



AOA Critical Issues in Education

Teaching in Orthopaedic Surgery: Effective Strategies for Educating the Modern Learner in a Modern Surgical Practice

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Abstract

Prioritizing the education of orthopaedic surgery residents and fellows is essential for the future of the field. This review highlights strategies that educators may find useful in improving their teaching skills for the modern orthopaedic surgery learner. Educators may benefit from focusing on active, effortful, and repetitive engagement in lecture; setting clear expectations to help track progress in clinic; and breaking skills into smaller steps in context of a framework when teaching procedural skills. Providing objective assessment and growth-oriented feedback helps establish a close rapport between educator and trainee while encouraging personal development. Through a remediation process that examines deficiency in core areas and equitability of the learning environment, the trainee and the educator may engage in a fair discussion that prevents trainees from falling behind. Finally, in the era of COVID-19, e-learning and virtual simulations have become increasingly used as effective modalities for teaching clinical knowledge and procedures to trainees. The medical education landscape has been changing at a rapid pace, and by evaluating and adapting to the novel educational models of today, the modern orthopaedic surgeon ensures a learning environment that is equitable, effective, and inspiring for the orthopaedic surgeon of tomorrow.

Early surgical education relied heavily on an apprenticeship model with senior clinicians, supplemented by classical texts. This educational process historically lacked universal guidelines for quality control, curriculum standards, or graduation standards¹. Throughout the 20th and 21st centuries, advancements in modern medical education including competency-based training programs have been paired with improvements in our understanding of how adults learn. Changes in educational models may challenge surgical educators searching for the most effective ways to

meet educational expectations, particularly in a practice environment with increasing administrative and financial burdens. Despite important advances in teaching through simulation, the foundation of surgical education remains dependent on teaching in the office and operative setting.

The purpose of this review was to update orthopaedic educators on key elements of effective teaching in surgical education. The review will cover principles of modern adult education with specific strategies for effective and efficient teaching

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for in-person and virtual lectures, the office, and the operating room. Approaches to engage with various types of learners and the importance of appropriate communication with practical tips for providing effective feedback will also be reviewed.

Principles of Educating the Modern Learner

Clinical education must consider social context, including generational differences in expectations, priorities, and learning styles. Millennials, who are growing to be at the forefront of medicine and health care, have been described as collaborative, tech-savvy, interconnected through social networks, and feedback-driven¹⁻³. They desire active, engaging, and multimedia forms of learning that extend beyond traditional didactics. Critical components of teaching that can be optimized for modern orthopaedic surgery learners include goal setting, collaboration and team-based learning, feedback, mentorship, and utilization of technology.

Modern trainees are generally more open about asking for help than prior generations. As such, explicitly setting clear goals early can focus trainees and bridge the gap between expectation and competency⁴. They are a feedback-seeking, success-oriented and improvement-oriented generation generally preferring a less structured, collegial type of feedback known as formative feedback^{4,5}. In contrast to previous models of surgical education, trainees today reject the fear-based culture of reprimand or shame, preferring personalized mentorship, which allows for closer and direct observation, thereby facilitating an active, hands-on learning process^{6,7}. Modern learners expect mentors to be accessible and flexible, having direct verbal and written communication, emphasizing on collaboration, leadership, and professionalism. Collaboration and teamwork have also become a cornerstone in today's training environment^{6,8-10}. Peer mentoring and encouraging teamwork have been shown to facilitate effective support, reduce potential for academic competition and stress, and lessen feelings of isolation^{4,7,11}.

In contrast to the lengthy didactics of prior medical education, technology-based and interactive teaching modalities are

more effective for trainees today, who have grown up amidst an explosive progression of technology. Social media platforms can allow mentors to engage trainees by using instant messaging to deliver teaching pearls, which allows for immediate user response and to share teaching conversations with a larger number of students². Social media has also emerged as a platform for networking and fostering mentorships—up to 14% of orthopaedic surgeons reporting having a professional Twitter account¹². Podcasts, websites, and virtual or simulated case-based learning can also keep the technology-inclined trainees engaged.

Tips for Effective Teaching in Different Learning Environments

Teaching in Lectures

As mentioned, modern learners prefer active styles of engagement over traditional lectures. Active, effortful, and repetitive engagement of the material allows for meaningful learning^{13,14}. Small group, case-based learning, and flipped classroom pre-materials encourage conscious participation and reinforcement of materials through collaborative strategies. A summary of collaborative learning strategies is outlined in Table I.

Teaching in Office and Inpatient Care

Effective teaching in clinic or on the wards involves objectively ensuring and tracking progress toward mastery of clinical knowledge. Guiding principles for educating through patient encounters is summarized in Table II and includes expectation setting, observation, assessment of clinical reasoning skills, feedback, and synthesis. Asking trainees their prior experiences and personal educational goals allows the learner to personalize their education and focuses the educator on what aspects of the patient encounter to focus on. Educators and trainees should set expectations not only for educational objectives such as history taking and physical examination but also for practical considerations such as desired workflow (i.e., introducing the trainee to patients and explaining their roles).

TABLE I Collaborative Learning Strategies Applied to Modern Medical Education

Collaborative Learning Strategies	Approach
Flipped classroom	Lecture time is spent on applying knowledge obtained beforehand through preassigned readings and brief, introductory recorded lectures. Note: Pre-materials should be of quantity that is reasonable for the learner to review (less than 30 min).
Team-based learning	Educator facilitates interactive small group discussions, with an emphasis on preclass preparation before the discussions.
Just-in-time teaching	Educators tailor the level of teaching to the learners' needs by incorporating pretests or audience response to prioritize lecture time for questions and content that addresses gaps in understanding.
Think-pair-share	Learners are prompted to reflect on some component of the lecture content alone for a minute (e.g., "think of a time you saw an ER consult related to this topic...") and then split into pairs or small groups where the individual's reflections are shared. When the large group is reconvened, pairs are invited to share reflections with the group to generate further discussion and create synthesis.
Problem-based learning	Educator guides learners through discussion of open-ended, clinically relevant cases in small groups to encourage collaboration, clinical reasoning, and self-directed learning skills.

TABLE II Teaching in the Office and Inpatient Setting: Principles for Teaching during Patient Encounters

Strategies for Teaching in Office and Inpatient Care	Approach
Expectation setting	<ul style="list-style-type: none"> ● Ask about prior experience and personal educational goals ● Solicit topics trainees find difficult and tailor education and exposure accordingly ● Establish practical expectations (i.e., orienting trainees to patient flow, defining role/responsibilities)
Observation	<ul style="list-style-type: none"> ● Observe the patient interaction and oral presentation ● Provide feedback on organization of history taking, skills of physical diagnosis, professionalism and ways of engaging patients
Assessment of clinical reasoning skills	<ul style="list-style-type: none"> ● Allow time to reflect on patient encounter ● Evaluate trainee's oral presentation based on organization and analysis of clinical information ● Review and evaluate assessment and plan
Feedback and evaluation	<ul style="list-style-type: none"> ● Preview formal and informal forms of feedback ● Should be transparent and objective ● Provided in a timely fashion relative to encounter ● Couple with opportunities for repeat performance
Synthesis and consolidation	<ul style="list-style-type: none"> ● Create time for synthesis and consolidation ● Draw connections throughout the rotation ● Provide guidance for continued reading ● Create a plan for reassessing in the future

Educators should aim to observe the trainee interacting with the patient because feedback is best given based on observed behaviors. When educators observe the trainee interacting with the patient, in addition to oral presentation skills, they can comment on trainees' professionalism, organization of history taking, and skills of physical diagnosis. Tools for objective evaluation of patient encounters are available and can guide educators on what aspects to consider in observing and giving feedback¹¹. Clinical reasoning skills are assessed with oral presentations, where educators may evaluate a trainee's analysis of clinical data and reflection through an assessment and plan.

Trainees should be given time to reflect on the patient encounter before presenting, which allows them to synthesize and consolidate clinical information for a more comprehensive assessment and plan. Educators may aid in the process through asking the trainee to seek connections between the days' and prior experiences and asking about topics the trainee found most challenging, allowing for a more personalized, engaging learning environment.

Feedback is essential for learning and growing as a clinician and surgeon. In the office setting, feedback should be directed at the organization and content of the presentation with a focus on how the trainee analyzed patient information. Previewing to trainees that feedback will come in various forms (formal and informal) will help raise their awareness to more subtle forms of feedback and allow them to incorporate the critiques into future patient encounters.

Teaching Procedural Skills

Teaching procedural skills has been traditionally learned through the *see one, do one, teach one* model in the clinical care setting. However, the use of simulation has allowed students, residents, and fellows to learn and demonstrate appropriate procedural skills

in the laboratory and acquire and practice more complex skills in the more limited patient encounters¹⁵. Simulations also allow a controlled setting to assess learners' performance.

Generally, the guiding principles for effective teaching of any type of procedural skill include breaking the skill into smaller steps, applying a framework, deliberate practice, assessing the learner, and providing objective feedback. Deliberate practice involves effortful, repetitive performance. Practice can be made more effortful through interweaving practice of different skills and procedural components in the laboratory and in the operating room. Laboratory trainings should incorporate practice of a variety of skills within 1 session to improve effortful learning. Adding additional and distinct practice settings further allow trainees to apply the newly rehearsed skills to varied settings resulting in more meaningful and durable learning^{13,15}. Breaking skills into smaller steps prevents cognitive overload to the learner and helps the educator to monitor progress more easily^{13,15}. One framework that incorporates these principles is the four-step process for learning procedural skills by Walker and Peyson in Table III^{16,17}. Assessment of procedural skills should incorporate direct observation, followed by feedback, and be paired with opportunities for repeated performance. Performance may be enhanced through focusing on learning gaps in the initial stages. Even when not actively performing the surgical procedure, the orthopaedic educator can assess and give feedback relating to whether the trainee understands the relevant anatomy or is able to vocalize the steps of the procedure.

Creating Space for Teaching with Limited Time

Time constraints in the office and in the operating room may represent barriers to teaching. Strategies to facilitate teaching

TABLE III Four-Step Process for Learning Procedural Skills by Walker and Peyson

Demonstration	Educator demonstrates at normal speed, without commentary
Deconstruction	Educator demonstrates while describing steps
Comprehension	Educator demonstrates while learner describes steps
Performance	Learner performs the task while describing steps

while maintaining efficient flow in patient care include deliberate scheduling, verbalizing the physical examination, teaching out loud, and collaborative documentation. On days when working with trainees, attendings may template patient visits and procedures that allow residents and fellows to spend time with new patients while the attending manages quicker follow-up patients. Surgeries may be organized similarly, with more complex cases being assigned based on seniority of residents or the experience level of the surgical first assist. In the office, verbalizing aspects of the physical examination while performing maneuvers helps familiarize residents with abnormal physical findings that cannot be replicated in the simulated setting. Educators may incorporate informal feedback through discussing differential diagnoses while counseling patients about treatment options and alternatives. Finally, trainees may help with the patient flow by documenting the patient encounter while the educator is counseling the patient. The educator's review of the patient encounter notes written by trainees represents another opportunity to assess clinical diagnosis and communication skills and should be paired with feedback.

Best Practices of Giving Feedback

Multiple barriers to giving and receiving feedback exist. Elucidating these barriers can help initiate a clearer dialog between the educator and the trainee that establishes rapport and allows for more effective personal growth of the trainee. Time constraints are one challenge. Reflection, which is essential for learning, requires time. Clear expectations should be established at the beginning of each rotation. Providing effective feedback is a key factor in the education of orthopaedic residents. The educator may avoid critiques when giving constructive feedback because of discomfort negatively affecting the relationship, and as a result, undesirable behaviors can go uncorrected. To combat this, educators need training in giving effective feedback and trainees should be reminded that learning is a process requiring deliberate and effortful practice to improve.

Feedback can be given as formative feedback or summative feedback, and both are important to enhance learning and improvement. Formative feedback is provided in real time, similar to coaching (i.e., during an operative procedure or at the end of an operative or office day) while summative feedback is provided at the end of a rotation and often used as assessment. Mid-rotation feedback helps communicate progress while end-of-rotation feedback reviews whether the goals and objectives

were met and plans for the future. Regarding the content of feedback, it should focus on objective, observed, and modifiable behaviors. It should avoid commenting or critiquing personality characteristics such as being "reserved," "confident," or "outspoken." Feedback should also give space for the trainee to reflect on their performance. The educator should reinforce desired behaviors and specify the actions that would result in improved performance (the desired alternative behavior). Finally, feedback should provide an opportunity for repeated performance; Table IV summarizes tips attendings may use in providing feedback.

As much as possible, orthopaedic educators should focus on growth-oriented feedback, coined by researcher Carol Dweck. Growth-oriented feedback acknowledges the learning as a process and recognizes improvement (getting better rather than being good), which shifts fear of judgment to meaningful growth and enjoyment of the challenges it presents. Strategies for giving growth-oriented feedback include complimenting the process, improvements, and efforts. Educators should avoid comments that suggest that knowledge or skills are innate or fixed, instead talking about them as characteristics that can be modified with practice and effort. A simple but useful strategy is to insert the word "yet" in feedback; for example, the educator may say "your tactile sense of the backwall when drilling is not reliable YET". This small modification can have a profound impact on the learner's psychology, beliefs, and motivation to improve.

Remediation

Remediation is not uncommon with orthopaedic surgery residents. A 2018 survey of 70 orthopaedic surgery residency program directors with a mean program size of 4.5 per year found that 158 residents were remediated within 10 years of the programs' history¹⁸. Deficiencies in the affective domain, including communication, professionalism, and patient care, were cited as the most common cause of remediation. First, clear communication of the trainee's deficient domain of performance needs to be clarified based on objective observation. Here, it is critical that educators challenge themselves to follow the educational principles outlined here and elsewhere and ensure that appropriate expectation setting, observed performance, and quality feedback have been provided equitably across all trainees.

TABLE IV Tips for Giving Feedback

- Comment on observed and modifiable behaviors
- Allow trainee to reflect on performance
- Specify the alternate desired behavior
- Provide a plan or opportunity for repeat performance
- Recognize effort as a positive attribute
- Focus on effort over an innate skill
- Praise the process
- Focus on improvement rather than results
- Insert the word "yet"
- Focus on learning over outcome

Failure to create a high-quality and equitable learning environment will result in lower overall performance and leave opportunity for implicit biases to affect the assessment process, which has been shown to affect non-White trainees disproportionately. A 2016 demographic survey of 79 orthopaedic surgery program directors regarding residents who left their program from 1998 to 2013 found that residents who are female (27%, $p = 0.0018$), single (51%, $p = 0.0028$), and without children (80%, $p = 0.0018$) are likelier to undergo attrition¹⁹. A 2018 study examining 2065 letters of recommendation found that “grindstone” words indicating work ethic were likelier to be used for White applicants than racial minorities (OR 0.96, $p = 0.04$)²⁰. A more recent study in the United Kingdom found that female trauma and orthopaedic trainees had a 26% increased risk of remediation²¹. A meta-analysis of 22 studies examining attrition within general surgery residents further corroborates this picture, with attrition significantly higher among female compared with male residents (25% vs 15%, $p = 0.008$)²². This discrepancy may be partly explained by race and sex affecting elements of residency such as being mistaken as staff with a lower training level and more frequently feeling overwhelmed²³.

The core areas of performance are knowledge, skills, and behavior. It is important that discussion of areas for improvement always be rooted in concrete examples that are paired with examples of the preferred behavior based on established expectations to minimize bias and favoritism. Table V provides some examples of deficiencies in each of these domains along with strategies for improvement. After objectively identifying the areas for improvement and soliciting the trainee’s perspective, the next step is to collab-

oratively develop an action plan. To engage the trainee and elicit their insight into the domains of desired improvement, it is important to destigmatize failure and draw on the educator’s personal experience to demonstrate vulnerability and decrease potential feelings of defensiveness the trainee may experience²⁴. Initial efforts should try to identify potential causes, including personal or professional stressors, cognitive challenges, or substance use disorders²⁵⁻²⁷. Promoting a culture of regular feedback that is coupled with inclusivity and belonging provides psychological safety and support for trainees, allowing them to ask for help when needed and preventing them from falling behind.

The Future of Orthopaedic Surgery Education

The COVID-19 pandemic placed an enormous strain on the resources of the current healthcare system, leading to cancellation of thousands of elective orthopaedic surgeries and increased mental and physical stressors for healthcare providers including residents and fellows^{28,29}. To maintain education, solutions that combine modern technology with conventional methods of education have been skillfully and creatively used. In particular, e-learning and simulations, including those that incorporate virtual and augmented reality, have emerged as powerful and cost-effective tools for educating residents³⁰⁻³⁴.

Virtual learning, or e-learning, uses online platforms to supplement or replace conventional modalities of in-person learning. A systematic review conducted by Thompson et al. in 2020 examined how virtual education was being implemented in orthopaedics during the COVID-19 pandemic and whether the new curriculums were effective³⁴. In examining 14 studies with a total of 1,548 participants, they found that of the 9 studies comparing e-learning to traditional learning, which

TABLE V Strategies to Support Learner Performance in Various Domains

Performance Domain	Examples	Strategies to Support Improvement
Knowledge	<ul style="list-style-type: none"> ● Incomplete or inaccurate patient presentations, diagnoses, plan, and documentation ● Low scores on rotation evaluations 	<ul style="list-style-type: none"> ● Address any cognitive barriers ● Review study strategies and offer best practices ● Establish clear expectations
Skills	<ul style="list-style-type: none"> ● Clinical reasoning deficiencies ● Physical diagnosis, procedural skill, and surgical skill deficiencies 	<ul style="list-style-type: none"> ● Ensure objective assessment ● Provide video feedback of performance for self-reflection ● Provide videos of desired/preferred technique and behavior ● Ensure knowledge deficits are not driving skills performance gaps, if so, focus first on bridging knowledge gaps ● Provide opportunities for practice and repeat performance
Behavior	<ul style="list-style-type: none"> ● Unprofessional or disruptive behavior ● Difficulty with timeliness, both at work and with administrative deadlines ● Strained professional relationships ● Not receptive to feedback 	<ul style="list-style-type: none"> ● Recognize that there are multiple perspectives on behaviors and inquire as to the learners’ experience ● Recognize if bias or stereotyping play a role in perception of behavior ● Offer tools to support organization (technology and coaching) ● Encourage self-reflection ● Emphasize accountability for the impact of behaviors on others, regardless of the intention ● Build sense of safety and belonging

included textbooks and didactic in-person lectures, e-learning participants had significantly higher outcome scores compared with control participants. One study compared a blended approach combining e-learning with face-to-face learning with e-learning alone and found that the former approach yielded higher assessment scores. Current attitudes among residents and attendings support a transition to e-learning. A survey of 100 attendings and 168 trainees in orthopaedic surgery found 86.6% and 84% of attendings and trainees, respectively, favored the use of e-learning as a supplemental role in residency and fellowship³¹. Despite some of the clear benefits of e-learning, challenges also exist. Engagement with the audience in virtual lectures requires deliberate effort on the part of the educator to increase interactivity. This can be achieved by direct question asking, soliciting questions in advance or through a chat room function, and the use of breakout rooms to facilitate small group discussion and interaction.

Amidst the technological progress over the past decade, surgical simulation has also emerged as a durable tool for training orthopaedic surgery residents and fellows^{30,32,33}. Agyeman et al. examined current literature to assess how surgical simulation bootcamps and virtual reality simulations are being used today³⁰. They found that surgical simulation orientation “camps” were reported to be helpful in improving self-confidence and basic surgical skills. Although bootcamps can be powerful tools for developing and maintaining skills, they require significant resources to execute. Further investigation is necessary to better understand when and how to best incorporate various high-fidelity and low-fidelity modes of simulation into orthopaedic training and education.

Summary

Despite the myriad pressures that orthopaedic educators face, prioritizing the education of our residents and fellows is critical to the future of orthopaedic surgery. Strategies to improve teaching skills for the modern learning and practice environment include clear expectation setting, teaching through both patient encounters and the electronic medical record, providing feedback based on direct observation along with an opportunity to repeat performance, fair processes in remediation, and incorporation of e-learning and simulation. As orthopaedic surgeons and as educators, there will continue to be innovations that challenge and improve our traditional models. Rising to these challenges calls on the orthopaedic surgeon to adopt a growth mindset in adapting to the changing needs and expectations of not only our patients but also our trainees. ■

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