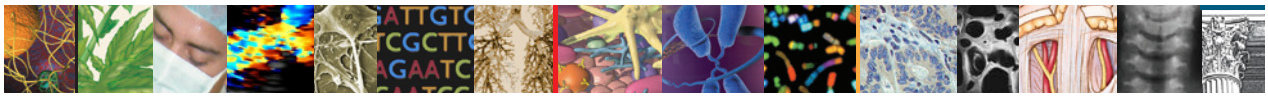

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Perspective

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Saying Goodbye to Lectures in Medical School — Paradigm Shift or Passing Fad?

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"Become a doctor, no lectures required."[1] This headline about the University of Vermont's proposed new approach to medical education generated considerable controversy. Although this proposed change is more drastic than the curriculum reform taking place at other medical schools, the movement away from traditional lecture-based courses has been under way in U.S. medical schools for more than three decades. Transformation began with the introduction of problem-based learning; more recently, lecture-based teaching has increasingly been replaced by team-based learning, interprofessional education, and exercises integrating clinical medicine and basic science. But are the newest proposed changes evidence-based, or are they merely the latest fad in medical education? Are all lectures to be avoided?

Most physicians today readily acknowledge that the biomedical information available exceeds what one person can learn and retain. Questions remain, however, regarding how much content students must learn, whether that learning is best done in traditional classroom settings, and what else is required for medical trainees to become successful lifelong learners and adaptable practitioners. The ubiquitous presence of personal and institutional technology permits rapid access to medical information and enables educators to focus on helping students develop a deeper understanding of human health and disease, problem-solving skills, and the ability to transfer knowledge learned in one context to another situation.[2] Educators giving a traditional lecture with dozens of content-heavy PowerPoint slides may confuse what they teach with what students learn: the fact that a teacher has presented a piece of information does not mean that students have learned it. In fact, cognitive-load theory suggests that our brains are limited in the amount of information they can process at a time[3]; 60 slides in 45 minutes may seem like an efficient way to teach, but it is unlikely to be an effective way to learn.

Students learning new material may be deceived by the illusion of knowing and the fallacy of understanding.[2] When students hear or read material that is fluent and well presented, it is common for them to believe they have now mastered the content.

Faculty and Students Interacting in Learning Studios at Harvard Medical School.
In the "Pathways" curriculum, students focus on the application of concepts to solve clinical problems. Selected lectures remain in most courses to create frameworks for subsequent learning.

Grace Fehrenbach.

When confronted with a problem that requires application of that information, however, they may realize that their understanding is superficial at best.

To promote more thorough understanding and enhance problem-solving skills and self-directed learning — critical skills for a doctor who will be practicing for 30 to 50 years and, in the case of self-directed learning exercises, a new requirement for accreditation established by the Liaison Committee on Medical Education — medical schools have begun emphasizing active learning and team-based activities. Acquisition of information occurs largely outside the classroom: in accordance with principles derived from cognitive science, factual content is presented in study assignments that aren't overwhelmingly long, and the content is interspersed with questions or problems to ensure that students can assess their level of understanding.

In the classroom, learning can be facilitated by the instructor, but it must be driven in large part by the student. Case vignettes are important for establishing the relevance of the material. Questions can be posed in a manner that requires retrieval of information, which solidifies memory but also compels students to view information from a new perspective and transfer it to the context of the given case. Instead of posing questions that begin with "what" (e.g., "What are the causes of hypotension?"), instructors can use "how" and "why" questions (e.g., "How do you think about blood pressure control?"; "Why would this patient be hypotensive under these conditions?"). Asking students to compare a new case or example with one they discussed the previous week further facilitates the transfer of knowledge.[3] Questions for which there can be multiple right answers can be the most compelling because they encourage discourse and generation of contrasting hypotheses. Time must be allowed for students to work in groups to discuss thoughts, test ideas (both theirs and others), and begin to learn how to think like a doctor. These activities require more effort from students than it takes to memorize facts, but they are also more effective for learning and retaining knowledge.[2]

This so-called flipped classroom approach is well suited to students who are members of the millennial generation.[4] These young adults are digital natives — they have grown up with technology and are intimately familiar with it. Raised to be part of teams, they thrive in collaborative environments. They are accustomed to finding information online and learn best from visually appealing content that keeps them engaged and is presented in short segments (such as videos that are less than 10 minutes long). The traditional lecture will quickly lose the attention of many of these students, and an unengaged student is not learning.

The early returns from this approach have been encouraging, particularly in college science courses and in the dozen or so medical schools that are implementing new curricula using these pedagogical methods (see photo). In a randomized, controlled trial comparing an early version of the flipped classroom with traditional problem-based learning tutorials, students found the alternative learning environment to be more engaging and thought-provoking.[5] Students who had performed relatively poorly in prior courses had a statistically significant improvement in their exam scores — possibly because interacting with their peers and sharing their ideas prepared them better. Faculty using a flipped-classroom approach often feel liberated from the tyr-

anny of the requirement to "cover" everything. Since acquisition of information is accomplished by the student outside class, interactions between teachers and students can focus on content that is difficult to understand and on the application of new concepts to real-world problems.

So is the lecture dead? If "lecture" refers to the traditional picture of a professor standing in front of and talking at a large group of students who are passively absorbing information, then yes, we believe medical schools should be largely abandoning that teaching format. But if it describes large-group interactive learning sessions with students who have prepared in advance, with frequent questions directed at the audience, time set aside for group discussion, and use of audience-response systems (to poll students on a question to assess for understanding, for example), then we believe an interactive lecture-style format should remain an option and can be an effective teaching tool.

An audio interview with Dr. Schwartzstein is available at NEJM.org

As we look to the future of medical education, we believe it's important to avoid zealotry with respect to pedagogical approaches, including the insistence that team-based learning methods must adhere to specific criteria or that no deviation from pure problem-based learning is allowed. We can often serve our students best by fusing elements of various methods, such as team-based or case-based learning and interactive large-group learning sessions, rather than feeling obliged to adhere to a particular format. But we must also use evidence-based approaches whenever possible and rigorously evaluate our innovations, acknowledging that important outcomes may include student engagement and problem-solving skills, team dynamics, and the learning environment as much as exam scores. In our daily lives as clinicians, we aim to create a culture of continuous quality improvement. We should strive to create the same culture in our educational lives.

Disclosure forms provided by the authors are available at NEJM.org.

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Medical Education in the Era of Alternative Facts

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Students currently entering U.S. medical schools arrive in an era of increasing distrust of large institutions, expanded use of social media for information, a political lexicon in which uncomfortable facts are derided as "fake news" while fabrications masquerade as reality, and the erosion of truth that such trends entail. The challenges for medical education are imminent and formidable. How do we, as teachers, merit the trust of future physicians? How do we pass on to them science's preeminent legacy of propelling advances in understanding, preventing, and curing illnesses? How do we instill in them a lifelong appreciation for the importance of hypothesis testing, peer review, and critical analysis of research? These questions should prompt an immediate review of the goals and processes of education and the values we need to emphasize in day-to-day interactions with students.

A useful early step in earning the warrants of students is a transparent review of the history of ideas in medicine. Such a survey would make clear that some ideas have worked, some have failed, and some have turned out to be built on scientific fraud — but that developing and testing hypotheses that might not pan out are essential to the scientific method. New ideas have often been rebuffed strongly by people in authority who had reason to fear challenges to the status quo. Some investigators didn't live long enough to see their novel ideas