

THE JOURNAL OF BONE & JOINT SURGERY

JB&JS

This is an enhanced PDF from The Journal of Bone and Joint Surgery

The PDF of the article you requested follows this cover page.

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

Stephen J. Pinney, Samir Mehta, Daniel D. Pratt, John F. Sarwark, Edmund Campion, Laurel Blakemore and Kevin P. Black

J Bone Joint Surg Am. 2007;89:1385-1392. doi:10.2106/JBJS.F.01487

This information is current as of April 2, 2009

Reprints and Permissions

Click here to [order reprints or request permission](#) to use material from this article, or locate the article citation on jbjs.org and click on the [Reprints and Permissions] link.

Publisher Information

The Journal of Bone and Joint Surgery
20 Pickering Street, Needham, MA 02492-3157
www.jbjs.org

Orthopaedic Surgeons as Educators

Applying the Principles of Adult Education to Teaching Orthopaedic Residents

By Stephen J. Pinney, MD, MEd, FRCS(C), Samir Mehta, MD, Daniel D. Pratt, PhD, John F. Sarwark, MD, Edmund Campion, MD, Laurel Blakemore, MD, and Kevin P. Black, MD

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 education¹⁻³. 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

Core Principle 1: What Students Learn Is More Important Than What Is Taught

The first and most important principle of adult education is that what students learn is more important than what is taught^{4,5}. 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—educators can take steps to identify program deficits and ultimately improve resident learning. The seven core principles that remain all represent ways of

Disclosure: The authors did not receive any outside funding or grants in support of their research for or preparation of this work. Neither they nor a member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, division, center, clinical practice, or other charitable or nonprofit organization with which the authors, or a member of their immediate families, are affiliated or associated.

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 learning⁶. 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."⁷ 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 situations⁸⁻¹¹. 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^{10,12,13}. 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^{14,15}. 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 steps⁶: (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 I Principles of Learning

Program Planning	
1	What is learned is more important than what is taught.
2	Program planning is critical to effective teaching and learning.
3	Residents learn from a hidden curriculum.
4	Learning is driven by the resident's perception of how he or she will be evaluated.
Learning	
5	Foster active, rather than passive, learning.
6	Teaching should engage residents at a level appropriate to their knowledge and ability.
7	Avoid cognitive overload of residents.
8	A threatened self-concept diminishes learning.

TABLE II Program Planning in a Resident Rotation**Needs assessment**

- What are the learning needs of the residents?
- What content does the program and/or rotation need to have taught?

Goals and objectives

- What are the expectations of the program planners?
- What are the learning objectives of the program?
- Have expectations been established at the start of the rotation?
- Has the resident received realistic rotation objectives?

Providing opportunities for learning (mode of instruction)

- What will a resident do and see in the clinic?
- What will a resident do and see in the operating room?
- Have any formal teaching sessions been planned?
- Has the resident been given assigned reading or other directed learning activities?
- What rotation problems may undermine the resident's ability to learn?

Designing appropriate evaluations

- How will formative feedback be given to the resident during the rotation?
- How will the resident be evaluated?
- How will the rotation be evaluated?

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 program¹⁶. For this reason, rotation-specific objectives should be discussed with residents at the start of every rota-

tion. 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 say⁸⁻¹⁰. 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-

cation divide evaluation into two categories: formative and summative evaluation. Formative evaluation provides information (usually in the form of feedback) for the purpose of making improvements, and it is most effective when it is given in advance of, and separately from, a final assessment. Summative evaluation is the final assessment or judgment of a learner. Often the most important component of a summative evaluation is not what happens in a formal evaluation process, such as a test or examination (or in the case of a residency program, the resident's final evaluation form), but rather the informal gathering of information along the way. For example, residents may not be very concerned about what is written on their evaluation form, but they probably care deeply about whether their orthopaedic educator will give them a strong recommendation when they are trying to secure a fellowship or find a job. Often the best way to improve resident learning is to improve the way residents are evaluated by effectively deploying both formative and summative evaluation techniques.

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 be-

cause 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 skills¹⁸⁻²⁰. 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 mentally²¹⁻²³. The physician-teacher can ac-

TABLE III Feedback by Means of Pendleton's Rules

1. The teacher asks (about a particular patient, operation, or rotation itself): "What went well?"
2. After the resident has responded, the teacher states what he or she thinks went well.
3. The teacher then asks: "What could you have done differently?" and/or "What could have been done differently?"
4. The teacher then states what could have been done differently from his or her perspective (as opposed to what went wrong).

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 ability²⁴⁻²⁶. 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

information²⁷. This means that teachers should avoid cognitive overload of residents as they are unlikely to retain a large number of isolated, newly acquired facts^{28,29}. 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^{30,31}. 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.

with use of a technique such as the One-Minute Preceptor (Table IV)³²⁻³⁴. 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.

A. Teach Basic Skills

Outside the Operating Room

The first recommendation for teaching surgery is to teach basic skills outside the operating room whenever possible. There is convincing evidence that controlled practice improves surgical performance of basic skills^{15,35,36}. However, despite an increasing use of surgical-skills laboratories and improvements in surgical training devices, many residency programs do not have a formal approach to teaching outside the oper-

ating room. There is a limit to what can be taught in a surgical-skills laboratory. However, skills such as suturing, applying uncomplicated hardware, and basic arthroscopy techniques can be learned effectively in the laboratory setting. Furthermore, the limits to what can be learned outside the operating room will continue to expand as more advanced surgical simulators are developed.

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 surgeons³⁷. 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 rest 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.

Stephen J. Pinney, MD, MEd, FRCS(C)
Department of Orthopaedic Surgery, University of California-San Francisco, 1701 Divisadero Street, Suite 280, San Francisco, CA 94115.
E-mail address: pinneys@orthosurg.ucsf.edu

Samir Mehta, MD
Department of Orthopaedics and Sports Medicine, Harborview Medical Center, 325 9th Avenue, Box 359798, Seattle, WA 98104. E-mail address: samir.mehta@uphs.upenn.edu

Daniel D. Pratt, PhD
Department of Educational Studies, University of British Columbia, Vancouver BC V6T 1Z2, Canada. E-mail address: dan.pratt@ubc.ca

John F. Sarwark, MD
Department of Orthopaedic Surgery, Children's Memorial Hospital, 2300 Children's Plaza, Northwestern University, Chicago, IL 60614.
E-mail address: J-sarwark@northwestern.edu

Edmund Campion, MD
Department of Orthopaedics, University of North Carolina, CB #7055, Bioinformatics Building, School of Medicine, Chapel Hill, NC 27599-7055. E-mail address: ecampion@med.unc.edu

Laurel Blakemore, MD
Orthopaedic Surgery and Sports Medicine, Children's National Medical Center, 111 Michigan Avenue, N.W., West 1.5, Suite 400, Washington, DC 20010. E-mail address: LBlakemore@cnmc.org

Kevin P. Black, MD
Department of Orthopaedics and Rehabilitation,
Penn State Hershey Medical Center, 500
University Drive, P.O. Box 850, M.C. H089,
Hershey, PA 17033-0850. E-mail address:
kblack@psu.edu

References

1. Dobbin KR. Applying learning theories to develop teaching strategies for the critical care nurse. Don't limit yourself to the formal classroom lecture. *Crit Care Nurs Clin North Am.* 2001;13:1-11.
2. Cassidy KL. The adult learner rediscovered: psychiatry residents' push for cognitive-behavioral therapy training and a learner-driven model of educational change. *Acad Psychiatry.* 2004; 28:215-20.
3. Tabbers HK, Martens RL, van Merriënboer JJ. Multimedia instructions and cognitive load theory: effects of modality and cueing. *Br J Educ Psychol.* 2004;74:71-81.
4. Hilton DJ, Kemmelmeier M, Bonnefon JF. Putting ifs to work: goal-based relevance in conditional directives. *J Exp Psychol Gen.* 2005;134:388-405.
5. Bijttebier P, Vertommen H, Steene GV. Assessment of cognitive coping styles: a closer look at situation-response inventories. *Clin Psychol Rev.* 2001;21:85-104.
6. Prideaux D. ABC of learning and teaching in medicine. Curriculum design. *BMJ.* 2003;326:268-70.
7. Anderson DJ. The hidden curriculum. *AJR Am J Roentgenol.* 1992;159:21-2.
8. Ginsburg S, Regehr G, Lingard L. The disavowed curriculum: understanding student's reasoning in professionally challenging situations. *J Gen Intern Med.* 2003;18:1015-22.
9. Kenny NP, Mann KV, MacLeod H. Role modeling in physicians' professional formation: reconsidering an essential but untapped educational strategy. *Acad Med.* 2003;78:1203-10.
10. Hafferty FW. Beyond curriculum reform: confronting medicine's hidden curriculum. *Acad Med.* 1998;73:403-7.
11. Wear D. On white coats and professional development: the formal and the hidden curricula. *Ann Intern Med.* 1998;129:734-7.
12. Marinker M. Myth, paradox and the hidden curriculum. *Med Educ.* 1997;31:293-8.
13. Cribb A, Bignold S. Towards the reflexive medical school: the hidden curriculum and medical education research. *Stud Higher Educ.* 1999; 24:195-209.
14. Lin E, Szomstein S, Addasi T, Galati-Burke L, Turner JW, Tiszenkel HI. Model for teaching laparoscopic colectomy to surgical residents. *Am J Surg.* 2003;186:45-8.
15. Rogers DA, Regehr G, MacDonald J. A role for error training in surgical technical skill instruction and evaluation. *Am J Surg.* 2002;183:242-5.
16. Pinney SJ, Page G. Guidelines for creating effective rotation-specific objectives. *Ann R Coll Physicians Surg Can.* 2001;33:12-7.
17. Pendleton D, Schofield T, Tate P, Havelock P. *The consultation: an approach to learning and teaching.* Oxford: Oxford University Press; 1984.
18. Joshi R, Ling FW, Jaeger J. Assessment of a 360-degree instrument to evaluate residents' competency in interpersonal and communication skills. *Acad Med.* 2004;79:458-63.
19. Musick DW, McDowell SM, Clark N, Salcido R. Pilot study of a 360-degree assessment instrument for physical medicine and rehabilitation residency programs. *Am J Phys Med Rehabil.* 2003; 82:394-402.
20. McLellan H, Bateman H, Bailey P. The place of 360 degree appraisal within a team approach to professional development. *J Interprof Care.* 2005;19:137-48.
21. Norman GR, Schmidt HG. The psychological basis of problem-based learning: a review of the evidence. *Acad Med.* 1992;67:557-65.
22. Beech DJ, Domer FR. Utility of the case-method approach for the integration of clinical and basic science in surgical education. *J Cancer Educ.* 2002; 17:161-4.
23. Beard JD, Robinson J, Smout J. Problem-based learning for surgical trainees. *Ann R Coll Surg Engl.* 2002;84:227-9.
24. Murdoch Eaton D, Cottrell D. Structured teaching methods enhance skill acquisition but not problem-solving abilities: an evaluation of the 'silent run through'. *Med Educ.* 1999;33:19-23.
25. Mandin H, Harasym P, Eagle C, Watanabe M. Developing a "clinical presentation" curriculum at the University of Calgary. *Acad Med.* 1995;70:186-93.
26. Ramsden P, Whelan G, Cooper D. Some phenomena of medical students' diagnostic problem-solving. *Med Educ.* 1989;23:108-17.
27. Achterberg C. Factors that influence learner readiness. *J Am Diet Assoc.* 1988;88:1426-8.
28. Anderson M. Annotation: conceptions of intelligence. *J Child Psychol Psychiatry.* 2001;42:287-98.
29. Anderson JR, Betz J. A hybrid model of categorization. *Psychon Bull Rev.* 2001;8:629-47.
30. Usatine RP, Tremoulet PT, Irby D. Time-efficient preceptors in ambulatory care settings. *Acad Med.* 2000;75:639-42.
31. Usatine RP, Nguyen K, Randall J, Irby DM. Four exemplary preceptors' strategies for efficient teaching in managed care settings. *Acad Med.* 1997;72:766-9.
32. Irby DM, Aagaard E, Teherani A. Teaching points identified by preceptors observing one-minute preceptor and traditional preceptor encounters. *Acad Med.* 2004;79:50-5.
33. Aagaard E, Teherani A, Irby DM. Effectiveness of the one-minute preceptor model for diagnosing the patient and the learner: proof of concept. *Acad Med.* 2004;79:42-9.
34. Ferenchick G, Simpson D, Blackman J, DaRosa D, Dunnington G. Strategies for efficient and effective teaching in the ambulatory care setting. *Acad Med.* 1997;72:277-80.
35. Melvin WS, Johnson JA, Ellison EC. Laparoscopic skills enhancement. *Am J Surg.* 1996; 172:377-9.
36. Rogers DA, Regehr G, Yeh KA, Howdieshell TR. Computer-assisted learning versus a lecture and feedback seminar for teaching a basic surgical technical skill. *Am J Surg.* 1998;175:508-10.
37. Lingard L, Espin S, Whyte S, Regehr G, Baker GR, Reznick R, Bohnen J, Orser B, Doran D, Grober E. Communication failures in the operating room: an observational classification of recurrent types and effects. *Qual Saf Health Care.* 2004;13:330-4.