In the June 1998 issue of Advances in Physiology Education, several distinguished physiologists reflected on the last 100 years of physiology education. In this issue, another group of physiologists, joined by an educational psychologist, considers the recent past and the future of physiology education.

As we planned the articles in this special section, I began thinking about how physiology education has changed in recent years. In many ways, the teaching of physiology has been reflected in its textbooks. Until the early 1980s, those books were mostly descriptive text, with only a few simple line drawings. Contrast that with the physiology textbooks of today, especially at the undergraduate level, with their opulent four-color figures that occupy as much space as the text. Books today come with computer software, CD-ROMs, video tapes, and web sites. What do these changes say about the way physiology is taught and about the way our students learn? My colleagues and I sometimes joke about the challenges of teaching the MTV generation, but this is the reality. Students today are the children who, instead of reading a book or watching a little TV, are spending their time glued to computer monitors, video games, and the TV. They think in sound bites. They do not read as much as previous generations, and their vocabularies are sometimes limited to a point that seems appalling to their elders. I was reading Charlotte's Web and short stories from a 1950s Childcraft to my niece and nephews and found myself translating words that children 40 years ago must have known. It was particularly depressing to have to explain that a pirate’s booty has nothing to do with “shake your booty.” What I have come to realize is that we have a generation gap in physiology teaching, just as we have a generation gap in so much of our daily society.

What has happened in the last 30 years to create such dramatic changes? In my opinion, the rapid advances in technology and the concomitant information explosion have had a direct impact on what and how we teach. As our scientific knowledge base expanded rapidly in the 1970s and 1980s, faculty were faced first with keeping current, and then with having to incorporate the new information into their teaching. Textbooks became thicker and thicker, and, for the first time in history, we knew more than we could possibly hope to teach within the confines of a structured physiology course. Where would it all end?

At first, some schools tried to compensate by increasing the number of contact hours and throwing more and more facts at the students, and then, as we demanded that our students learn (or perhaps it would be more accurate to say memorize) more, some of the skills that we had unconsciously incorporated into our more leisurely teaching were neglected. We no longer had time to talk about the classic experiments in physiology, so our students never learned about the processes of science: how to design a controlled experiment, and how to critically analyze results. Somehow, the basic themes and principles of physiology got lost in the morass of detail. We nurtured students who could memorize and regurgitate reams of facts but could not construct or interpret data in a graph. They could recite pathways but were unable to tie together disparate bits of information to solve a problem. Laboratories, traditionally the place where students could actively experiment with concepts they were studying, disappeared or were replaced with “cookbook” experiments that did not require the students to think.

During the same time period, information about how people learn was gradually finding its way into the
physiology classroom. The transfer of educational research to teaching scientists has always been slow. Traditionally, graduate students in the “hard” sciences take no formal education courses. Most of us learned to teach by observing others and then developing our own teaching style based on what we felt was effective. The traditional separation of schools of science and schools of education is still present, but, as more and more physiology faculty develop competency in educational methodology, we now have scientists instructing scientists on how to teach.

Research into how we process and remember information has shown that people learn best when they are actively engaged with the material. As a result of these findings, summarized in this issue of Advances in Physiology Education in the article by Marilla Svinicki, the format of physiology courses has been changing. The new teaching techniques masquerade under many names: problem-based learning, active learning, collaborative and cooperative learning, inquiry learning, or discovery learning. No matter what the name, these teaching methods share two important characteristics: they mark a shift from a teacher-centered to a student-centered classroom, and they place the responsibility for learning back where it belongs—on the student. Several articles in this issue discuss different models for nonlecture-based instruction. Problem-based learning in medical schools and in an undergraduate setting is addressed in the two articles by William Galey and Sheella Mierson. Ann McNeal, Donald Stratton, and I present three different approaches for teaching students about the process of science in laboratory settings.

These innovative teaching methods have not been wholeheartedly embraced by everyone. Debates have raged over whether it is better to teach content or to sacrifice some content in the interest of teaching process and skills. This debate has been particularly heated at the medical school level, where school reputations rise and fall partly on the basis of scores for standardized basic science examinations. Manpower and faculty time commitment are also major considerations in the decision to implement active learning methods. Unarguably, it is less demanding on the faculty to schedule a lecture for 160 students in an auditorium than to split those students into small groups with separate faculty facilitators. However, that same large lecture setting can be modified for active and problem-based learning if the faculty are willing to be flexible.

If we agree that we cannot possibly teach students everything there is to know about physiology, then it becomes imperative upon us as physiologists to decide what content should be covered in a physiology course. What is essential for this population of students? What are the basic tenets of physiology? What common themes span the spectrum of physiological systems and form a framework upon which students can tack new knowledge as they acquire it? Dan Lemons and Joe Griswold discuss how they have approached this problem in their article on setting benchmarks for physiology learning.

How to teach in the wake of the information explosion is only half the problem facing us as instructors. The other half of the problem is technology and what its role in physiology education should be. As we move into the 21st century, we have access to computer simulations, interactive (and not-so-interactive) software, data-acquisition systems, Internet resources, and multimedia for the classroom. However, in many ways, technology does not match the needs of students, as discussed in the article by Rob Carroll, and in some settings it has created more problems than solutions.

Technology by itself does not improve teaching, although many people fail to recognize that fact. When I reviewed grant proposals for the Instrumentation and Laboratory Improvement Program of the National Science Foundation, we were inundated with proposals for the purchase of computers and the software program A.D.A.M., the Animated Dissection of Anatomy for Medicine. However, the vast majority of the grant writers had not thought beyond the purchase of the software; they had no idea of how to integrate A.D.A.M. into their curricula. The prevailing theme in the grants was “If I have A.D.A.M., my students will learn anatomy better.” However, the writers failed to understand that the software was a resource, just like a textbook, and not a substitute instructor.

Thoughtfully incorporating technology into the classroom or student laboratory requires a tremendous
time commitment. Considering the other demands on
the time of most faculty, it is not surprising that the
use of technology in physiology education has been
limited. One problem that confounds faculty hoping
to incorporate multimedia resources and computers
into their teaching is the difficulty of selecting appro-
propriate software. There is no quality control, such as
that obtained through peer review. Physiology soft-
ware is often self-published or produced by textbook
publishers who are responding to market demands for
software ancillaries. There is no single source, equiva-
 lent to Books in Print, for determining what programs
are available, and there is often no way to assess the
accuracy and appropriateness of a given application
for a particular student population. Even if instructors
had the time, many programs are not available for
preview and must be purchased sight unseen. I would
guess that most of us who use physiological simula-
tions in our teaching have a drawerful of discarded
programs that we tried and abandoned. What can be
done to help us deal with assessing physiological
software? A few resources are currently available. The
Technology Committee of the Human Anatomy and
Physiology Society has compiled an annotated list of
teaching software for anatomy and physiology. Also,
in this journal, associate editor Harold Modell orches-
trates reviews of software sent to the American
Physiological Society (APS). A widely disseminated
clearinghouse for physiological software that allowed
dialogue between users, such as a section on the APS
web site, would certainly be beneficial to the physi-
ological community around the world. In her article,
Marsha Matyas of the APS Education Office addresses
this and also some of the plans of APS for supporting
the teaching needs of its members in the years to
come.

Another problem raised by technology is teaching
students how to critically evaluate information pub-
lished over the Internet. How many times have you
heard students say, “But it MUST be right... I read it in
a book!” When you translate this belief to material
read on the Internet, the potential for students to
acquire erroneous information becomes enormous. If
you have ever asked students to conduct web searches
on a physiological topic, you know how much of the
information they find is suspect, such as “facts” about
nutritional supplements posted by the companies that
manufacture or sell the products.

In many ways, we are extraordinarily fortunate to
have the problem of how to incorporate technology
into our teaching. Many physiology departments
around the world do not have the luxury of computer
access for their students or even for their faculty. In
the final article of this special section, Ann Sefton,
Chair of the Commission for Teaching of the Interna-
tional Union of Physiological Sciences, examines the
future of physiology teaching from an international
point of view. Most of us cannot appreciate the
difficulty of teaching physiology in developing coun-
tries, where they may have only one textbook for 200
students and where one overhead projector bulb must
last for an entire year. The appropriate use of animals
in laboratories or practical exercises is another item of
concern in many countries. We have a responsibility
as part of the worldwide community of physiologists
to look beyond our borders and ask what we can do to
improve physiology education everywhere as we
enter the 21st century.

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