



Learning in the Operating Theatre: A Thematic Analysis of Opportunities Lost and Found

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OBJECTIVE: The operating theatre (OT) is an important learning environment. Trainees face barriers to learning in the OT that may reduce meaningful educational interactions. The impact of these barriers on the intraoperative learning experience of trainees and the strategies that they employ to overcome them are not known. This qualitative study aimed to describe the intraoperative learning experiences of senior general surgery trainees in Australia and their strategies to optimize learning in the OT.

DESIGN, SETTING, PARTICIPANTS: The authors developed a semi-structured interview guide based on published literature. Purposive sampling was used to identify a representative group of general surgery trainees in Australia, who were interviewed in a private setting with audio recordings deidentified for verbatim transcription and analysis. Thematic analysis was conducted using an interpretivist approach to produce a coding framework.

RESULTS: Ten trainees participated in the study. Themes were divided into external and internal barriers to learning, promoters of effective learning and actions to facilitate learning. External barriers included cultural neglect of an important issue, with inadequate prioritization of teaching and a lack of structure for intraoperative learning. From this, we identified the theme of missed opportunities. Internal barriers included difficulties in developing assertiveness required to address these issues and a failure to adequately plan for learning, with reliance on the

mentor to initiate. Actions to facilitate learning were rarely employed by trainees, as most were unaware of strategies to maximize intraoperative learning.

CONCLUSIONS: Trainees find the barriers to learning in the OT difficult to address and are not well acquainted with strategies that may allow them to maximize their learning. (J Surg Ed 78:1227–1235. © 2020 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgery, education, medical education

COMPETENCIES: Practice-Based Learning and Improvement

INTRODUCTION

The operating theatre (OT) is an important learning environment for surgical trainees, where they must develop technical skills, clinical experience, communication skills and judgement. Unfortunately, learning in the OT is often unguided and unstructured,^{1,2} with education expected to be a by-product of time spent in the OT. The teaching interactions that occur are often sporadic and unfocused,¹ occurring in fewer than 50% of observed cases³ and frequently do not include discussion of operative planning or wisdom derived from the surgeon's experience.³

Previous studies that have explored intraoperative education have focused on the importance of the teacher in optimizing learning,^{4–7} however both supervisor and trainee play an important role in the creation of a meaningful educational interaction.⁸ Although most surgical trainees are motivated and driven,⁹ many feel inadequately prepared for independent operating at the conclusion of training.^{10–13} It is likely that the root of

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this problem lies in the inevitable barriers that face both the surgeon and the trainee in the contemporary training environment, which must be successfully navigated before meaningful educational interactions can occur.⁸ The impact of these barriers on the intraoperative learning experience of general surgery trainees and the strategies that they employ to overcome them are not known.

This study aims to describe the intraoperative learning experience of senior general surgery trainees in Australia and to explore the strategies they employ to access and optimize learning in the OT.

MATERIAL AND METHODS

The University of Melbourne Human Ethics Advisory Group and the General Surgeons Australia Research Subcommittee approved the study.

Participants

All current final or penultimate year general surgical trainees in Australia were considered for inclusion in the study and were contacted by email through the Royal Australasian College of Surgeons. There were no exclusion criteria. This included a single mail-out to approximately 240 trainees. Participants received a plain language statement that explained the project and what their participation would involve. We received 18 responses and used purposive sampling was used to include trainees from different training locations. The demographic characteristics of this population was representative of Australian general surgical trainees.^{14,15}

All trainees work in the public setting at academic centers or university-affiliated sites. We conducted 10 interviews before reaching data sufficiency.

Data Collection

This qualitative study utilized semi-structured interviews to explore trainees' experiences with intraoperative education. We developed an interview guide based on a comprehensive review of the literature,^{1,4,5,7,8,10,16–31} with input from all 3 authors (AP, senior surgical trainee completing Master degree in surgical education; DN, university professor with a PhD in medical education; BL, practicing surgeon and senior lecturer with an interest in surgical education). It was pilot tested on BL and a final-year surgical trainee before its use with study participants. The primary researcher (AP) conducted all interviews on Skype (Microsoft, Redmond, Washington) and verbal consent was obtained. Each interview lasted 30 to 50 minutes and was conducted in a private setting with audio-recording. Initial questions explored the trainee's experience with learning in the OT. Subsequent

questions focused on their approach to learning, barriers to learning as well as factors and strategies that allow them to better access learning from supervisors in the OT. The semi-structured interview format allowed modification or addition of questions to explore themes as identified. Recordings were transcribed by an online independent transcription agency. All transcripts were checked for accuracy against the original recordings and de-identified prior to analysis.

Data Analysis

We determined sample size by data sufficiency, which occurs when new information from additional participants produces little or no change in the findings. Although sample size from various geographic sites was small, there were no site-specific themes identified and the homogeneity of the responses indicated thematic saturation was achieved. Thematic analysis³² was conducted using an interpretivist approach to produce a coding framework. Investigator (AP) developed a preliminary coding framework based on initial transcripts. Investigator (AP) coded all transcripts, and the other investigators independently coded 2 transcripts to ensure agreement between investigators. Investigators compared their codes and reached consensus through discussion in the case of disagreement, negotiating the final coding framework. An immersion and/or crystallization approach³³ was used, examining data in detail with intermittent periods of reflection to identify and articulate themes and subthemes.

RESULTS

Participants

Ten senior surgical trainees participated in the study. Trainees were based in a variety of university-affiliated training centers across Australia. Demographic details are summarized in [Table 1](#). One trainee had previously completed a higher degree in the field of surgical education.

Major Themes

A data corpus of 370 minutes of recorded interviews was analyzed (median interview time 37 min; range 30-49). Analysis resulted in the identification of 386 extracts, which were initially grouped into 34 codes. By merging codes and structuring hierarchically, we identified 3 main themes: "barriers to learning," "promoters of effective learning," and "actions taken to maximise learning." Representative quotations are listed in the corresponding tables.

TABLE 1. Demographic Details

	Number of Trainees (n = 10)
Age	
30-34 years	3
35-39 years	6
40+ years	1
Sex	
Male	5
Female	5
SET year	
4	2
5	7
5+	1
Training State	
New South Wales	2
Queensland	1
South Australia	1
Victoria / Tasmania	5
Western Australia	1

Barriers to Learning

We developed a hierarchy of barriers to learning, with the first order division defined as external and internal barriers, and assigned subthemes within this hierarchy (Tables 2 and 3).

External Barrier: Nonmodifiable Factors. The nonmodifiable external barriers to learning are common to all training units and are beyond the control of the trainee. They included time pressure, the composition of the theatre team and the circumstances of the patient. All trainees acknowledged these barriers as a factor that affects learning in a real-world environment and an unavoidable part of surgical training. They were aware that it is not appropriate for them to be the primary operator in all cases and that their supervisors' other responsibilities influenced the available time for teaching.

In Australia, many units also run post-fellowship training programs. Having a fellow on the unit can have positive and negative effects on a trainee's operative exposure, depending on the fellow's level of seniority and teaching skills. Some trainees thought that they had missed out on a significant amount of operative teaching with priority given to fellows and difficulty sharing components of the cases.

External Barrier: Lack of Structure and Prioritization of Education.

All trainees highlighted the lack of structure and prioritization of intraoperative teaching and learning during their training. They described the nature and content of their operative learning experience as haphazard and highly dependent on factors beyond their control. In addition to lack of structure, participants described a cultural neglect of what they see as an important issue.

TABLE 2. External Barriers to Learning

Nonmodifiable factors
<i>"It makes a big difference that the list isn't already massively overbooked or there's pressure to do other things, (such as) emergency cases. . . Time (pressure) also in terms of when your supervisor needs to go. . . you know, if they have other commitments"</i>
<i>"I've felt that. . . you'll actually miss out on quite a bit of primary operating because they (the fellow) don't feel confident in their own skills to be able to teach you that skill. So, therefore you don't do any part of it. You just assist them."</i>
Lack of structure and prioritization of education
<i>"I think there's no structure (to operative teaching). I think some surgeons have structure and it's absolutely fantastic, but I think most surgeons don't do it in a structured way and it's terrible"</i>
<i>"It would really help the registrars (if there were more structure to intraoperative education) because we're really learning on our own, ad hoc things from here, there and everywhere but there's no system. There's no system to this madness."</i>
<i>"I've noticed like the anaesthetic team will take time to teach their juniors. The scrub team will take time to teach their juniors, but yet the surgeons, we don't defend that time."</i>
<i>"What I wanted was him to just to scrub in and help me do the case. . . show me during the case. But it was either he does it or he's not involved at all. It was a real struggle and. . . I couldn't really find a way around that."</i>
<i>"I think we'd need to highlight a quarantine time... I know everyone wants to get on with life... They need to sort of build that into the system. It's a systems issue"</i>
<i>"Like a sincere, hardworking person. And I think that's, that's the basic requirement of any surgical registrar... and if you have that, I think the surgeon. . . should feel obligated to teach you. But I don't think they feel obligated to teach. They are conscious that surgical trainee has certain numbers to fulfil. . . but I don't think they feel obligated (to teach)"</i>
<i>"It is both haphazard in the supervision that I've had and the preparedness of supervisors to teach. . . I think there's certainly scope to have a more structured approach to intraoperative teaching, requiring some preparation at the beginning of each case."</i>

They contrasted the lack of prioritization that teaching receives within surgery, with the teaching behaviors they have observed in other specialties.

This lack of prioritization extended to implicit expectations about when and how teaching would occur. Some trainees thought that despite fulfilling their role as a competent surgical trainee, many supervisors did not recognize a duty to teach them intraoperatively. They accepted that certain supervisors are not expected to teach and struggled with escalating the issue. As 1 trainee outlined, even when a supervisor is willing to allow the trainee to operate independently, it can still be difficult to have meaningful educational interactions if education is not seen as a priority.

TABLE 3. Internal Barriers to Learning

Waiting to be taught

"I don't necessarily think about what I'm going to learn that day going into theatre"

"It's very easy to just go to a list and assist"

"I take it as part of training... you will meet consultants who don't give you a lot and you will meet consultants that are very giving... That's how it is. We've all just accepted it"

"It's hard (when) it's sort of a constant thing (not letting trainees operate)... where it's not just me, it's been people before me and it'll be people after me... I know it's hard cause you don't want to be annoying... I didn't want to be annoying them every week trying to say I need to do this case."

"I wasn't confident enough to (initiate learning)... They (the surgeons) would often apologize. 'I really should let you do this case, but we've got a lot to do so I'll have to do this one.' And it would happen again and again and again."

Lacking assertiveness

"I'm still not very good at it... I think it's important to ask... but I think sometimes I hesitate... I almost think they're not going to give (it to) me, so there's no point asking... or I think... they might be anxious... So then I don't ask... (I try) not to bother them too much while they are operating."

"I thought I'd get onto SET training and (it would) be like, come and learn how to do this and come and do this. Then I learned that if I am not assertive, which I have not been very good at doing, no one's going to invite you to come in and do things. You have to be assertive and put yourself out there."

"There's the (consultants) who are not going to let you, and were never going to let you (regardless of whether you ask for the opportunity to operate), that's how I would see the situation anyway."

"I think if you don't have it (assertiveness), you will lose out... you suffer in silence... then after a while you get frustrated... and then you come to terms with it, you accept it and then you hope that the next rotation will be better."

"I realize that now that we're more senior. The buck is going to stop with us. So it is more important that we learned certain things."

"I think as a trainee we should be... actually trained to ask... (for) permission to operate. Because you do miss out a lot of good cases"

"You're dealing with so many different personalities, times, conflicting confounding factors, you have to create your own opportunity and your own experience sometimes. Otherwise, there's so many times, especially when we were junior, you just feel disgruntled and frustrated and think how am I going to learn if I don't get the opportunity to do it."

Self-Doubt

"If I feel like I'm being reassured and confident... with what I'm doing, then I'll be more relaxed and just... be able to crack on. Whereas... if I get criticized, um, particularly depending on the way the criticism comes through, if it's not constructive, then I think I'll often get a bit nervous and then it ends up kind of being a downward spiral where then I'm more likely to not look confident."

"It (confidence) is massively important. If I am under pressure with someone breathing down your neck... I find I just do

silly things... I do things I wouldn't normally do, or I am hesitant while operating... I'm certainly not as good an operator when I'm under like psychological pressure. If there is time pressure or a sick patient where I'm by myself, that's fine. Like I can do the normal thing. But it's more the interpersonal pressure. If I sense that... then I think my performance is impaired."

Internal Barrier: Waiting to Be Taught. Trainees described a passive approach to intraoperative learning and often struggled to instigate learning opportunities. All trainees acknowledged the importance of being mentally prepared for a learning experience, however, also reflected that they do not always actively plan for learning in the OT. One of the important internal barriers to learning was the tendency of trainees to rely solely on the supervisor to initiate teaching.

Internal Barrier: Lacking Assertiveness. When no teaching eventuated, trainees preferred to accept the situation as the status quo: as the situation facing all trainees, that would be difficult and futile to attempt to address. Trainees did not lack motivation or enthusiasm to operate, but rather wanted to protect their relationship with the supervisor by avoiding what they perceived would be an uncomfortable conversation.

Trainees described difficulty in being assertive with their supervisor in the OT. The relationship between the surgeon and trainee is inherently shaped by the power dynamic that exists, and trainees strive to ensure the relationship remains positive. Therefore, to avoid disagreement, trainees accept the operative opportunities offered to them by their supervisor as a reflection of what they deserve. When not given the chance to operate, trainees tended to rationalize why they were not entrusted, usually to avoid the frustration of a missed learning opportunity. Trainees lacked the skills to create opportunities for themselves and described appreciating the importance of being assertive as they reached the end of the training program. They regretted the missed opportunities. Developing assertiveness appeared closely linked with the evolution of the trainee's clinical identity as the surgeon - when the trainee makes the mental transition to adopt the mindset of the surgeon and begins to see themselves as the one responsible for the patient, rather than as an assistant to the supervisor.

Internal Barrier: Self-Doubt. Internal stressors had a powerful effect on trainee performance and ability to learn in the OT. Feelings of anxiety or inadequacy led to a downward spiral of worsening performance and increasing feelings of uncertainty. Trainees highlighted the importance of positive feedback in maintaining the confidence required to perform well. The support of a supervisor

(continued)

facilitates the trainee's self-assurance that allows them to relax and focus on the operation. Conversely, when the supervisor does not provide this, both the trainee's performance and ability to learn are adversely affected.

The potency of these feelings of self-doubt hinge on the importance of confidence, competence, and certainty to the trainee's surgical identity as well as the perceived importance of their supervisor's opinion of them. These stressors posed a far greater challenge to the trainee than other external stressors.

Factors That Promote Effective Learning

The Qualities of the Supervisor. All trainees agreed on the value of a supportive supervisor and described patience and an encouraging nature as key attributes of a good teacher. They noted that the teaching behaviors of good teachers were not governed or constrained by the many external pressures that have the potential to adversely impact learning in the OT (Table 4).

Safe Struggle. The most valuable learning experiences described by trainees centered on the moments in which their supervisors offered support or guidance, but continued to entrust the trainee with the control of the

operation, allowing them to safely explore their zone of proximal development.¹⁹

Reputation. As the determinants of entrustment were explored, we identified the sub-theme of "reputation." Trainees described the importance of their supervisors' perceptions of them in determining their level of operative involvement. In particular, many highlighted the positive effect of demonstrating competence when presenting their preoperative assessment and management of the patient.

Actions Taken to Facilitate Learning

Lack of Specific Strategies. Actions to facilitate learning were rarely employed by trainees and many were unaware of specific strategies that can be used to maximize intraoperative learning. As 1 trainee described, it is not something that receives focus during their training. When posed with the open-ended question "how do you maximize your learning in the OT?," trainees did not volunteer specific strategies beyond preoperative preparation. When specifically questioned about the other described techniques, they acknowledged their benefit and reflected on positive learning experiences that had been associated with their use when initiated by a supervisor. However, they did not conceptualize them as strategies that they could initiate or had actively employed during their training (Table 5).

Preoperative Preparation. Trainees recognized that preparation is crucial in maximizing learning in the OT. It demonstrates to the supervisor that the trainee is taking responsibility for their learning and prompts them to include the trainee to a greater extent. It also boosted trainees' self-confidence and ability to perform. Trainees regretted their lack of preparation for learning during their training.

Structuring Goals and Part-Task Training. Formally structuring goals with a supervisor at the start of a rotation was a strategy that allowed trainees to better understand their training needs, and to feel empowered to negotiate operative opportunities. Furthermore, on a day-to-day basis, structuring goals preoperatively affords the trainee the benefits of part-task training.³⁴ They are able to tackle manageable components of a procedure that are appropriate for their level of training and avoid cognitive overload,³⁵ while maximizing the scaffolding component of the cognitive apprenticeship model.^{36,37} Part-task training is underutilized and helps to mitigate the time pressures that often prevent trainees from doing cases, as well as ensuring that the trainee's learning needs will become an active consideration in the supervisor's operative plan. Consequently, neither the supervisor nor the

TABLE 4. Factors That Promote Learning

The qualities of the supervisor
"With the surgeons that are like that (good teachers), no matter who the theatre staff is, how rushed they are, how stressed they are, it would always be like that."
"I think the surgeons that are good teachers will always find something intraop to teach you, irrespective of it being a difficult case, irrespective of the environment, they always find something to teach you."
Safe struggle
"Surgeons who will not take over as soon as I get into trouble or if I'm not sure... I've learned best when... they stop and they say, 'well, what do you think is going wrong?' Or 'what would you do next?' Or 'do you want me to take over?' Or they might say... 'no, I'm not going to take over. You need to do this, look at the screen, look at this point and I want you to do (it) this way.' And I think that's when I learned the best. When they just pushed me that little bit. But under supervision... then you realize, oh, actually I can do this. Now that they've made me do this, I feel a little more confident."
Reputation
"I've always found if I've read up on it or taken an active interest in it, not only am I able to ask more... questions through the case and that might... make the surgeon feel I'm also involved and then they might make me... more involved in the case as well."
"It's a whole spectrum from the time... you first ring them up... when you're on call with them, to when you first ward round with them... it's every interaction that builds up to your operating."

TABLE 5. Actions Taken to Facilitate Learning

Lack of specific strategies

"It's not really something that I've focused on specifically. . . Not in terms of my actual learning improvement. . . I just assumed that with repetition. . . I'll eventually get the hang of it. . . In the old days, surgical trainees worked a lot harder, worked way more hours. They did more work after hours by themselves. Just through sheer numbers and time and working really, really hard, you would just get the hang of it. . . We don't have the same opportunities as our mentors. . . so every learning opportunity needs to be maximized."

Preoperative preparation

"(Be well prepared) so I can ask insightful questions. Not just to impress the person, but to actually make them realize "Oh, she's thought about it." You come on the same level as them. You're not asking basic questions, you're asking stuff to do with the (particulars of) the procedure. That allows the surgeon. . . to talk with you about it and make you feel more involved and included."

"I've gone a couple of years. . . floating through without really knowing why. But if I had just asked more early on, I think that I would have got more out of it."

Structuring goals and part-task training

"What I wish I had done (throughout my training). . . and what I now (tell) people to do, especially it's the unaccredited regs. . . is to set out (your goals) at the start of your rotation. . . say "this is what I'm aiming to get to at the end." And if you set it out, then you don't feel so embarrassed saying "can I do the operation?"

"Component learning is really important. . . it means that the trainee doesn't become overwhelmed. . . And going back and forth between assisting, having you go and then assisting again because I think once you've tried to do it yourself, then you'll appreciate a whole lot more what the surgeons doing in certain parts of the operation."

"The best way I learn is if I know at some point the surgeon will ask me to take over, you know, even if it is for a small section of the operation, even if it is for a couple of minutes, they tell me I will do this part. . . I think that's when I started focusing a lot more."

Feedback

"Something that's not often done that I've heard talk about is debriefing after the procedure to think about how that experience was, how did you go?"

"You have to actively solicit because everyone's busy. Everyone's thinking about something else."

Mental rehearsal and shared mental model

"What I have found valuable is the theatre experiences when we've taken a few minutes before the case to talk about what we're going to do, have a look at the imaging together. And, so then it makes me feel like I am operating with them, not just assisting them. . . they will allow me opportunities to do things in the case that they were comfortable for me to do."

"When bosses do that kind of, um, conversation before the theatre case started. . . that's been valuable. . . some bosses are good at saying these. . . (are) parts of the operation that I will need to get used to doing and talk you through."

trainee will feel uneasy or resentful when the supervisor resumes control of the operation once the trainee has completed the agreed component.

Feedback. From a first-principles perspective, trainees recognized the value and importance of feedback and reflection, yet lacked the knowledge to instigate their use in a practical way. Apart from the "prescribed" mid-term and end-of-term feedback sessions, these tools were not commonly employed by trainees. There was a perception that supervisors do not have time for this process.

Mental Rehearsal and Shared Mental Model. The concepts of mental rehearsal and construction of a shared mental model were not familiar to trainees. They understood their importance but did not identify them as specific learning strategies that can be actively employed. For example, although not specifically aware of the Briefing, Intraoperative teaching, Debriefing model,¹ trainees recognized the value of a preoperative discussion with the surgeon to frame the learning objectives for the case, yet rarely initiated this process.

DISCUSSION

This qualitative study explored the experience of senior general surgery trainees with learning in the OT. They described a number of barriers to effective learning that echoed what has been described in the surgical education literature,^{12,22,38} yet highlighted the fact that they are rarely discussed among surgical trainees. In addition to the inevitable nonmodifiable pressures and contextual barriers, trainees reflected on the lack of structure, and prioritization of education in the OT. In addressing these problems, trainees worry about unnecessarily burdening their supervisors and potentially damaging the complex and invaluable mentor-mentee relationship, despite acknowledging that supervisors appear to enjoy teaching interactions when they do occur. Because of the importance of the mentor-mentee relationship to trainees – a unanimously expressed sentiment among respondents – and their lack of familiarity with the educational strategies to promote learning, they feel unable to successfully navigate barriers to learning and hence tend to accept the situation as the status quo.

This issue of lack of prioritization of intraoperative teaching was a common theme raised by trainees and most felt unable to effectively address the issue. They relied on time spent with positive supervisors to gain experience, however tended to simply accept the

situation if they were working with a supervisor who would not prioritize teaching. Historically, the sheer number of hours spent in the OT accounted for the fact that pure teaching moments²⁹ may not occur frequently enough to allow optimal learning^{1,3} and that teaching interactions are often sporadic and unfocused.¹ However, with the modernization of the surgical training environment, the methods and structure of intraoperative teaching must also evolve. Trainees must better understand the nature of the barriers to learning they encounter and need guidance in developing practical management strategies. Previous studies have concentrated on the role of the supervisor in driving the educational relationship, with authors suggesting the need for an analysis of the teaching culture within the surgical department to improve the teaching environment.⁷ We propose that trainees should be included when addressing the issue. Understanding the OT as a learning environment and addressing the relevant theoretical considerations would provide trainees with a framework and strategies to overcome the barriers that they face. The fact that trainees reflected on the value of such strategies when specifically questioned yet lacked the familiarity and skills to independently employ them as learning tools highlights an important target for educational intervention.

Trainees may benefit from a better understanding of the central tenets of the cognitive apprenticeship model (modelling, coaching, reflection, articulation, and exploration)³⁶ to be able to access learning opportunities in the OT. Supervisors and trainees agree the most effective intraoperative teaching strategies include having an instructional plan,⁸ with a preoperative discussion of the case, including the “steps” and potential pitfalls, providing “real-time” intraoperative feedback, and postoperatively providing specific examples of what needs to be improved and what was done well.⁷ Based on the literature review and our findings, it appears that a preoperative discussion between trainee and surgeon rarely occurs.³⁰ Similarly, feedback and reflection are not effectively utilized by trainees,³⁹ despite the fact that they have been demonstrated to improve technical performance in surgery.^{40,41} We propose that through additional focus on educational theory, these issues would be addressed. For example, if trainees were provided with a simple and time-efficient structure to initiate the process, such as the “educational time-out”⁴² or the Briefing, Intraoperative teaching, Debriefing model,¹ it is likely they would achieve as significant improvement in the level of educational engagement from their supervisor.

The strategy of mental rehearsal⁴³ represents another underutilized technique that has the potential to improve a trainee’s intraoperative learning experience.

Such targeted preparation not only clarifies learning objectives, but it reduces the trainee’s cognitive load³⁵ and hence maximizes the attention that can be devoted to learning during the case. In combination with part-task training,³⁴ trainees would feel empowered to instigate an alignment of goals with their supervisor preoperatively, more clearly articulate the learning components of the case and be mentally prepared to scaffold the “teachable moments” that may arise. Furthermore, these strategies may help to mitigate the feelings of self-doubt that have such a profound adverse impact on intraoperative learning.

It must be acknowledged that teaching trainees about the educational theory relevant to learning in the OT may not translate into a sustained change in behavior. Furthermore, didactic teaching at a single time-point is unlikely to result in any meaningful application of these techniques on an ongoing basis. Therefore, we propose that a peer-peer coaching intervention targeting junior and senior trainees may be an effective and feasible way to pragmatically address this issue and future research will address this.

The limitations of this study include potential responder bias, as study participants were invited to participate by email. It is possible that trainees who had had bad experiences with intraoperative education, or those who were particularly interested in the topic were more likely to respond. Therefore, although similar in terms of demographic characteristics, we are unable to be certain that the group of trainees interviewed in this study is truly representative of the population of general surgery trainees in Australia with respect to learning behaviors. However, given that surgical trainees are already a highly selected cohort of intelligent and conscientious doctors, we believe the description of these issues still to be an important finding, even if they do not affect all trainees. Secondly, the study was limited to trainees of the Australian Surgical Education and Training program and therefore we approach generalizing the results with care. However, we believe that our results resonate with the international literature.

CONCLUSIONS

Trainees find the barriers to learning in the OT difficult to address and are not well acquainted with strategies that may allow them to optimize their learning. Future research may determine whether incorporating educational theory into the surgical curriculum helps future trainees engage more productively with their supervisors and whether a peer-peer coaching intervention may allow habitual utilization of the techniques to maximize learning in the OT.

ETHICAL APPROVAL

The University of Melbourne Human Ethics Advisory Group 28/08/2019, 1954799.1.

PREVIOUS PRESENTATIONS

None.

REFERENCES

1. Roberts NK, Williams RG, Kim MJ, et al. The briefing, intraoperative teaching, debriefing model for teaching in the operating room. *J Am Coll Surg.* 2009;208:299–303.
2. Mayer RE. Should there be a three-strikes rule against pure discovery learning. *Am Psychol.* 2004;59:14.
3. Scallon S, Fairholm D, Cochrane D, et al. Evaluation of the operating room as a surgical teaching venue. *Can J Surg.* 1992;35:173–176.
4. Cox SS, Swanson MS. Identification of teaching excellence in operating room and clinic settings. *Am J Surg.* 2002;183:251–255.
5. Iwaszkiewicz M, DaRosa DA, Risucci DA. Efforts to enhance operating room teaching. *J Surg Educ.* 2008;65:436–440.
6. Ko CY, Escarce JJ, Baker L, et al. Predictors of surgery resident satisfaction with teaching by attendings: a national survey. *Ann Surg.* 2005;241:373.
7. Vollmer CM, Newman LR, Huang G, et al. Perspectives on intraoperative teaching: divergence and convergence between learner and teacher. *J Surg Educ.* 2011;68:485–494.
8. Vikis EA, Mihalynuk TV, Pratt DD, et al. Teaching and learning in the operating room is a two-way street: resident perceptions. *Am J Surg.* 2008;195:594–598.
9. Monkhouse S. Learning in the surgical workplace: necessity not luxury. *Clin Teach.* 2010;7:167–170.
10. Bell Jr RH, Biester TW, Tabuenca A, et al. Operative experience of residents in US general surgery programs: a gap between expectation and experience. *Ann Surg.* 2009;249:719–724.
11. 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.
12. Teman NR, Gauger PG, Mullan PB, et al. Entrustment of general surgery residents in the operating room: factors contributing to provision of resident autonomy. *J Am Coll Surg.* 2014;219:778–787.
13. Yeo H, Viola K, Berg D, et al. Attitudes, training experiences, and professional expectations of US general surgery residents: a national survey. *Jama.* 2009;302:1301–1308.
14. McDonald RE, Jeeves AE, Vasey CE, et al. Supply and demand mismatch for flexible (part-time) surgical training in Australasia. *Med J Aust.* 2013;198:423–425.
15. Royal Australasian College of Surgeons Activities Report, 2019. https://www.surgeons.org/-/media/Project/RACS/surgeons-org/files/reports-guidelines-publications/workforce-activities-census-reports/RACS_ActivitiesReport_2019_Final.pdf?rev=18f6e4d0106342c39ffdd701cf8e-c260&hash=95CA575D81347EFD5B37908FC8-FECB9D. Assessed November 18, 2020.
16. Ong CC, Dodds A, Nestel D. Beliefs and values about intra-operative teaching and learning: a case study of surgical teachers and trainees. *Adv Health Sci Educ.* 2016;21:587–607.
17. Sandhu G, Magas CP, Robinson AB, et al. Progressive entrustment to achieve resident autonomy in the operating room: a national qualitative study with general surgery faculty and residents. *Ann Surg.* 2017;265:1134–1140.
18. Sandhu G, Nikolian VC, Magas CP, et al. OpTrust: validity of a tool assessing intraoperative entrustment behaviors. *Ann Surg.* 2018;267:670–676.
19. Sadideen H, Kneebone R. Practical skills teaching in contemporary surgical education: how can educational theory be applied to promote effective learning. *Am J Surg.* 2012;204:396–401.
20. Champagne BJ. Effective teaching and feedback strategies in the OR and beyond. *Clin Colon Rectal Surg.* 2013;26:244.
21. Butvidas LD, Anderson CI, Balogh D, et al. Disparities between resident and attending surgeon perceptions of intraoperative teaching. *Am J Surg.* 2011;201:385–389.
22. Moulton C-A, Regehr G, Lingard L, et al. Operating from the other side of the table: control dynamics and the surgeon educator. *J Am Coll Surg.* 2010;210:79–86.

23. Ahmed M, Arora S, Russ S, et al. Operation debrief: a SHARP improvement in performance feedback in the operating room. *Ann Surg.* 2013;258:958-963.
24. Bonrath EM, Dedy NJ, Gordon LE, et al. Comprehensive surgical coaching enhances surgical skill in the operating room: a randomized controlled trial. *Ann Surg.* 2015;262:205-212.
25. DaRosa DA, Zwischenberger JB, Meyerson SL, et al. A theory-based model for teaching and assessing residents in the operating room. *J Surg Educ.* 2013;70:24-30.
26. Timberlake MD, Mayo HG, Scott L, et al. What do we know about intraoperative teaching?: a systematic review. *Ann Surg.* 2017;266:251-259.
27. Meyerson SL, Teitelbaum EN, George BC, et al. Defining the autonomy gap: when expectations do not meet reality in the operating room. *J Surg Educ.* 2014;71:e64-e72.
28. Pernar LI, Breen E, Ashley SW, et al. Preoperative learning goals set by surgical residents and faculty. *J Surg Res.* 2011;170:1-5.
29. 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.
30. Snyder RA, Tarpley MJ, Tarpley JL, et al. Teaching in the operating room: results of a national survey. *J Surg Educ.* 2012;69:643-649.
31. Hauge LS, Wanzek JA, Godellas C. The reliability of an instrument for identifying and quantifying surgeons' teaching in the operating room. *Am J Surg.* 2001;181:333-337.
32. Braun V, Clarke V. *Successful Qualitative Research: A Practical Guide for Beginners.* sage; 2013.
33. Crabtree B, Miller W. *Research methods for primary care.* Doing Qualitative Research, 3. Thousand Oaks, CA, US: Sage Publications, Inc; 1992.
34. Spruit EN, Band GP, Hamming JF, et al. Optimal training design for procedural motor skills: a review and application to laparoscopic surgery. *Psychol Res.* 2014;78:878-891.
35. Van Merriënboer JJ, Sweller J. Cognitive load theory in health professional education: design principles and strategies. *Med Educ.* 2010;44:85-93.
36. Collins A, Brown JS, Holum A. Cognitive apprenticeship: Making thinking visible. *Am Educ.* 1991;15:6-11.
37. Reznick RK. Teaching and testing technical skills. *The Am J Surg.* 1993;165:358-361.
38. Kiran RP, Ali UA, Coffey JC, et al. Impact of resident participation in surgical operations on postoperative outcomes: National Surgical Quality Improvement Program. *Ann Surg.* 2012;256:469-475.
39. Ahmed M, Sevdalis N, Paige J, et al. Identifying best practice guidelines for debriefing in surgery: a tri-continental study. *Am J Surg.* 2012;203:523-529.
40. Rogers DA, Regehr G, Howdieshell TR, et al. The impact of external feedback on computer-assisted learning for surgical technical skill training. *Am J Surg.* 2000;179:341-343.
41. Hamad GG, Brown MT, Clavijo-Alvarez JA. Postoperative video debriefing reduces technical errors in laparoscopic surgery. *Am J Surg.* 2007;194:110-114.
42. Lillemoe HA, Stonko DP, George BC, et al. A preoperative educational time-out is associated with improved resident goal setting and strengthens educational experiences. *J Surg Educ.* 2020;77:18-26.
43. Arora S, Aggarwal R, Sirimanna P, et al. Mental practice enhances surgical technical skills: a randomized controlled study. *Ann Surg.* 2011;253:265-270.