Adv Physiol Educ 30: 135–140, 2006;
doi:10.1152/advan.00087.2006.

Teaching and learning in the interactive classroom

D. U. Silverthorn

Department of Integrative Biology, University of Texas, Austin, Texas

Submitted 24 August 2006; accepted in final form 28 August 2006

Silverthorn, D. U. Teaching and learning in the interactive classroom. *Adv Physiol Educ* 30: 135–140, 2006; doi:10.1152/advan.00087.2006.—The Claude Bernard Distinguished Lectureship of the Teaching of Physiology Section is presented annually at the Experimental Biology meeting. The lectureship is named for Prof. Claude Bernard, the experimental physiologist who is credited with introducing the concept of homeostasis. The 2006 Claude Bernard Distinguished Lecture was given by Dr. Dee U. Silverthorn from the University of Texas at Austin, TX.

active learning; student-centered instruction; science education reform

IT IS A TREMENDOUS HONOR to give the Teaching Section's 2006 Claude Bernard Distinguished Lecture, and one of the nicest things about it is that it requires you to sit down and indulge in retrospection about your own teaching and that of those who came before. Consequently, I decided to start by learning more about Claude Bernard, the experimental physiologist after whom this lecture is named. Claude Bernard (1813–1878) is probably best known for his description of homeostasis–the constancy of the *milieu interieur*–but, as it turns out, Prof. Bernard could be considered an early proponent of the interactive classroom, the topic of my talk, because it was reported that he disliked lecturing and was much happier in the laboratory, where he could demonstrate physiological phenomena to his students and interact with them as he taught (3, 5).

For many centuries, the professor was the primary source of information, the font of knowledge. Books were nonexistent or scarce, as they still are today in developing countries of the world, and information was passed orally from teacher to pupil. The didactic lecture is an effective method for conveying information from one person to a larger number of students, but, as most of us have experienced, simply telling information to someone does not ensure that learning takes place. When I began teaching, the education paradigm had not changed much from the one that existed in the time of Claude Bernard. For example, an etching of a Smithsonian lecture hall circa 1856 (Fig. 1) shows the lecturer, or "sage on the stage," as the focus of the room, with students arranged in rows facing him. Even today, newly constructed classrooms often have the same configuration as those lecture halls built centuries ago.

In the last 30 years, however, technological advances have begun to change how students acquire facts. No longer do they need to depend on the teacher to tell them what they should know. Physiology textbooks have changed from page after page of printed text with a few simple black-and-white line drawings or graphs to glossy four-color publications with three-dimensional computer-aided illustrations that occupy more space than the text. I still remember my reaction upon seeing the first four-color physiology textbook to be published: "This is a comic book, not a serious textbook!" Now, textbooks come with a host of technology-driven ancillaries: interactive CDs, websites, animations, and simulated laboratory experiments . . . ways to convey information that were almost unimaginable 30 years ago.

Students have changed in the last 30 years as well. The generation of students we are now teaching grew up with computers. They have always known the internet, videos, and CDs, but they may have never seen a typewriter. They laugh when you tell them that computers used to be larger than cars, because the students in the class of 2007 have always had computers that fit into their backpacks (1). What this means is that we are teaching a generation whose view of information access and transfer is totally different from that of their older instructors. When students today want to know about something, they are far more likely to Google it or go to Wikipedia than they are to pull down a book from a bookshelf. Every year when I talk to my students about finding scientific information, at least two-thirds of my juniors and seniors have never gone into the stacks in one of the University of Texas libraries to look for a book. What is more depressing for older scientists whose publications predate electronic indexing in PubMed is that for many students, if they cannot find information online, it might as well not exist.

We, as teachers, must now recognize that our students no longer have to depend on us for the acquisition of information, which may be one reason some professors report low attendance in class. Why wake up for an 8 AM lecture if you can learn the material on your own? And that brings me to the fundamental question that we each need to answer: What is my role as a teacher? What can I do during my face-to-face time with students that they cannot do as effectively on their own?

We know that one thing that our students can do very well on their own is memorize facts. But, science education reform efforts in the last 10 years have been calling for teachers to move away from memorization of unrelated facts and instead emphasize better conceptual understanding of basic principles. However, progress in this arena has been very slow, particularly at the undergraduate level.

So, in the remainder of this discussion, I would like to examine three aspects of teaching in the 21st century that I believe support improved student learning. First, what happens in an interactive classroom, and how does it differ from the traditional lecture? Second, what happens to students when they come into an interactive classroom and are asked to change from passive note-taking mode to active participation? And, third, what happens to faculty when they either decide on their own or are told by the administration to change their teaching to a more interactive student-centered format?

Address for reprint requests and other correspondence: D. U. Silverthorn, Dept. of Integrative Biology, Univ. of Texas, 1 University Station, C0930, Austin, TX 78712 (e-mail: silverthorn@mail.utexas.edu).

1043-4046/06 $8.00 Copyright © 2006 The American Physiological Society

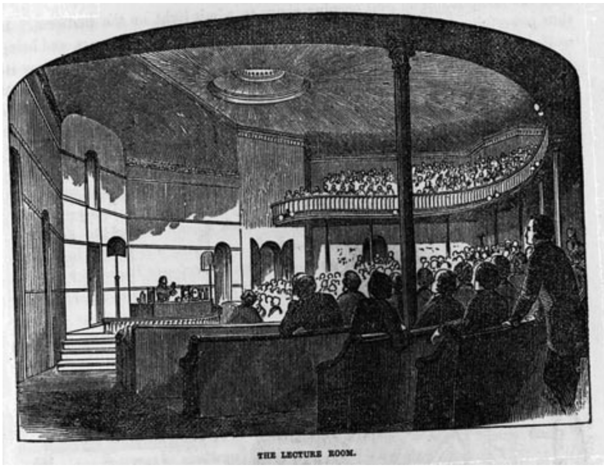

Fig. 1. A lecture hall in the Smithsonian Institute circa 1856 is similar to many classrooms in use today, with rows of students focused on the lecturer. [Reproduced with permission from the Smithsonian Institution Archives (record unit 95, box 31, folder 40, image no. MAH-43804k).]

The Interactive Classroom

As an example of an interactive classroom, I will describe what takes place in my large upper-division physiology classes at the University of Texas at Austin, TX (UT). My teaching strategy is not something that developed overnight, or even in one or two years. It has been a gradual process of trial and error. In many ways, my classroom has been my laboratory and my students are my lab rats. To quote Claude Bernard: "In experimentation . . . above all one must observe" (3). Each semester, I watch and listen to my students and my teaching assistants and try to decide which variable needs to be tweaked the next semester. Teaching is an iterative process, and I believe that when we stop trying to improve our teaching, it is time to retire.

Before I describe what takes place in my classroom, I want to be clear about two things. First, I am not advocating that we do away with lectures completely. There are some concepts in physiology (renal clearance comes to mind) that we all recognize as difficult for students to learn, and these concepts are probably best introduced in a lecture format in which the professor can ask and answer questions and monitor student understanding. Lectures are also essential for conveying the most recent scientific discoveries that may not yet be in textbooks, which are about a year out of date on the day when they first come out in print. But, I *am* advocating modifying the classic didactic lecture, in which the professor talks for 50 min or more, and perhaps asks a few questions that are answered by assertive students in the front rows, to a format that has students spending less time taking notes and more time testing their understanding of content.

I also need to say that I am not trying to advocate a single "best way" to teach. Teaching is highly individual and site specific, and what works for me in my classes may not work for you, particularly if you are not comfortable with it. For example, I have a colleague who specializes in classes where he takes on the persona of famous biologists through the centuries: Aristotle, Darwin, and Pasteur, for example. Aside from the fact that the vast majority of historically significant biologists before the 20th century were men, enacting classroom drama is just not my thing. We have to know ourselves and do what works best for us in our particular classroom.

In the traditional lecture class, students come to class, take notes on information that is given in the lecture, and then go home to study their notes, read the book (maybe), and work assigned homework problems. The difficulty with this strategy is that the teacher has no guarantee that the students learned anything during lecture or that they are learning at home. I recently gave a guest lecture on pulmonary gas exchange for a graduate class at a medical school. I was told that the students had heard lectures on pulmonary mechanics and oxygen transport, so I began class by asking them three simple questions on that material, using an electronic response system so that they could answer anonymously. Guess what? The majority of the class could not answer the questions correctly! After all, the test was still a week away. The teacher who had given the pulmonary physiology lectures was appalled. And how could I talk to them on pulmonary gas exchange if they did not remember the concepts underlying ventilation and hemoglobin binding of oxygen? That simple demonstration underscored an important lesson: just because we tell something to students does not mean they have learned it!

How can we tell what our students know and understand? The best way is to make them talk to us. From the time I started teaching I have always used a Socratic lecture format, where instead of simply conveying information for 50–90 min, I would pose questions for the class. But, I learned that even that simple form of interaction was threatening for many students in a large lecture setting. There was always a group of students, usually sitting at the front of the room, who would answer questions and talk to me as if we were chatting in my office, while the remainder of the class sat passively at the back and listened and took notes. So during the years I have been at UT, my class has evolved until now I barely lecture during a 90-min session. Most of my time with the students is spent having them talk and work on problems.

I have had many instructors tell me that they cannot give up lecture time because they have too much content to cover. But with my strategy, I have found that it is possible to convey significant amounts of content and make time for classroom activities. Creating a successful class like this requires five steps.

1. Develop clear objectives. In my classes, I decided that the development of basic skills is as important as learning content, so many of my class objectives are related to appropriate web searching, using indexes such as PubMed, reading and critiquing the scientific literature, and data analysis and presentation. Keeping these noncontent objectives in mind helps me design multipurpose classroom activities.

2. Identify essential content. This may be the single biggest stumbling block to changing the way science is taught in the United States. There has been such an exponential growth of what we know about biology since the 1980s that even researchers in a particular field are hard pressed to keep up with the literature. At the same time, in physiology and introductory biology, there has been a sense that we must teach it all. With each passing year, this becomes more difficult, yet many teachers are reluctant to cut back on the content they relay to their students. And they feel that the only way their students will learn is through a lecture format. I have actually heard teachers say, "They won't learn it if I don't tell it to them."

What happens when these students no longer have a teacher to tell them what to know?

One of the most valuable lessons I learned about identifying essential content came from working with a group of biomedical engineers as part of the National Science Foundation-sponsored Vanderbilt-Northwestern-Texas-Harvard (VaNTH) Engineering Research Center (www.vanth.org). Physiology is one of the core domains taught in biomedical engineering, but, as I talked to faculty in different programs, I realized that none of the engineering programs taught physiology as the traditional march through the physiological systems. Instead, I found that most programs concentrated on three to four systems, and they were not always the same ones. When I talked to the engineers about why they felt they could leave out certain physiological systems, they said they assumed that if their students had learned, for example, the basic concepts for fluid flow and pressure-flow relationships in the cardiovascular system, they could easily apply the same principles to air flow in the respiratory system. The key point here is that the students had to understand and remember the concepts, not simply memorize a bunch of equations and facts. Our task as teachers is to identify those essential concepts.

3. Decide what students can learn on their own. Can students learn basic facts on their own? Based on my teaching experience, I think that given well-written objectives and access to good resources, most students can teach themselves the basics. And I believe that by having the expectation that they will learn material on their own, we are fostering the skills and attitudes that they need to become self-directed life-long learners. The challenge of teaching this way is the student who comes to class with the attitude of "You're being paid to be the teacher . . . just tell me what I need to know."

To free up lecture time for working on problems, I make my students responsible for learning basic facts about a topic before they come to class. I decided that it was a waste of my time to stand up in lecture and say "The functions of the cardiovascular system are . . ." and wait while students wrote my list down. Some teachers speed up the notetaking process by giving the students copies of their Powerpoint slides, but then students may not come to class if everything they need to know is on the handout.

As a compromise, I created a student workbook that includes preclass reading assignments, information and figures for use in class, and lots and lots of problems. The preclass work tells the students which pages to read and includes basic content questions that are covered in the reading, such as "List the functions of the cardiovascular system" and "Trace a drop of blood from the left ventricle to the left atrium." If you have ever picked up a used textbook and seen the margin-to-margin yellow highlighting, you know how badly students need guidance on how to extract the key points from a paragraph. Some students answer the questions as they read, using the workbook to guide their note taking. Other students read the assignment and then test how well they understood what they read by trying to answer the questions. Student study strategies are as variable as teaching preferences, so I do not force them into any one method. But, I do expect them to have read and learned the basics before they come to class.

4. Use class time for practice and ungraded assessment. I usually start the class period with a brief overview of the topic for the day and perhaps a short quiz if I think they are not doing their preclass reading. Then, we move to asking and answering questions and doing small-group work. The student workbook contains the last three years' test questions, and I use those both for class problems and for additional practice. When we get to topics that I know are conceptually difficult, such as renal clearance, I may give a short lecture, but most of the time in class is spent working problems in groups.

The physical arrangement of the classroom is important for a successful interactive classroom. I teach in classrooms where the students can work comfortably with others around them and I can use my cordless microphone and walk between the rows. I usually roam the lecture hall, coming face to face with all the students . . . there is no place to hide, and everyone becomes accountable. I also use electronic response systems (Fig. 2) so that everyone answers the questions, not just the quickest or most vocal students. With these response systems, the students and I get instant feedback, and the teaching that takes place matches what the students need. Does a method like this work? I like to think so, and my evidence is that I have 95% attendance in an 8 AM class.

5. Make sure the graded assessment matches class activities. This may seem obvious, but I have observed several examples at my own institution where the assessment did not match the classroom activities, and student learning suffered as a result. In one instance, the professor used a traditional lecture setting to deliver very entertaining descriptions of classic experiments in biology and then wondered why the students could not design an experiment when presented a problem to solve on the test. In that instance, the teaching would have been more successful if the instructor during the lecture had given the class the question posed in the classic experiment and then allowed the students to brainstorm strategies for answering the question before describing how the experiment was actually conducted. In almost the reverse scenario, another teacher spent class time having students work on problems, but his tests focused on the memorization of trivial facts not covered in lecture. After two tests, many students stopped coming to class, and those that did attend talked about social matters during the problem-solving sessions because they had been trained that paying attention to what went on in class would not help them on the tests.

Student Reactions to the Interactive Classroom

Most students who attend an interactive class enjoy the challenge and working with their classmates. But, over the years, despite everything I have tried, there are always a few students who struggle through the semester and never make the transition from sitting passively in lecture to becoming an active participant. About 10 years ago that became the focus of my classroom research, which leads into my second topic: what happens to students when you ask them to participate in an interactive classroom?

This research started when I was working with a doctoral student in Science Education, Patti Thorn. Patti had a Master's in microbiology and was interested in active learning, so she decided to enroll in my Physiology course for one of her required science credits. After a few days in my class, she came to me extremely frustrated. Patti's prior education in science had been primarily through lectures and cookbook labs, and, despite the fact that she had studied educational theory in her

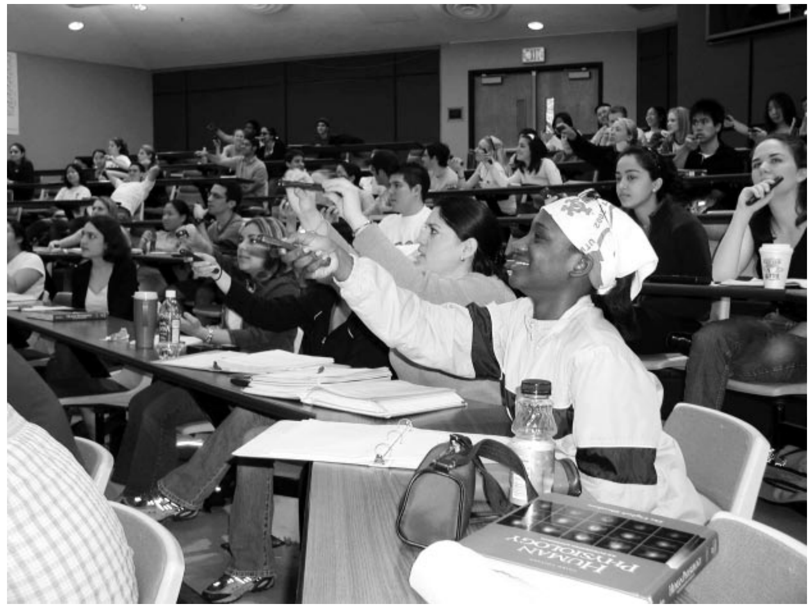

Fig. 2. Students in a large interactive classroom answer questions individually using an electronic response system.

doctoral program, she found that the reality of being in a class where she was expected to put learning theory into action was another matter. We talked about this conflict and agreed that Patti would chronicle her reactions to class in a journal. She also changed seats on a regular basis so that she could talk informally to the other students. Patti then shared the information she collected with me.

What I realized from analyzing my own and Patti's observations was that my students' behavior closely paralleled that reported by Donald Woods at McMaster University for students participating in a problem-based learning curriculum (7). When suddenly placed in a class that demands that they become independent learners, many students experience a fairly predictable series of reactions . . . reactions that are similar to Elisabeth Kubler-Ross's stages of coping with catastrophic news (4), although not necessarily in the same order.

The initial reaction is disbelief (denial). I observe this in my students on the first day of class when I tell them that this physiology class will not be the traditional lecture class they have come to expect. Typical comments include "Yeah, teachers always give you the idea that *their* class will be different and when it all shakes out, they are all the same." This stage persists for a few weeks until they realize that I am serious: I am not going to give them a lecture where they can write down what I want them to know, and they better not skip doing the workbook because if they do, they cannot follow what is going on during class. At that point, many students move into a second stage, which is shock or panic: "She is really serious . . . I can't believe this is happening."

The shock stage is quickly followed by what Woods called "strong emotion," which in my students manifests as a combination of anger and frustration. Typical student comments include "Why won't she just tell me what I need to know?" "She just needs to do her job and lecture!" and "Class time is worthless." What the students are really saying is "You've changed the rules!"

Most of my students are juniors and seniors with high grade-point averages, and by this stage in their college careers they have well-developed expectations of how a "good class" should be conducted. At UT, that often means they are expecting a well-organized, entertaining lecture where they can take copious notes that they then memorize to make a good grade on a multiple-choice exam. Many of these same students have never taken tests that do not give them a lot of content they recognize, and some have poorly developed thinking and reasoning skills. When they suddenly find themselves in a class where they can't make an A by the simple memorization of facts, and this may affect whether they get into medical school, they can become very hostile.

At this point, my main challenge is to overcome their resistance to change. A few students simply drop the class, but, for the ones who remain, it becomes very important to reassure them that the grading scheme in place will reward them at the end and not penalize them while they are trying to learn how to adapt to a new class style. In my class, this means a two-option grading scheme (Table 1), where the second option minimizes the weight of poor grades in the first part of the class. From here on, the students tend to follow one of two paths.

Most students accept the reality of the course structure and begin to adapt, particularly if they are flexible and can tolerate ambiguity. We have discovered that acceptance is the point

Table 1. *The two-option grading scheme for an interactive physiology course*

Option I	Option II
Three cumulative tests (75%)	Three cumulative tests (35%)
No final exam	Comprehensive final exam (40%)
Class work (10%)	Class work (10%)
Homework (10%)	Homework (10%)
Discussion attendance (5%)	Discussion attendance (5%)

For *option I,* students with a B average or better at the end of the semester may exempt from the final exam and take their *option I* grade. If the student takes the comprehensive final exam, then *option II* applies. *Option II* is required for everyone with less than a B average, including pass-fail students. Students who have an excused absence for a test must take the final exam and have the following grading scheme: comprehensive final exam (50%), class and discussion work (25%), and test average (25%).

where we have to be ready to help by encouraging students and letting them know that we have intentionally pushed them out of their "comfort zone." It is critical to give students alternative ways to approach the course, such as new study strategies. Most students, once their attempt to adapt meets with some success, experience a return of confidence. Often these students have to redefine what "success" means. Before this class, success was making an A on an exam. Now success is measured against progress ("I'm doing better than I was") and is related to mastery of the material.

The final stage for the students who adapt is a sense of self-empowerment. Often, the written course evaluations include comments such as "That was the hardest course I've had in college but I can't believe how much I've learned!" and "If I survived that . . . there's nothing I can't do!" These students become willing to tackle bigger goals with more confidence and such belief in themselves that it is hard to imagine they will be anything but successful. What is particularly interesting is that this last stage may not fully reach the students' consciousness until a year or two later, when they enter medical school and suddenly recognize how they have retained what they learned in their physiology class. I often learn about this stage by emails that begin with "You may not remember me . . ."

Unfortunately, there are usually a few students each semester who are unable to adapt and who continue to struggle with the demands of the class despite help. These students may become depressed, stop trying, or simply give up, saying "I can't learn this way." In some instances, continued failure to adapt to the new learning style causes the students to reexamine their career goals and decide that perhaps they should consider alternatives other than a career in medicine or biomedicine. If I can find the right intervention, some of them finally become successful. But, there are always a few students who never make the transition and fail.

Faculty and the Interactive Classroom

The challenge of coping with instructional change is not restricted to students. My experience working with a group of faculty members who were trying to incorporate more active learning in their classrooms (6) demonstrated that changing the way we teach is not simple. As with the students, there is a process and some critical barriers to overcome, and not everyone may be able to overcome them.

The reasons instructors have trouble changing how they teach are varied and complex. One simple reason is that many of us are products of the system that we are trying to change. We learned to teach with the "see it-do it" model, and, consequently, some faculty members have the attitude that "I learned this way; therefore, my students should be able to as well." Other factors that come into play are a lack of role models and a peer support system, lack of administrative support, and lack of appropriate teaching and assessment materials that deal with conceptual understanding and not simply memorization of facts. Finally, student resistance and anger, as discussed earlier, may impede the implementation of new teaching strategies. When teachers try something different in the classroom and students resist, the teacher may back down. Often, this is due to fear of what will happen to their student evaluations and contract renewals. I have been told by many instructors that they once tried active learning but the students hated it, so they went back to what was tried and true.

Successfully creating an interactive classroom requires a teacher who believes that students are capable of independent learning, given proper guidance and support. The interactive classroom becomes a place where learning focuses on concepts, principles, and application of knowledge rather than transfer of facts. In many ways, the classroom becomes where students learn what they do not know rather than what they do know.

So, here are six hints for success that emerged from my observations of students and faculty in interactive classrooms.

1. Define your goals and objectives. This step requires reflection on what we are teaching and to whom. We must be flexible enough to change our teaching to fit our student population and to tailor what we do to their needs. For example, I know that my prenursing students need more direction and hand-holding than my premed students do, but that my graduate students are not that different from my premeds. What is appropriate for one institution or population of students is not necessarily right for another.

2. Start small and don't change too many things at once. One of the biggest teaching disasters I have ever seen was a young postdoc who was teaching for the first time in our Nursing Physiology course. He had attended a faculty development seminar on student-centered teaching and enthusiastically decided to implement ALL the good ideas he heard about there. So he had his students working in teams, writing their own test questions, evaluating each other, and contracting with him for their grades. The one thing he did right was conduct a midsemester evaluation of his teaching, which told him that the students were all unhappy with the class. Unfortunately, there was no agreement as to which of his innovations was the worst, and he was left to salvage the semester as best he could.

3. Tell your students what you're doing and why, and KEEP TELLING THEM. This is one difference that we have noticed between faculty members who are successful in changing to an interactive classroom and those who continue to encounter student resistance. My story of why this is important comes from another colleague who came to one of our faculty development workshops and went home excited about student peer evaluation of written work. He started requiring his students to grade each other's laboratory reports and thought this technique had worked beautifully until he saw his teaching evaluations, which said, "The professor is lazy. He made us do his grading for him." His mistake was that he had failed to tell the students why he was having them grade each other's work.

Another colleague told students how the class structure would be different and why on the first day of class, but she did not repeat it. Remember the stages the students go through? When they hit the panic-anger stage, they have forgotten why you changed the rules on them. It is important to revisit your goals with students periodically so that they understand you are not teaching this way just to torture them.

Some years ago, I thought I had avoided this trap because at the beginning of the semester I talked to my students about how the class was going to be different from their usual UT science class. I showed them Bloom's taxonomy of educational objectives and told them how we would spend the semester concentrating on problem-solving and higher-level skills. I thought I was doing a great job of communicating my goals until I read one of my end of semester evaluations, which said, “I thought you said we weren’t going to have to memorize anything.” So, I changed what I say. Now, I tell students that they have to become a database of memorized information, stored and flexibly retrievable, so that they can find the information they need to solve problems they have never seen before.

4. Provide students with tools to help them change. How many times do students come in with an F on a test saying, “But I really knew the material!” It is important to teach students the difference between knowing and understanding and to show them that their study strategies should match the type of learning they desire. Many students develop study routines that made them successful in the “memorize and dump” classes, but when they find that their entrained study habits no longer work, they get frustrated. I use a variety of strategies to help these students make the transition to higher level learning. At the beginning of the semester, I have them take the visual-aural-read/write-kinesthetic learning preferences test with its study strategies (www.vark-learn.com), and I require them to make and use maps organizing large amounts of physiological information. Many of students initially resist these new ways of studying, but a lower grade on a test than they like is a powerful wakeup call and is often sufficient to initiate change.

5. Match the assessment to your teaching style, goals, and objectives. Assessment can be by group or individual. If your class time is spent problem solving but your tests demand memorization and regurgitation of petty details, students will decide that their time is better spent memorizing details. To show them that you value developing problem-solving skills, you must be consistent and give them classroom practice with the kinds of problems they will be asked to work on the test.

6. Have the right attitude. The final hint for success is for the teacher to approach classroom change with flexibility, patience, and a sense of humor. Usually nothing works the way you think it will, and sometimes it does not work at all and you need to rethink and try again. Finally, successful teachers constantly reflect on teaching and learning. This means thinking about each class . . . what worked, what didn’t. Where are the students having problems and what can I do to help them? This kind of reflection makes teaching a dynamic process, a creative endeavor.

We can all expect more challenges to change our teaching in the years to come. The iPod is almost ubiquitous now, and at some schools pod-casting lectures is becoming commonplace. I was talking to the director of a Medical Physiology course a couple of weeks ago, and his institution was considering taping the physiology lectures for students to view on their own time and then using the scheduled faculty contact time with the students for working problems and case studies. What other roles might teachers play in the future?

I would like to close with one more quote from Claude Bernard that I thought was particularly appropriate to this discussion: “A fact itself is nothing. It is valuable only for the ideas attached to it, or for the proof which it furnishes” (2). If, at the end of our course, the students appreciate the significance of this quote, then I think we have succeeded as teachers.

ACKNOWLEDGMENTS

I acknowledge Dr. Patti M. Thorn, whose insight contributed to my interpretation of what happens to students and faculty members who encounter or begin to implement interactive classroom techniques. I also thank all my graduate teaching assistants at the University of Texas whose input helped me decide which changes were working and which were not. I also acknowledge the support of Dr. Marilla Svinicki and the University of Texas Center for Teaching Excellence and Dr. Marsha Matyas and the American Physiological Society (APS) Education Office. Finally, thanks to my colleagues from the Teaching Section of the APS, the Human Anatomy and Physiology Society, and the International Union of Physiological Sciences.

REFERENCES

1. **Beloit College.** *Beloit College Mindset List. Beloit College’s Class of 2007 Mindset List* (online). http://www.beloit.edu/~pubaff/mindset/2007.htm [25 Mar 2006].
2. **Grande F and Visscher MB** (editors). *Claude Bernard and Experimental Medicine*. Cambridge, MA: Schenkman, 1967.
3. **Enersen OD.** *Who Named It? Whonamedit.com. Claude Bernard* (online). http://www.whonamedit.com/doctor.cfm/846.html [20 Mar 2006].
4. **Kubler-Ross E.** *On Death and Dying*. New York: MacMillan, 1969.
5. **Physiology Division, School of Biosciences, University of Westminster.** *Claude Bernard* (online). http://users.wmin.ac.uk/~mellerj/physiology/bernard.htm [20 Mar 2006].
6. **Silverthorn DU, Thorn PM, and Svinicki MD.** It’s difficult to change the way we teach: lessons from the Integrative Themes in Physiology Curriculum Module Project. *Adv Physiol Educ* 30:204–214, 2006.
7. **Woods DR.** *Problem-Based Learning: How to Gain the Most From PBL.* Waterdown, Ontario, Canada: Woods, 1994.