Ten principles
for effective clinical teaching

BY CLAUDIO VIOLATO, PHD

Most physicians will teach medical students, residents, patients or other learners at some time during their career. Notwithstanding scientific advances in the study of thinking, perception, memory, learning and teaching in the past several decades, much of teaching in medicine is based on lore, intuition, anecdotal evidence and personal experience. But there are evidence-based principles of best practices for clinical teaching.

PRINCIPLE 1: **Effortful and challenging learning is durable and results in long-term retention. Although "no pain no gain" may be an overstatement, there is some validity to it.**

Learning that is easy and entertaining is evanescent—here today, gone tomorrow. Three important elements of learning are encoding (creating long-term memory traces), consolidation (organization, re-organization, stabilization of memory traces) and retrieval (cues that allow remembering the memories). Learning psychologists refer to "desirable difficulties" that enhance all three elements. Short-term complexity makes learning difficult and requires effort and focus. Learning is then slower, but more durable, precise and elaborated so remembering increases and forgetting decreases. For example: teaching medical interviewing with difficult patients includes difficulties that can enhance learning, compared to interviewing with "easy" patients.

Teaching Tip: In your clinical teaching, use patients of graduated difficulty (e.g., agitated, angry, incoherent) to enhance student learning of history taking and medical interviewing.

PRINCIPLE 2: **Effective teachers create opportunities for continuous learning, to help students continually develop and acquire skills and knowledge to improve clinical performance.**

Both teachers and students must work hard to form the cognitive structures and neural networks of meaningful learning that is deep and durable. With continuous learning (for example, exploring the latest techniques for minimally invasive direct coronary artery bypass surgery), students acquire knowledge and increase their "learning intelligence"—or knowledge of how to learn.

The human brain's remarkable changeability—its neuroplasticity—refers to changes in neural pathways, synapses and myelination due to learning, thinking, emotions and changes in behavior. Although the architecture and gross structure of the brain are largely genetically determined, the detailed structure and neural networks are shaped by experience and can be modified.

A recent naturalistic study has elegantly demonstrated this. To become a licensed taxi driver in London, trainees must learn the complex layout of London's streets during a four-year training period. Trainees who passed the tests of London streets had an increase in gray matter volume in their posterior hippocampi in brain scans. Controls and trainees who failed did not have structural brain changes.

Teaching Tip: Teach your students continuous learning skills (eg. read and abstract medical journals). Provide techniques (eg. clinical relevance) for critically evaluating research findings or guidelines and demonstrate how to apply these techniques.

PRINCIPLE 3: **Frequent and regular assessments enhance student learning, capitalizing on the testing effect.**

Retrieval practice with testing—using memory to recall or retrieve facts or knowledge—is more effective than reviewing content or re-reading text. Long-term memory is increased when some of the learning period is devoted to retrieving the information to be recalled. Testing practice produces better results than other forms of studying. This is called the forward effect of testing.

A recent randomized study of neurology continuing medical education courses compared the effects of repeated quizzing—test-enhanced learning—and repeated studying on retention. Performance on a final exam after five months showed that repeated quizzing led to significantly greater long-term retention (almost twice as much) than either repeated studying or no further exposure.

Teaching Tip: Have your clinical learners quiz and test themselves and each other on skills, techniques and the material to be learned.

PRINCIPLE 4: Spaced practice and learning is more effective than massed practice.

Massed or block studying (e.g., six continuous hours) is less effective for learning than distributed or spaced out practice (e.g., three study sessions of two hours each). The initial learning curve is flatter than with massed practice, but learning is more durable and the rate of forgetting is flatter as well. Combining initial block practice (producing rapid learning) with spaced practice (producing reduced forgetting) maximizes the efficiency of learning principles.

Surgical residents learning microvascular anastomosis in a distributed group performed better on efficiency of hand movements, expert global ratings of performance and success on live anesthetized rats' anastomosis than a massed learning group. Similarly, gastroenterology residents in a spaced course learned more nutrition knowledge in the short term and at a three-month post-test than a comparison massed group. As the theory predicted, surgical skills and nutrition knowledge were learned more effectively and better retained in the long-term through spaced learning as compared to massed learning.

Teaching Tip: Space out learning in "chunks" of time over several days, rather than in a massed block.

PRINCIPLE 5: Deliberate practice and learning is effective for improving knowledge or performance.

Deliberate practice is a purposeful, planned and structured activity with the specific goal of *improving* knowledge or performance. Psychologist K. Anders Ericsson, the foremost expert on the topic, has identified four essential components of deliberate practice that results in optimal learning of diagnostic accuracy. For example, in learning to use mammograms in diagnosis, residents view one mammogram (#1: a structured task) at a time from a library of digitized mammograms (#2: prior knowledge) with a known location of tumors and correct diagnoses. Residents provide detailed diagnoses and receive *immediate feedback* from a teacher about accuracy. Residents then have the opportunity for reflection and correction (#3: focus and motivation). They continue to examine series of cases and repeat the process over many occasions (#4: repetition). Learning will be much faster and allow residents to achieve a higher level of diagnostic accuracy than the conventional haphazard methods now employed.

> Based on findings of cognitive and educational psychology, we can use evidence-based practices to facilitate clinical teaching and learning.

Teaching Tip: Create deliberate practice opportunities for clinical learners using structured tasks based on prior knowledge, with opportunities for reflection; repeat the process as needed to achieve mastery. Provide immediate, constructive, formative feedback.

PRINCIPLE 6: Feedback is very important to facilitate learning and improvement of skills.

The illusion of knowing misleads learners about their own competence and provides a false sense of confidence. Novice learners are susceptible to illusions of knowing, especially when engaging in unproductive strategies such as re-reading text, underlining, highlighting, watching recorded lectures, etc. Tests, quizzes and other forms of objective feedback should always be part of any learning activity to maximize the learning and to correct the illusion of knowing. Corrective information for physicians in the form of multisource feedback, for example, can result in improved practice.

Teaching Tip: Use credible feedback (e.g., objective scores) to maximize learning and check the illusion of knowing. (Neither "Great work!" nor "How did you ever pass the boards?" is useful, credible feedback)

PRINCIPLE 7: Interleaved and varied practice maximizes learning in the clinical environment.

Interleaving practice involves working on multiple skills in parallel or series with the following principles:

- Activate prior knowledge and prepare instructions (e.g., demonstrate cardiac and pulmonary auscultation).
- Use the principles of deliberate practice with the interleaving process.
- Be wary of "flow"—automated responses that elicit the illusion of knowing—and make each task effortful and challenging.
- Review prior knowledge so as to consolidate and integrate new learning; capitalize on the spacing effect.
- Track progress with test and performance data. This will confirm progress and identify diagnostic information about areas in need of remediation.

The effectiveness of interleaving on medical students' learning of ECG diagnosis has been demonstrated empirically. Students were randomly assigned to instructional approaches organized around features (e.g., QRS voltage) or diagnostic categories (e.g., bundle branch blocks), followed by interleaved (examples from various categories were mixed together) or block practice (examples in a single category). Students in the interleaved practice had superior diagnostic accuracy compared to the block groups.

Teaching Tip: Use examples from various categories mixed together when

teaching skills, procedures or content. For example, vary the area for physical exam from patient to patient when teaching palpation skills.

PRINCIPLE 8: **Advanced organizers activate prior knowledge that facilitates new knowledge integration.**

Almost all new learning is based on prior knowledge. Advanced organizers are mechanisms to help students elicit what they already know, so as to facilitate the integration of new knowledge. Learning is based on some complex processes of receiving information and combining it with pre-existing knowledge. One such process in learning is *subsumption,* in which new material is related to relevant ideas that students already have.

Teaching Tip: Provide an advanced organizer in the form of a diagram, sketch or bullet points of the material, skill or procedure that you teach.

PRINCIPLE 9: **Effective learning is multimodal, engaging all learning styles.**

Teaching and learning styles should be based on the content and instructional objectives. The style of presentation should be what is appropriate to the material to be learned. In teaching anatomical structures and function, for example, visual styles with physical models, pro-section or 3-dimensional visual technology should be used.

The empirical evidence clearly shows that matching instruction to learning style does not improve learning. Students who say they are "visual learners" do not do better with curriculum that is visual compared to when the same is presented in other modalities (e.g., aurally).

Teaching Tip: For teaching case history, for example, aural styles modelling empathic listening and communication (e.g., repeating key phrases, nodding and making eye contact, touching on shoulder) should be used.

PRINCIPLE 10: **Schemas are cognitive representations of some knowledge area such as "pulmonary edema." They are central to the organization and assimilation of new information.**

Jean Piaget's theory (one of the great cognitive-developmental theories of the 20th century) is that we adapt to the world using the dual processes of assimilation (taking information into schemas, or patterns of thought or behavior) and accommodation (changing the schemas as a result of new information). These schemas are representations of perceptions, ideas, and/or actions that go together (e.g., pneumonia and infectious diseases). Piaget's theory helps explain key ideas such as deliberate and interleaved practice, retrieval practice and learning styles.

Improvement in learning results when schemas are altered, an accommodation that requires cognitive effort. Medical teachers can use organizations of schemas or *cognitive maps* to help students organize their learning and facilitate the assimilation of new information and the subsequent accommodation by expanding, altering or reorganizing schemas.

Teaching Tip: Develop a cognitive map by relating schemas to each other and to the whole in teaching skills, knowledge or procedures. Draw the maps for students (e.g., circles, squares, triangles, etc.) and show the interrelations (e.g., unidirectional, bidirectional arrows, etc.) between various schemas.

Conclusion

Based on findings of cognitive and educational psychology, we can use evidence-based practices to facilitate clinical teaching and learning. Learning is most effective when it is effortful, spaced, deliberate, interleaved and followed by frequent and timely feedback. We can capitalize on the testing effect of learning and have students test themselves. Advanced organizers activate prior knowledge and connect new learning. Instruction and learning can be designed for many learning styles. Finally, by helping students extract key ideas and organize them into schemas and cognitive maps, learning can be facilitated and enhanced. MM

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