Orthopaedic Surgeons as Educators. Applying the Principles of Adult Education to Teaching Orthopaedic Residents


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Orthopaedic Surgeons as Educators

Applying the Principles of Adult Education to Teaching Orthopaedic Residents

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Teaching residents the knowledge, skills, and ethical values of orthopaedic surgery is critical to our profession. Currently, the standards for orthopaedic residency training are set by the Orthopaedic Residency Review Committee (RRC) of the Accreditation Council for Graduate Medical Education and the American Board of Orthopaedic Surgery. However, the means by which those standards are to be achieved is largely left up to individual residency programs. This article considers how we might improve the quality and effectiveness of orthopaedic education if we apply to residency programs the core principles of adult education. These core principles form the central theme of the American Academy of Orthopaedic Surgeons (AAOS) Course for Orthopaedic Educators, the first course among all medical specialties to be devoted entirely to education and the longest-running continuing medical education course offered by the AAOS. This article reviews the critical elements involved in educating orthopaedic residents, applying the core educational principles established by the Course for Orthopaedic Educators. We suggest that if orthopaedic educators understand the educational process and the principles that underlie it, they will be able to improve the quality and effectiveness of residency education and thus ultimately improve the profession. This article presents eight core principles of adult education and outlines how they can be applied by orthopaedic educators—both by program planners and by physician-teachers.

The Eight Core Principles of Adult Education

Cognitive psychologists and educational scholars have generated a large body of peer-reviewed research on effective techniques of adult education. This research established a set of core educational principles (Table I) that can be used by orthopaedic educators to improve resident learning. The eight core principles presented here are not the only ones that might be applied to medical education. However, they are featured in the AAOS Course for Orthopaedic Educators because they capture key themes in current research in adult education and as such they can guide orthopaedic educators in their typical roles as program planners and physician-teachers. The eight core principles are outlined below, with an explanation of the relevance of each principle to medical education. We divided the principles into two groups: four core principles of program planning and four core principles of effective teaching. After explaining each group of principles, we show how they can be applied to orthopaedic residency training.

The Four Core Principles of Program Planning


The first and most important principle of adult education is that what students learn is more important than what is taught. This first principle governs the seven that follow because all ask us as educators to look at learning, not at teaching, and at what students understand rather than what we think we have imparted. Imagine spending time teaching a resident only to realize later that the crucial information or skill set was not actually learned. There are many reasons why this could—and often does—happen: perhaps the resident did not really understand what was being taught, or maybe he or she understood but soon forgot. If orthopaedic education is to be effective, we must think in terms of what the residents are actually learning, not just what we are trying to teach. By focusing on the end effect—on what is actually learned, not just what we are trying to teach. By focusing on the end effect—on what is actually learned, not just what we are trying to teach. By focusing on the end effect—on what is actually learned, not just what we are trying to teach. By focusing on the end effect—on what is actually learned, not just what we are trying to teach. By focusing on the end effect—on what is actually learned, not just what we are trying to teach. By focusing on the end effect—on what is actually learned, not just what we are trying to teach.
ensuring that true learning takes place. As such, all seven relate back to the first: what students learn is more important than what is taught.

Core Principle 2: Program Planning Is Critical to Effective Teaching and Learning
This principle challenges orthopaedic educators to review all of the elements of the program that influence a resident’s learning. Because program planning is critical to effective teaching and learning, orthopaedic educators must attempt to arrange the elements in a manner that optimizes learning. Asking questions such as: “What type of clinical experiences are the residents having?” “Who are their role models?” “How effective are their formal teaching sessions?” and “How are they being evaluated?” will help educators to focus on the whole residency program, not just one or two elements of that program. Failure to do so risks putting residents in an environment that undermines their learning.

Core Principle 3: Residents Learn from a Hidden Curriculum
As we plan programs, we should be aware that the curriculum exists at two levels: the overt curriculum that we deliver deliberately and the hidden curriculum that we deliver unawares. The hidden curriculum has been defined as “the indelible message, often non-verbal, that a person takes from an event or an experience.” Why do we use the term hidden? We mean that this aspect of the curriculum is actually hidden from teachers, who may not be aware of the values that they model in day-to-day activities. Students, we must be aware, learn as much from what we do as from what we say. In terms of medical education, then, we must grasp that residents learn values and ethical reasoning by watching how we behave toward colleagues and patients and by observing how we deal with challenging situations. They also learn from the entire milieu in which they (and we) work. They learn from how the faculty treat the patients and interact with each other—they learn, in short, from the whole interpersonal and professional environment. They may also learn things we did not intend to teach them, such as habits that long ago became invisible to us but remain obvious to others. Role modeling is a powerful mode of teaching, and the hidden curriculum is a powerful mode of learning; indeed, the importance of this hidden curriculum is now recognized in medical education literature. Effective medical educators must take into account the fact that students learn from them as role models, and therefore they should try to model as well as to teach the highest ethical values of the profession.

Core Principle 4: Learning Is Driven by the Resident’s Perception of How He or She Will Be Evaluated
Resourceful students figure out how they are being evaluated and then focus on learning and doing the things that they think will lead to a positive evaluation. When used correctly, evaluation provides a powerful tool to drive a resident’s learning. This principle challenges program planners to establish key learning objectives and then to link them firmly to evaluation. By organizing residency programs so that residents are motivated to act in certain ways and embrace certain values, we can dramatically improve resident learning.

Applying Principles 1 Through 4 to Program Planning
These four principles can be used to plan orthopaedic training programs more effectively. Orthopaedic training is delivered through both informal and formal programs: residency programs, individual service rotations, and grand rounds are examples of programs designed to foster learning. The level of planning in such educational programs varies. Many programs are structured intuitively—and often quite successfully so. However, educators should be aware that the way in which a program is organized has a direct bearing on how successful it is at fostering desired learning outcomes. Good program planning, therefore, is based on the first four principles. Such planning involves assessing the program in terms of what the students need to learn (in educational terminology, this is called a needs assessment), setting clear learning objectives based on these needs, using these objectives to guide opportunities for learning (remembering both the overt and the hidden curriculum), and linking these objectives to effective evaluation techniques. While a variety of program planning methods have been outlined, most include four key planning steps: (1) conduct a needs assessment, (2) set learning objectives, (3) provide opportunities for learning, and (4) design appropriate evaluations.

For example, these planning steps can be applied to a residency rotation. Most residency programs offer residents a series of rotations, often divided by subspecialty. These rotations can be analyzed, and often improved,
TABLE II Program Planning in a Resident Rotation

<table>
<thead>
<tr>
<th>Needs assessment</th>
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<tbody>
<tr>
<td>• What are the learning needs of the residents?</td>
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<tr>
<td>• What content does the program and/or rotation need to have taught?</td>
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<table>
<thead>
<tr>
<th>Goals and objectives</th>
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<tbody>
<tr>
<td>• What are the expectations of the program planners?</td>
</tr>
<tr>
<td>• What are the learning objectives of the program?</td>
</tr>
<tr>
<td>• Have expectations been established at the start of the rotation?</td>
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<tr>
<td>• Has the resident received realistic rotation objectives?</td>
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</table>

<table>
<thead>
<tr>
<th>Providing opportunities for learning (mode of instruction)</th>
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</thead>
<tbody>
<tr>
<td>• What will a resident do and see in the clinic?</td>
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<tr>
<td>• What will a resident do and see in the operating room?</td>
</tr>
<tr>
<td>• Have any formal teaching sessions been planned?</td>
</tr>
<tr>
<td>• Has the resident been given assigned reading or other directed learning activities?</td>
</tr>
<tr>
<td>• What rotation problems may undermine the resident's ability to learn?</td>
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<table>
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<tr>
<th>Designing appropriate evaluations</th>
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</thead>
<tbody>
<tr>
<td>• How will formative feedback be given to the resident during the rotation?</td>
</tr>
<tr>
<td>• How will the resident be evaluated?</td>
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<tr>
<td>• How will the rotation be evaluated?</td>
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by performing a formal program assessment (Table II).

1. Conduct a Needs Assessment
Performing a needs assessment does not have to be a complicated matter. An orthopaedic surgeon who is responsible for coordinating a three-month rotation for second-year residents on the arthroplasty service, for example, might ask the following questions: Who are the learners on this rotation? What is their background knowledge? What are they to learn on this rotation?

Possible answers to these questions might seem obvious: the surgeon is training a group of second-year orthopaedic residents who need to learn how to perform primary hip and knee arthroplasty. On closer examination, however, it is clear that the second question can lead to important insights for program planning. For example, not all second-year residents have equivalent background and experience. Those taking the rotation early in the academic year are likely to be substantially less experienced than residents assigned to the service toward the end of the second year. In other words, while there may be a certain core content that all residents on the arthroplasty rotation should be expected to master, not all second-year residents start with the same level of knowledge and skill. A needs assessment will bring these issues to light.

2. Set Learning Objectives
Setting learning objectives is a key educational practice that leads to good learning. What is meant by learning objectives? These are the intended learning outcomes of any educational program. In the case of orthopaedic surgery rotations, learning objectives should be rotation-specific as the RRC assesses an orthopaedic program by looking at the objectives that have been established for each rotation. Such objectives should, in turn, guide instructional methods and drive the evaluation process.

In many residency programs, learning objectives are implied or unstated. Learning can—and indeed often does—occur without explicit objectives. However, educational programs are more effective if learners know the objectives before the start of the program. For this reason, rotation-specific objectives should be discussed with residents at the start of every rotation. These objectives should be presented in a concise, well-written document that outlines the core knowledge and skills to be learned. Most importantly, these learning objectives must specify the knowledge, skills, and ethical values that will form the basis of the resident’s evaluation. This is an example of the fourth principle in action: residents will quickly determine what they should master in order to receive a good evaluation.

3. Provide Opportunities for Learning
The heart of program planning lies in providing opportunities for learning. In a residency rotation, opportunities for learning may include spending time in the clinic or the operating room, teaching in morning rounds, doing assigned reading, or participating in a variety of other activities designed to foster learning. However, residents also learn from the hidden curriculum—that is, they learn as much from what their teaching physicians do as from what they say. Residents also learn from their working milieu about the ethics and interpersonal dynamics of the profession. Taking the time to examine the opportunities for learning—including direct and indirect teaching—in a residency rotation is a key step in improving resident learning.

4. Design Appropriate Evaluations
Designing appropriate evaluations is the final element of effective program planning. Here we refer to two forms of evaluation: the assessment of residents and the assessment of the program by the residents themselves. These evaluations are critical for two reasons. The first reason, as outlined in the fourth principle, is that students quickly figure out how they will be evaluated and focus their efforts accordingly. The second reason is that residency programs are themselves evaluated in turn. An educational program that is not organized to promote ongoing improvement through systematic evaluation by learners runs the risk of becoming outdated and ineffective.

Experts in the field of adult edu-
Structively. However, many of us avoid their attention quickly, clearly, and constructively. Such deficiencies must be brought to ethics. In order for residents to improve, feedback if they are to identify and address deficiencies before the summative evaluation.

A. Use Formative Evaluation Techniques
In a prolonged program such as a residency, educators should make regular formative evaluations that should be discussed with the resident. Residents need feedback if they are to identify and address deficiencies in skills, knowledge, or ethics. In order for residents to improve, such deficiencies must be brought to their attention quickly, clearly, and constructively. However, many of us avoid giving feedback on such deficiencies because we find giving negative feedback extremely difficult. A tool that can help with delivering such formative evaluations is Pendleton’s rules for providing feedback (Table III).17

Applying Pendleton’s rules to formative residency evaluations would suggest that we start by having residents themselves assess “What went well?” and “What could have been done differently?” in a rotation or learning event. This approach works well for three reasons. First, it starts with the positive—what has gone well. Second, it gives the resident the opportunity to identify what could have been done differently. Finally, it uses the expression different rather than the negative term wrong. Very often the resident has the same concerns about his or her skill and knowledge that the orthopaedic educator has. Pendleton’s rules provide a useful framework for giving both constructive and critical feedback. This tool can be used during mid-rotation evaluations or at any point when a resident needs to receive feedback. However, whether or not Pendleton’s rules are used, residents must receive a mid-rotation (formative) evaluation that allows them to identify and address deficiencies before the summative evaluation.

B. Use Summative Evaluation Techniques
Summative or final evaluations are also important and can be generated in many ways. To be effective, however, the evaluations must mirror rotation-specific objectives and must accurately assess the resident’s knowledge, skills, and behaviors. To make an effective summative evaluation, supervising physicians should try to get feedback from multiple sources (such as nurses, allied health-care personnel, and other physicians), especially when assessing such things as interpersonal skills.18,20 While it is natural to use one’s experience with residents to form an opinion of their abilities, it is important that this subjective (and thus possibly biased) opinion should not form the sole means of evaluation.

C. Evaluate the Program
Finally, the residents’ evaluations of their training program are critical for program development. Residents are usually in the best position to comment on the quality, efficiency, and effectiveness of the educational program that they have experienced. For this reason, the RRC looks closely at the mechanism by which residency programs get feedback from their residents. Regular evaluation of the strengths and weaknesses of a rotation by residents should be considered by anyone who is involved in teaching orthopaedic residents at the rotation level. This type of feedback, when acted upon, allows the educational component of the rotation to be improved over time.

The Four Core Principles Governing the Physician-Teacher
Whereas the first set of principles relates to promoting learning more broadly through program planning, the next set of principles (5 through 8) promotes effective learning in interactions between the resident and the physician-teacher.

Core Principle 5: Educators Should Foster Active Rather Than Passive Learning
Learning is more intense and more permanent when the learner’s mind is actively engaged. Experiences that actively engage the learner in the process typically lead to deeper and more sustained learning. This means that teaching is more effective when it actively involves the learner either physically or mentally.19,20 The physician-teacher can ac-

<table>
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<th>TABLE III Feedback by Means of Pendleton’s Rules</th>
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<td>1. The teacher asks (about a particular patient, operation, or rotation itself): “What went well?”</td>
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<td>2. After the resident has responded, the teacher states what he or she thinks went well.</td>
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<tr>
<td>3. The teacher then asks: “What could you have done differently?” and/or “What could have been done differently?”</td>
</tr>
<tr>
<td>4. The teacher then states what could have been done differently from his or her perspective (as opposed to what went wrong).</td>
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comply with this by asking probing questions at an appropriate level, actively involving residents in surgery, and/or encouraging residents to write summary notes or draw diagrams while studying. In summary, active learning means engaging residents with authentic questions and tasks appropriate to their level of knowledge and ability.

**Core Principle 6: Teaching Should Engage Residents at a Level Appropriate to Their Knowledge and Ability**

Teaching that focuses on knowledge and skills that the resident already knows is not helpful. Similarly, teaching that is directed well beyond the comprehension of the learner also limits a resident’s learning. To be effective, teaching should engage residents at a level appropriate to their knowledge and ability. In other words, teaching must be focused at the resident’s zone of development—that is, right at the point where the learner is beginning to have knowledge gaps or misconceptions. In medical education, this means that residents learn best when the physician-teacher takes account of their level of prior knowledge and skills. These can vary widely among residents, and they are not necessarily related to the resident’s year in training. To foster the acquisition of new knowledge and skills, the physician-teacher must identify what a particular resident already knows and can do. A first step in any learning encounter, then, should be to identify the resident’s zone of development. To do this in an efficient manner, an orthopaedic educator must ask probing but nonthreatening questions to determine the limits of the resident’s knowledge. Teaching should then be directed to the zone between what the resident already does safely and competently without supervision and what the resident can do only with guidance.

**Core Principle 7: Avoid Cognitive Overload of Residents**

Most individuals have a short-term memory that is limited to seven (plus or minus two) discrete bits of unrelated information. This means that teachers should avoid cognitive overload of residents as they are unlikely to retain a large number of isolated, newly acquired facts. However, if facts are organized into a logical framework, they are much easier to learn and retain. As an example, information that is organized according to specific disease processes, classic clinical presentations, or treatment regimens for certain conditions is more likely to be retained than if such information comes in a piecemeal fashion. An orthopaedic educator can make learning more efficient by suggesting a framework for a certain aspect of medical information or by questioning residents to see if they have already developed effective frameworks for understanding and organizing such information.

**Core Principle 8: A Threatened Self-Concept Diminishes Learning**

Educational research has shown that emotions and cognition are interactive. Excessive anxiety decreases our ability to process information. As a result, a negative learning environment, however it is created, limits a student’s ability to process, synthesize, and retain information. Learning requires a receptive mind; negative emotions interfere with our cognitive functioning. Therefore, a threatened self-concept diminishes learning.

In terms of medical education, this means that high expectations should be accompanied by a positive learning environment and support until residents have gained a measure of mastery over the new material. Positive assessments should never be seen as the result of favoritism or of effort alone in the absence of actual achievement. The corollary is that negative assessments should not be seen as unfounded or lacking in constructive advice. Residents may forget what we said, but they will never forget how we made them feel.

**Applying Principles 5 Through 8 to the Teaching of Residents**

These core principles can be applied as a framework for the effective teaching of residents. These four principles go back to the first and overarching principle: the measure of teaching effectiveness is what was actually learned rather than what was taught. This section illustrates how these principles can guide orthopaedic educators across the variety of settings in which they teach residents: (1) in the clinic, (2) in the operating room, and (3) in large and small groups, as in grand rounds, core curriculum lectures, or regularly scheduled teaching rounds.

1. **Teaching in the Clinic**

For many orthopaedic surgeons, seeing patients in the clinic is a busy time, often with few free moments for the formal teaching of residents. However, this setting is one of the primary places where residents learn. The ability to assess a patient, develop a diagnosis, and outline an appropriate treatment plan lies at the heart of our specialty. In addition, the clinic is the main location where the doctor-patient relationship is established and developed. Therefore, orthopaedic educators must look for strategies to take advantage of the teaching opportunities in the clinic setting, and ideally they should strive to integrate teaching seamlessly into clinical activities. An efficient approach to teaching in the clinic is essential. We therefore divide clinic time into a beginning, middle, and end to consider which teaching strategies to apply before, during, and at the end of the clinic time in order to maximize the learning experience.

Meeting the resident before seeing patients in the clinic to review the day is the first step to successful teaching in this setting. The physician should assess the resident’s experience with the type of patients who are going to be seen and elicit the resident’s goals for learning in the clinic. In light of this information, the physician should briefly review the learning opportunities that the resident is likely to encounter in the clinic as well as set realistic learning goals.

During clinical encounters, it is important to promote active participation by the resident. This can be done...
TABLE IV One-Minute Preceptor

| Outside the patient’s room (after the resident has seen and examined the patient):                      |
| 1. Obtain a commitment regarding the diagnosis and plan. |
| 2. Probe for supporting evidence.                        |
| After the physician-teacher has examined the patient and determined the diagnosis:                   |
| 1. Teach general rules and/or principles.                |
| 2. Reinforce what was right.                             |
| 3. Correct mistakes.                                    |

The One-Minute Preceptor involves five steps, done in two sessions. The first session (the first two steps) takes place outside the examining room after the resident has seen the patient but before the attending surgeon has reviewed the patient. The first step is to get a commitment from the resident regarding a diagnosis. The second step is to probe for supporting evidence that has allowed the resident to come to this diagnosis. This step helps the orthopaedic educator to identify the resident’s zone of development—what is known and understood and what is not.

The second session (the final three steps) takes place after the teaching surgeon has examined the patient and established the diagnosis. This session can occur in front of the patient (if done diplomatically) or can occur outside the examining room. The third step is to teach general concepts illustrated by the case of the patient. The fourth step is to reinforce what the resident has done correctly, while the final step is to correct any mistakes the resident has made. The One-Minute Preceptor is congruent with the fourth through the eighth principles and formalizes what many successful orthopaedic educators already do. This tool takes very little time, fosters active learning, helps to identify the resident’s zone of development, and forces the resident to be active rather than passive during clinical encounters.

Finally, at the end of the time in the clinic, the surgeon should try to cement some of the learning experiences that occurred during that time. One way to do this is to spend a few minutes identifying and reviewing the lessons learned from the clinic experience.

2. Teaching in the Operating Room
Acquiring competence in surgical technique represents a core objective of orthopaedic residency training. However, patient safety must always be paramount, and operating time is expensive. Teaching a resident to operate safely without jeopardizing patient care and wasting operating time can be a challenge. However, it can be achieved by adhering to a few basic principles. These include teaching basic skills outside the operating room, clarifying learning objectives and expectations before each operation, dividing the operation into component parts and deciding in advance which parts the resident will do, reviewing the results of each operation with the resident to identify lessons learned, and remembering the hidden curriculum—that what we model is as important as what we teach formally.

B. Clarify Learning Objectives and Expectations Before Each Operation
The second recommendation is to clarify learning objectives with the resident before each operation. This can be done at the scrub sink before an operation although it is perhaps more effective if it is carried out formally in preoperative rounds. It is essential to ensure that the resident knows what the operation is, why it is being performed, and the various steps of the procedure. This is a concrete example of the sixth principle—determining the resident’s zone of development with respect to the operation in question.

C. Divide the Operation into Component Parts and Decide in Advance Which Parts the Resident Will Do
Before surgery, the teaching surgeon should establish which parts of the operation the resident will do. All but the most basic operative procedures require multiple steps, and some of these steps, or modules, are more difficult than others. To ensure that residents are not working beyond their comfort zones or zone of development, it is helpful to divide the operation into modules and assess the resident’s level of involvement for each section of the operation. The type of operation as well as the background and skill of the resident are factors that should determine the resident’s involvement in each step. By identifying the various steps, the orthopaedic educator will be in a better position to determine whether the resident should be observing, operating with major assistance, operating with minimal assistance, or operating independently.
D. Review the Results of Each Operation with the Resident to Identify Lessons Learned

The fourth recommendation for teaching surgical skills is to take time to review the lessons learned from each operation. This can be done after each operation or at the end of the day. There is always something that can be learned from each operation. Without ongoing reflection, the resident may not learn key points or may acquire a misconception.

E. Remember the Hidden Curriculum

A final point to bear in mind is that much of what a resident learns in the operating room does not occur by means of direct teaching but rather by role modeling. What we do is as important—perhaps even more important—than what we teach formally. The hidden curriculum plays a major role in how we learn to be surgeons. Consider, for example, an attending physician’s interaction with the surgical support staff. Residents often base their own behaviors on how their educators interact with other operating-room personnel. Therefore, it is critical that physician-educators attend to what they are teaching unintentionally through their own behavior or role modeling.

3. Teaching in Groups: The Art of Asking Questions

Formal teaching in a residency program occurs during grand rounds, core curriculum lectures, or scheduled teaching rounds. It is these types of structured sessions that many medical educators associate with teaching residents. As we have seen, these sessions are in fact only one component of such teaching, but they remain a key component and one that we can improve by applying the core principles of adult education.

Formal teaching can be divided into large-group and small-group teaching sessions. Large-group teaching typically occurs through formal lectures. Good lectures are characterized by content that is clearly presented, meaningfully organized, and delivered in manageable chunks—all of which should be defined from the learner’s point of view. In an effort to counteract the inherently passive nature of large-group lectures, presenters should try to make their lectures interactive. Interspersing questions, encouraging audience participation, and using an audience response system are all strategies for keeping the audience engaged in the presentation.

In contrast, small-group teaching is characterized by direct interaction between the orthopaedic educator and the learner. This often takes the form of asking challenging but nonthreatening questions. Asking questions in a small group setting serves two purposes. It can “diagnose the learner”—that is, it can help to identify a resident’s knowledge gaps and misconceptions. It can also stimulate critical thinking by challenging residents to move beyond what they currently know and understand. When it is done well, questioning ensures that residents are actively engaged in the learning session.

Both small and large-group teaching rely on good questions to be effective. But what is a good question? A good question has three components. First, the question should relate to key concepts that are central to the understanding of the subject. Second, the question should have a specific purpose. This may include identifying relevant knowledge gaps and misconceptions—in other words, finding the resident’s zone of development. Third, a good question should demand critical thinking. Questions that ask how or why typically demand more critical thinking than questions that demand only a recall of facts. It is entirely appropriate to set clear expectations that require preparation by residents. Indeed, knowing that one will be on the spot is a strong motivating force. However, deliberate attempts to intimidate or embarrass should be avoided, as they tend to interfere with information processing and diminish learners’ confidence.

Overview

Core education principles provide a framework for thinking about how to teach residents effectively. Several of the principles outlined can help orthopaedic educators to be more effective program planners; others guide the physician-teacher. The key underlying principle on which this article and all good medical teaching rests is the realization that what a resident actually learns is more important than what is taught.

Orthopaedic educators bring personal styles and approaches to their work. In essence, they teach who they are as much as what they know. It is important to remember that there are many ways of being an effective educator. The principles that we offer are not prescriptions for how to be an educator. They are, instead, guidelines for thinking about principled approaches to educating the next generation of orthopaedic surgeons.

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