPANTS: A total of 77 surgical residents were surveyed. Data saturation occurred after 12 semistructured interviews with attending surgeons, corresponding to the top 15% of faculty.

RESULTS: Interviewees described both personal characteristics and specific teaching approaches that facilitated successful learning. These included providing exceptional surgical education as a mission, a strong influence from past mentors and role models, a love for the profession, and a low rate of self-professed burnout. Desirable teaching methods included promoting a culture of psychological safety (the perceived ability to take interpersonal risks within one's environment), progressive autonomy, accountability of trainees, and individualized teaching for the learner. Interviewees saw education as inseparable from clinical duties, and all surgeons believed providing exceptional patient care was the foundation of effective surgical teaching. The derived themes suggested that educators prefer "cognitive-based" approaches, focusing on learning processes rather than specific outcomes.

CONCLUSIONS: This study identified characteristics and educational styles of highly effective educators in a cohort of academic surgeons. This framework may inform the development of educational programs for residents and faculty in effective teaching methods. (J Surg Ed 76:1293−1302. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Psychological safety, Mentorship, Cognitive learning theory, Grounded theory, Qualitative methods

COMPETENCIES: Practice-Based Learning and Improvement, Interpersonal and Communication Skills, Professionalism

INTRODUCTION

With the inception of the modern surgical residency at the turn of the 20th century, Dr. William S. Halsted brought education to the forefront of surgical training. To this day, teaching residents and medical students remains integral to the mission of academic surgery, not only to train the next generation of surgeons, but, as Dr. Halsted understood, to develop teachers and role models who will

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propagate the training paradigm.[1] A century later, however, continued excellence in surgical education faces new challenges. Both teachers and learners must master an exponentially expanding knowledge base and adapt to new technologies.[2] Faculty often lack financial incentivization and/or educational resources to train housestaff.[2] And the introduction of work-hour restrictions has led to some concern regarding the breadth of operations that residents can perform independently and proficiently upon graduation.[3–6] These concerns persist despite the implementation of a variety of novel education models.[7–9]

To address the need for sustained innovation in surgical education, investigators have turned to novel research approaches to gather data about optimal teaching strategies. Qualitative research – which systematically explores how individuals interpret or understand social phenomena through their own experiences[10] – is one such method that has proved fruitful in evaluating surgical teaching. Structured analyses of intraoperative video recordings have identified effective techniques within domains of verbal teaching,[11,12] physical teaching,[13] and narrative-based teaching.[14] In addition, qualitative studies examining the perceptions of master surgeon-educators through the use of survey and interview instruments have provided models for both global approaches to surgical teaching[15] as well as granular techniques such as fostering resident autonomy in the operating room.[16] However, surgical educators selected for study are typically identified based on the researchers' perception of the attendings' reputations, availability of videotapes, or a focus on single subspecialties. In order to obviate this selection bias, we chose to allow residents themselves to choose the most effective teachers for study.

While their knowledge regarding effective surgical education may be tacit, housestaff are uniquely positioned as the contemporary recipients of surgical teaching, evidenced by the ubiquity of resident-chosen teaching awards in general surgery programs. By surveying surgical residents at a large academic medical center, we aimed to make this tacit knowledge explicit and identify faculty perceived as leading educators. We hypothesized that analysis of in-depth interviews with this cohort of surgeons would reveal personal qualities and teaching methods characteristic of highly effective surgeon-educators. Thus, we sought to improve the knowledge base of optimal strategies in surgical education in an attempt to reclaim "what works" in the modern era.

MATERIAL AND METHODS

After the Institutional Review Board at the University of Pennsylvania deemed this research protocol exempt, we conducted a qualitative study utilizing both a survey and an interview instrument with the Department of Surgery at the University of Pennsylvania Health System (UPHS). We surveyed surgical residents (n = 77) in May 2016, asking participants to "nominate up to 3 faculty members who you would describe as exceptional surgeon-educators. These faculty members should be exemplary teachers in and out of the operating room." In the same survey, we also asked the residents to nominate faculty in 2 other domains: those of exemplary humanism and exceptional technical skill. We used Spearman's rho to determine correlation between nominations in these separate categories to ensure residents were not simply choosing the same faculty for each. All categorical and preliminary general surgery, integrated vascular, and plastic surgery housestaff were included. These residents share a common core curriculum and rotate through many of the same surgical services over the first 3 years of training at UPHS. All housestaff spending less than 1 year in general surgery rotations were excluded.

Surgeons (n = 72) from the 3 major UPHS teaching hospitals from the core surgical specialties (e.g. General Surgery, Colorectal, Transplant, Vascular, etc.) were included in the survey, listed in alphabetical order. We invited the most frequently nominated surgeons to participate in individual semistructured interviews conducted by a medical student investigator (D.H.). Two rounds of interviews were conducted, first from September 2016 to March 2017, and then from December 2017 to January 2018. Interviews were approximately 45 minutes in length and utilized open-ended questions to assess the qualities, habits, and experiences that contributed to the interviewees' views and practices regarding surgical education (Appendix I). Thirteen faculty members were invited to interview over the study period; 12 were scheduled. After informed consent was obtained, each encounter was recorded and then anonymized and transcribed verbatim by a professional service. Data analysis was performed by 4 of the investigators (R.S., D.H., A.B., and C.C.) using Grounded Theory method to identify common educational themes. No compensation was provided to the interviewees.

Grounded Theory Method

Grounded Theory is commonly used in qualitative research, usually to describe social phenomena or patterns of human behavior.[17] Interviews with open-ended questions allow participants to provide detailed and robust answers to questions that may be difficult to capture in quantitative data collection. Analysis of the interviews is then conducted using an inductive and iterative approach, building from the participants' unique and specific experiences to generate broader themes and

often a conceptual model representing a sum of the data.[18] Data is continuously gathered until additional interviews no longer deepen the understanding of the conceptual framework nor identify new or contradictory themes (i.e., data saturation).

We utilized this approach over several months on an initial set of interviews. Data saturation was not reached after 6 interviews, so a second set of interviews was conducted after calibration. The group iteratively provided feedback to each other on the process, discussed emerging themes, and coded the data using a constant comparison method. Coding was performed in 3 steps, using open (breaking down and categorizing the data), axial (putting the data back together to form broader categories), and selective coding (determination of final themes).[19] After independently coding the second round of interviews, the 4 investigators reconvened monthly to continue categorization of themes until consensus was achieved. Further interviews were not sought as data within the last 3 transcripts fit within existing themes and no longer contributed new themes or challenged previous data. The full study team agreed upon the final conceptual model.

RESULTS

Of the 43 (55.8%) residents who answered the survey, 35% were women and 40% were senior residents (PGY-4 through PGY-7), which is representative of the program. Of the 72 surgical faculty, there were 58 men and 14 women, and 45 (62.5%) received at least one nomination. Twelve surgeons (16.7%) with the most nominations participated in the interviews. Nominations for highly effective educators had a low-positive correlation with nominations for humanism (Spearman's rho = 0.367) and a negligible correlation with resident-perceived technical skill (0.116), meaning a relatively unique cohort was chosen. Surgeons identified numerous personal characteristics, habits, and educational approaches that clustered around 4 central domains: (1) the patient, (2) the learner, (3) the educator, and (4) the culture of surgical education. Table 1 presents the demographic information of the interviewees. Representative quotes from each domain are provided in Table 2. Of note, 9 (75%) interviewees reported winning prior teaching awards as faculty.

The Patient

All surgeons (12/12) emphasized that exceptional patient care was a core tenet of excellent surgical education. For many, this meant modeling a decision-making process that placed the patient and the patient's experience constantly at the center of that approach.

> *"I try not only to focus on the actual anatomic and physiologic basis of the disease but also to try to get the residents and even the med students into the theory of doing what. . .you would do for your family because you'll never take a shortcut with your mother, with your sister, with your son, with your daughter. You'll do whatever it takes to do the right thing." (Interviewee #2)*

Some surgeons took the role of the patient a step further, arguing that patient care was inextricable from the education of medical students and residents.

> *"I can't really separate. . .patient care or teaching. I mean I kind of see it as the same thing, where we take care of the patients collectively."* (Interviewee #10)

The Learner

The second domain focused on the learner, which included various pedagogical approaches taken to facilitate learner-centered education for all trainees. Three themes were identified: individualized learning, multimodal learning, and trainee autonomy.

TABLE 1. Demographics of Effective Surgical Educators in the Department of Surgery at the University of Pennsylvania (n = 12)

Age in years, mean (range)	**49 (39-64)**
Race, no. (%)	
Caucasian	10 (83)
Black or African-American	1 (8)
Asian/Pacific Islander	1 (8)
Gender, no. (%)	
Male	12 (100)
Surgical subspecialties represented, no. (%)	
General surgery	2 (17)
Transplant surgery	1 (8)
Vascular surgery	1 (8)
Endocrine and oncologic surgery	3 (25)
Plastic surgery	1 (8)
Trauma surgery	3 (25)
Hepatobiliary and pancreatic surgery	1 (8)
Academic title, no. (%)	
Assistant Professor in surgery	3 (25)
Associate Professor in surgery	6 (50)
Professor in surgery	3 (25)
Years in practice, mean (range)	14 (3-31)
Self-reported hours worked per week, mean (range)	71 (50-105)
Nominations, mean (range)	6 (4-19)

TABLE 2. Representative Quotations from Each of the Four Domains of Highly Effective Surgical Education

Domain	Themes (Frequency)	Representative Comments
The Patient	Exceptional patient care as a core tenet of excellent surgical education (12/12)	*"When the resident experience gets fragmented. . . it's so much less effective than going to clinic, meeting the patient and working them up, figuring out what to do, being there for the operation, caring for them in the hospital and seeing them in follow-up. So, the more you can provide them a longitudinal experience, I think the better from every standpoint."* (Interviewee #6)
The Learner	Strategies included individualized learning (8/12), multi-modal teaching (7/12), and trainee autonomy (8/12)	*"You need to provide them an environment where they feel that they can manage the patients, but yet provide enough oversight so that when they know they're beyond their level of knowledge. they have the ability to turn to you at any time and you can support them in their decision-making. And you have to have a feeling of enough trust to work together in that capacity. It goes a long way to furthering their education and their independence."* (Interviewee #1)
The Educator	Surgeons discussed the importance of attention to education (11/12), love for the profession (9/12), and a prominent role of past mentorship (8/12)	*"I wouldn't want to be in an environment without students or residents. I think that would be sort of a sterile kind of a learning environment. I mean, oftentimes, those students or residents ask questions that. . .help me be a better doctor."* (Interviewee #7) *"It's a privilege to take care of people as a surgeon. And I think we need to teach and mentor the next generation and be good role models for them."* (Interviewee #7)
The Culture	Surgeons promoted a culture of psychological safety (10/12), accountability (8/12), and collegiality (12)	*"I don't think fear of retribution. . .should exist at a teaching hospital. It should be kind of an open community where people can express questions about your judgment. . .so that you can have a conversation about why you're doing whatever you're doing. And that, I think, only improves the learning process, as opposed to not communicating what your intentions are." (Interviewee #10)*

1. *Individualized learning*. Most surgeons (8/12) reported a teaching approach that tailored both content and delivery to target each individual learner. This often took the form of adjusting the level of difficulty to the experience level of the student, resident, or fellow.

   "It's a good idea just to get a sense of what does the person you're talking to already know[s]. Because there's no point in telling them something they already know. And if they know less than you think they do, then maybe you have to start a couple of steps further back. So, it's a good way to sort of titrate what you're about to say to the knowledge of the person that you're talking to." (Interviewee #8)

2. *Multimodal learning*. More than half of the surgeons (7/12) described teaching methods that allowed their trainees to learn through multiple sensory modalities, noting the benefits of reinforcing concepts through different intellectual perspectives.

   "In surgery. . .there's the physical patient, there's x-rays, there's lab and then there's what we've seen and touched in the operating room which helps people put things together. So, the more sensory experience. . .the greater there is the ability to create learning and memories." (Interviewee #1)

3. *Autonomy*. Most surgeons (8/12) explained that deliberate efforts to give the learner autonomy were critical to continuous growth throughout training.

   "Surgical education is a very human-to-human, one-on-one interaction. It's rounding, it's operating, it's spending time with residents and students, embracing them into your clinical practice and allowing them to care and take the front row, if you will. This [allows] me to back off. For me, I think that's what the ultimate is in surgery education." (Interview #12)

Critical to providing autonomy for the learner in a progressive fashion was deliberate attention paid to effective modeling of surgical excellence from a top-down approach, from attending surgeon to chief resident and down through the team.

"In the operating room with a chief resident, if I've never done a case with them, I want to show them. . .a good way to approach this and make sure I impart that skill set to them. Then they can - by case three, I may not even need to be in the room. I

know they know how to do it. I'm letting them teach the next tier down." (Interview #2)

The Educator

A third domain included attitudes and experiences of the educators themselves. Three themes within this domain were identified: attention to education, love for the profession, and a prominent role of past mentorship.

1. *Attention to education*. Almost every surgeon (11/12) noted a deliberate attention to the education of their trainees as an intrinsic aspect of their work.

   "Even if it's an emergency case that I'm doing… you can always throw in one or two teaching points for people who want to learn, because they're all hungry to learn, and they're hoping to learn, even if the case is busy." (Interviewee #9)

   Some surgeons highlighted this deliberate focus on education as a focal point of not only their daily practice, but also their professional goals as an academic surgeon.

   "One gets the perception that education…gets shortchanged for I guess understandable reasons — patient safety and quality of care and whatnot. But I make it primary and paramount in…my clinical mission." (Interviewee #12)

2. *Love for the profession*. Most surgeons (9/12) reported their personal love for the surgery as a vocation, noting the importance of this passion in their roles as educators.

   "I've always admired people that have that drive and passion, and I always wanted to be someone like that. And thankfully I have that love and that just sort of tremendous veneration of the specialty and the field…that keeps me energized." (Interviewee #3)

   In addition, 4 surgeons explained that love for their job contributed to low amounts of self-professed burnout. They subsequently noted the importance of low burnout for effective teaching. One interviewee even argued that teaching trainees has a protective effect in preventing burnout through encouraging optimal surgical care and efficiency in one's clinical practice.

   "I think because of my passion for [teaching] I don't really sense any burnout, and it's not because it's not a lot of work. Each year, over the past now nearly eight years that I've been on faculty, my operating room volume has gone up. My clinic volume has gone up. And that is probably steering towards a direction where you'd be easily could burn out. But it hasn't really fazed me… You learn yourself in interacting with your residents, with your students in how to just be more efficient, be more optimal." (Interviewee #10)

3. *Role of past mentorship*. Most surgeons (8/12) appreciated the importance of past mentors in their dedication to surgical education, often describing a sense of gratitude toward these early positive experiences with role models and a desire to pass on their knowledge to the next generation.

   "I feel deeply indebted to the surgical educators that I was exposed to. And feel like it's invaluable and vitally important to pass on knowledge in a user-friendly digestible way to the next generation. So I'd say that's my primary motivation." (Interviewee #3)

The Culture

The final domain characterized the culture of surgical education, in which 3 themes were identified: promoting a sense of psychological safety, accountability, and collegiality in the educational environment.

1. *Psychological safety.* Almost all surgeons (10/12) worked to promote a culture of psychological safety in surgical education. These surgeons advocated an environment in which trainees felt safe taking risks in pedagogical activities and felt welcomed to ask questions to attending surgeons. Humiliation of trainees was criticized as counterproductive to the learning process. Many surgeons felt a duty to encourage a culture in which their trainees felt safe and respected.

   "The goal in the operating room is to keep it sort of relaxed because surgery is very stressful to begin with. It's a pretty intensive atmosphere. If you're walking in as a resident or a student, you're on edge. So as an attending, I think my job is to make sure you're relaxed and have fun and learn… I don't want to be the attending throwing things and yelling at people, because then you never learn. And that's what actually discourages students from picking surgery as a profession." (Interviewee #9)

2. *Accountability*. Most surgeons (8/12) created a culture of accountability in their educational practice. This included setting expectations of preparedness and active engagement from trainees, but at later stages in

training this took the form of responsibility and defending decision-making in patient management.

"My chief residents have a lot of freedom to make decisions on patients that I may call them out on. But as long as they can defend themselves, I'll say fine. And even in the operating room, they may want to do something a little bit different than I'm used to doing it. But if they can defend their choice then I tend to go with it and try to build them up with their own set of freedom." (Interviewee #2)

3. *Collegiality*. More than half of surgeons (7/12) noted that a culture of collegiality, in which trainees are treated with the same respect as faculty-level colleagues, was beneficial to the learning environment. Within this culture, treating trainees as peers, rather than promoting a top-down hierarchy, was helpful in forming engaging educational relationships.

"I had an attending who would – even [as] a medical student – . talk with me as if I was another fellow attending surgeon. And I think that impressed on me the importance of a give-and-take interaction with regards to teaching." (Interviewee #10)

"I consider [the residents] as family. I consider them as peers, colleagues. Treat them with respect. Treat them like I'd want someone treating one of my own kids." (Interviewee #12)

DISCUSSION

In-depth interviews of 12 academic surgeons considered effective surgeon-educators by their residents revealed numerous qualities and teaching methods that facilitated successful learning. These themes support well-described learning theories and provide contrast to others. Several themes suggest that many of these educators prefer "cognitive-based" learning approaches rather than behavioral ones. Cognitive learning theory is an educational construct that focuses on the importance of how the learner acquires and processes information to generate to knowledge.[20] Students are active participants in their own learning, and bring different backgrounds, skillsets, and motivations to the educational environment.[21] In contrast, "behavior-based" approaches are teacher-centric, where "learners are passive responders to environmental stimuli" and progress is quantified through specific outcomes.[21] The theme of multi-modal learning demonstrates this cognitive malleability and acknowledges that students and trainees may benefit from different learning approaches: auditory, visual, and physical teaching to appeal to learners more broadly.[22,23] Accountability – requiring trainees and especially chief residents to "think for themselves" and "defend" their actions – also reinforces a cognitive approach. Accountability and autonomy allow for "self-directed learning," which is a core tenet of not only cognitive learning, but also adult learning theory, which acknowledges that personal motivations of the learner are key drivers for growth and appetite for learning.[15,24] Self-directed learning is ubiquitous in medical education across all specialties and levels of training.[25–28]

In another nod to process over outcome-based learning, surgeons discussed the importance of allowing trainees to make mistakes. As one interviewee stated, "You have to be willing to recognize that sometimes mistakes will be made and you have to be. . .willing to take them as an attending and fix them, whatever way or shape or form that occurs" (Interviewee #1). For obvious reasons, allowing mistakes can be particularly challenging while also maintaining patient safety. But mistakes are often not forgotten and can be translated into vital educational experiences.[29,30] "Figuring it out" as means of knowledge generation through process is vital for cognitive learning.[21] In some respects, allowing mistakes may be viewed in direct opposition to behaviorism and competency-based learning. In a cognitive approach, failing can generate knowledge, while in behaviorism, failure is failure.

In addition to identifying preferred teaching styles, the call for psychological safety is particularly noteworthy. Psychological safety describes "the degree to which people view [their] environment as conducive to interpersonally risky behaviors like speaking up or asking for help".[31] While psychological safety is a known foundational concept in the field of organizational behavior and business,[32–34] its application to the medical learning environment is limited. Perceived psychological safety is a predictor of trainee satisfaction,[35] team performance and adaption,[31,36,37] and is a cultural value that promotes patient safety through error reporting and effective communication within the surgical team.[38–40] However, its potential impact on positive learning outcomes for housestaff is yet to be explored. A psychological safe environment is prerequisite for learning from past failures and may facilitate cognitive learning.[33] Cultivating psychological safety may also have a particularly important impact on education in the hierarchical organizational structures such as surgery, especially for junior residents who perceive more risk in their learning environment.[39]

Four interviewees discussed how teaching may prevent burnout in the educator. One interviewee stated, "I think that what we do in academics probably, to some degree, prevents [burnout] because every day is, from a clinical, academic and teaching perspective, very different." (Interviewee #1). Risk factors for burnout have been identified. Female surgeons, surgeons in private practice, those with less day-to-day job satisfaction or who perceive less autonomy, and those who work more hours per week are at higher risk.[41,42] Given the known devastating effects of surgeon burnout,[43,44] a potentially protective effect of teaching warrants further investigation. Trainees benefit from structured mentoring programs in residency,[42] and it is certainly reasonable to hypothesize that there might be a mutual benefit. Interestingly, psychological safety may play a crucial mediatory role in the relationship between teaching and burnout.[45]

This study is not without its limitations. Arguably the most important is the lack of gender diversity in the surgeon cohort, despite women comprising 35% of respondents and approximately 20% of faculty. While faculty were chosen from a variety of subspecialties and stages in their career, women were notably underrepresented. We consider this evidence of implicit bias both a limitation and a finding. Gender bias is well-documented in the surgical literature with global awareness now increased by the #ILookLikeASurgeon movement.[46–48] Interestingly, when the same resident cohort was asked for nominations for "highly humanistic surgeons" within our institution, women were relatively overrepresented in the top faculty (30%).[49] We do not know whether new themes would have emerged in a more diverse sample, but our results should be interpreted with this in mind.

The study setting was a single, large, urban academic medical center; thus, findings may lack generalizability to other institutions. Some residents may not have had exposure to all surgical faculty within the department. Interviewee demographics also skewed heavily to Caucasian males, which may limit transferability of our findings. Our survey response rate was low (55.8%), which may have introduced selection bias. While only 12 interviews were conducted, this represented approximately the top 15th percentile of nominated faculty. Attempting to expand the interview cohort could have diluted the sample. Those receiving fewer nominations may not be widely recognized as exemplary surgical educators, diminishing internal validity. These results are self-reported qualities and habits. Perceptions of their own behaviors may not actually be observed in and out of the operating room. At a minimum, however, the surgeons aspired to these qualities and teaching methods. Finally, while the surgical educators may express views that they find particularly important in education, we do not present objective data regarding the quality of the teaching provided or future surgical outcomes of the attendings or trainees.

CONCLUSIONS

We identified personal characteristics and teaching styles of highly effective educators in a cohort of academic surgeons. These surgeons, chosen by their own surgical residents, espoused educational values that support a cognitive-based learning approach. Many of the derived themes, such as learner autonomy, accountability, importance of prior surgical mentors, and education as a mission harken back to traditional, Halstedian values. At the same time, educators also saw the utility of newer approaches, such as creating a culture of psychological safety, multimodal learning, and teaching as a means of preventing self-burnout. These findings may shed light on best practices for modern surgical teaching approaches, and demonstrate the importance of dynamic, individualized learning. In contrast to the increasingly standardized and competency-based approach, the best educators seem to follow specific principles to customize education for each learner.

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ETHICAL APPROVAL

This study was approved by the Institutional Review Board at the University of Pennsylvania.

APPENDIX I

Suggested interview guide for faculty members participating in semistructured interviews.

Questions

1. Do you pay deliberate attention to being a surgical/clinical educator in the operating room as well as during clinic?

Suggested follow-up questions:

- What factors do you believe help you to be an exemplary teacher?
- What is the most personally satisfying or meaningful aspect of your work?
- How would you rate your degree of work-life balance/interference?
- How would you rate your degree of burnout with your job?
- Do you feel that burnout affects being a good teacher?
- Have you had any formal instruction or training in teaching/education?
- Previous recognition for teaching (e.g. teaching awards, etc.)?
- Any role models who were most pivotal in development of your role as an educator? Why were they influential? Please elaborate.

Suggested additional questions, if answered "yes" above:

- What factors do you believe help you to maintain positive attitudes toward patients and learners?
- What activities do you engage in on a regular basis to focus on clinical education in your practice (e.g. self-reflection on clinical practice, time spent on formal feedback and reflection on clinical practice, well-being and factors that promote well-being; deliberate attention paid to self-care)? Please elaborate on these topics.
- Is there anything else that motivates you to sustain you as a teaching role model?
- What experiences have you had in the past that influence your current teaching practices? These experiences can come from outside of medicine, preclinical (childhood, family upbringing, educational environment, personal or family experiences with illness), or clinical realms (e.g., med school, residency, or practice).

2. Based on your experience, what do you feel is the most effective teaching method in the operating room? In the clinic?
3. How would you describe your teaching style?
4. What resources might people benefit faculty to improve their teaching? To improve our residents' teaching skills?
5. If you were to design a curriculum to teach faculty how to be a good teacher, what components would be included? What methods do you think would be effective in increasing the importance of clinical education to other faculty?
6. Why do you think you were nominated by our residents as an outstanding teacher?

REFERENCES

1. Cameron JL. William Stewart Halsted. Our surgical heritage. *Ann Surg.* 1997;225(5):445–458.
2. Debas HT, Bass BL, Brennan MF, et al. American Surgical Association Blue Ribbon Committee Report on Surgical Education: 2004. *Ann Surg.* 2005;241:1–8.
3. Napolitano LM, Savarise M, Paramo JC, et al. Are general surgery residents ready to practice? A survey of the American College of Surgeons Board of Governors and Young Fellows Association. *J Am Coll Surg.* 2014;218:1063–1072. e31.
4. Cortez AR, Katsaros GD, Dhar VK, et al. Narrowing of the surgical resident operative experience: A 27-year analysis of national ACGME case logs. *Surgery.* 2018;164:577–582.
5. Drake FT, Aarabi S, Garland BT, et al. Accreditation Council for Graduate Medical Education (ACGME) surgery resident operative logs: the last quarter century. *Ann Surg.* 2017;265(5):923–929.
6. Mattar SG, Alseidi AA, Jones DB, et al. General surgery residency inadequately prepares trainees for fellowship: results of a survey of fellowship program directors. *Ann Surg.* 2013;258:440–449.
7. Schneider JR, Coyle JJ, Ryan ER, et al. Implementation and evaluation of a new surgical residency model. *J Am Coll Surg.* 2007;205:393–404.
8. Klingensmith ME, Awad M, Delman KA, et al. Early results from the flexibility in surgical training research consortium: resident and program director attitudes toward flexible rotations in senior residency. *J Surg Educ.* 2015;72:e151–e157.
9. Cogbill TH, Malangoni MA, Potts JR, Valentine RJ. The general surgery milestones project. *J Am Coll Surg.* 2014;218:1056–1062.

10. Malterud K. Qualitative research: standards, challenges, and guidelines. *Lancet.* 2001;358:483–488.

11. Roberts NK, Brenner MJ, Williams RG, et al. Capturing the teachable moment: a grounded theory study of verbal teaching interactions in the operating room. *Surgery*. 2012;151:643–650.

12. Sutkin G, Littleton EB, Kanter SL. How surgical mentors teach: a classification of in vivo teaching behaviors part 1: verbal teaching guidance. *J Surg Educ.* 2015;72:243–250.

13. Sutkin G, Littleton EB, Kanter SL. How surgical mentors teach: a classification of in vivo teaching behaviors part 2: physical teaching guidance. *J Surg Educ*. 2015;72:251–257.

14. Hu Y-Y, Peyre SE, Arriaga AF, et al. War stories: a qualitative analysis of narrative teaching strategies in the operating room. *Am J Surg*. 2012;203:63–68.

15. Pernar LIM, Ashley SW, Smink DS, et al. Master surgeons' operative teaching philosophies: a qualitative analysis of parallels to learning theory. *J Surg Educ*. 2012;69:493–498.

16. Chen XP, Sullivan AM, Smink DS, et al. Resident autonomy in the operating room: how faculty assess real-time entrustability. *Ann Surg.* 2018. https://doi.org/10.1097/SLA.0000000000002717. Epub ahead of print.

17. Foley G, Timonen V. Using grounded theory method to capture and analyze health care experiences. *Health Serv Res.* 2015;50:1195–1210.

18. Cochran A, Elder WB, Neumayer LA. Characteristics of effective mentorship for academic surgeons: a grounded theory model. *Ann Surg.* 2019;69(2):269–274. https://www.ncbi.nlm.nih.gov/pubmed/?term=characteristics+of+effective+mentioship+for+academic+surgeons. Epub ahead of print.

19. Strauss AL, Corbin JM. Basics of Qualitative Research: Grounded Theory Procedures and Techniques. Newbury Park, CA: Sage Publications; 1990.

20. McSparron JI, Vanka A, Smith CC. Cognitive learning theory for clinical teaching. *Clin Teach.* 2018. https://doi.org/10.1111/tct.12781. Epub ahead of print.

21. Kay D, Kibble J. Learning theories 101: application to everyday teaching and scholarship. *Adv Physiol Educ.* 2016;40:17–25.

22. Samarakoon L, Fernando T, Rodrigo C. Learning styles and approaches to learning among medical undergraduates and postgraduates. *BMC Med Educ.* 2013;25:13–42.

23. Lujan HL, DiCarlo SE. First-year medical students prefer multiple learning styles. *Adv Physiol Educ.* 2006;30:13–16.

24. Garrison DR. Self-directed learning: toward a comprehensive model. *Adult Educ Q.* 1997;48:18–33.

25. Barrows HS. Problem-based, self-directed learning. *JAMA*. 1983;250:3077–3080.

26. Slotnick HB. How doctors learn: physicians' self-directed learning episodes. *Acad Med.* 1999;74:1106–1117.

27. Lewis CE, Chen DC, Relan A. Implementation of a flipped classroom approach to promote active learning in the third-year surgery clerkship. *Am J Surg.* 2018;215:298–303.

28. Caplan R. The evolution of individualized CME. *Iowa Med.* 1991;81:48–49.

29. Engel KG, Rosenthal M, Sutcliffe KM. Residents' responses to medical error: coping, learning, and change. *Acad Med.* 2006;81:86–93.

30. Bosk CL. Forgive and Remember: Managing Medical Failure. 2nd ed Chicago: University of Chicago Press; 2003.

31. Edmondson AC, Higgins M, Singer S, Weiner J. Understanding psychological safety in health care and education organizations: a comparative perspective. *Res Hum Dev.* 2016;13:65–83.

32. Edmondson A. Psychological safety and learning behavior in work teams. *Adm Sci Q.* 1999;44:350–383.

33. Edmondson AC. Teaming: How Organizations Learn, Innovate, and Compete in the Knowledge Economy. 1st ed San Francisco: Jossey-Bass; 2012.

34. Wisdom J, Wei H. Cultivating great teams: what health care can learn from Google. NEJM, Catalyst. February 21, 2017. https://catalyst.nejm.org/psychological-safety-great-teams/. Accessed 7 December 2018.

35. Torralba KD, Loo LK, Byrne JM, et al. Does psychological safety impact the clinical learning environment for resident physicians? Results from the VA's Learners' Perceptions Survey. *J Grad Med Educ.* 2016;8:699–707.

36. Tucker AL, Nembhard IM, Edmondson AC. Implementing new practices: an empirical study of organizational learning in hospital intensive care units. *Manage Sci.* 2007;53:894–907.

37. Edmondson AC. Framing for learning: lessons in successful technology implementation. *Calif Manag Rev.* 2003;45:34–54.

38. Aubin D, King S. Developing a culture of safety: exploring students' perceptions of errors in an interprofessional setting. *J Interpr Care.* 2015;29:646–648.

39. Appelbaum NP, Dow A, Mazmanian PE, et al. The effects of power, leadership and psychological safety on resident event reporting. *Med Educ.* 2016;50:343–350.

40. Derickson R, Fishman J, Osatuke K, et al. Psychological safety and error reporting within Veterans Health Administration hospitals. *J Patient Saf.* 2015;11:60–66.

41. Pulcrano M, Evans SR, Sosin M. Quality of life and burnout rates across surgical specialties: a systematic review. *JAMA Surg.* 2016;151:970–978.

42. Elmore LC, Jeffe DB, Jin L, et al. National survey of burnout among US general surgery residents. *J Am Coll Surg.* 2016;223:440–451.

43. Dzau VJ, Kirch DG, Nasca TJ. To care is human - collectively confronting the clinician-burnout crisis. *N Engl J Med.* 2018;378:312–314.

44. Wallace JE, Lemaire JB, Ghali WA. Physician wellness: a missing quality indicator. *Lancet.* 2009;374:1714–1721.

45. Swendiman RA, Edmondson AC, Mahmoud NN. Burnout in surgery viewed through the lens of psychological safety. *Ann Surg.* 2019;269(2):234–235. https://www.ncbi.nlm.nih.gov/pubmed/30169397. Epub ahead of print.

46. Meyerson SL, Sternbach JM, Zwischenberger JB, Bender EM. The effect of gender on resident autonomy in the operating room. *J Surg Educ.* 2017;74:e111–e118.

47. Seemann NM, Webster F, Holden HA, et al. Women in academic surgery: why is the playing field still not level? *Am J Surg.* 2016;211:343–349.

48. Hughes KA. I Look Like A Surgeon goes viral: how it happened. *Bull Am Coll Surg.* 2015;100:10–16.

49. Swendiman RA, Marcaccio CL, Han J, et al. Attitudes and habits of highly humanistic surgeons. *Acad Med.* In press.