

This issue concludes the NABT's celebration of its 75th Anniversary. Since my term as *ABT* editor will also be over at the end of this year, this will be one of my last official opportunities to share my ideas about biology education. First I will tell you a little about myself, and then I will share some reflections on biology education past, present, and future.

I was always interested in a career in teaching, and biology was my favorite subject. During my senior year in college as a pre-med biology major, I was sent a military draft notice. The draft board gave me three choices: (a) graduate, and we send you to OCS and you will go to Vietnam; (b) graduate and go to med school; when you finish you will go to Vietnam, as we need physicians badly; or (c) get certified to teach secondary science as a critical industry, and you are deferred indefinitely. The decision was a no-brainer. I began a 12-year career teaching high school biology in San Jose, California, the next year.

My classroom curriculum emphasized evolution, ecology, genetics, and the human body. My students said that all I ever emphasized was sex and evolution. Well, why not? I also taught about every science except physics, and my favorite class was a six-week summer session in field ecology with lots of field trips. After teaching biology for just a few years in the late 1960s, I attended an NABT Convention in San Francisco. One of the featured sessions was a debate over evolution versus creation. Speakers on the evolution side included none other than Theodosius Dobzhansky, who made his now famous statement, "Nothing in biology makes sense except in the light of evolution." The creation side was represented by Duane Gish from the Creation Research Institute. It was a lively debate, but the creation side offered mostly character criticisms of the evolution speakers and did not address the issue at hand, whereas the evolution speakers offered data-based evidence. Between this event and attending many other sessions by biologists and biology teachers, I got hooked

on the NABT and have been a proud member ever since. Some of you know that I was awarded an NABT Honorary Membership in 2007.

Even though I enjoyed teaching biology very much, I became interested in research on learning biology and curriculum development. After earning a PhD at the University of California, Berkeley, I taught biology and science education courses at the University of Nebraska, Louisiana State University, and Clemson University. I was always interested in making biology a more active and thoughtful experience for students. (When I interviewed with Clemson in 1986, I told them that I had twice been at a sports-crazy university and I now preferred a place where academics was more emphasized. You can imagine the chuckles.)

### The Past

Let's first look back at some of the major events in biology education of the past century. My first observation is that, historically, the biology textbook has defined the curriculum. Biology teachers use the textbook to guide what happens in the biology classroom. There have always been textbooks for the college population, but these students represent a small percentage of students engaged in taking biology courses, so college texts will not be discussed here. Traditionally, the primary site of biology education was high school and, for some time, mostly the 10th grade. Here is a brief history of popular, national-level biology curricula (textbooks).

The first widely used high school biology textbook in the United States was *Biology for Beginners* by Truman J. Moon (1921, Holt, New York). The name changed to *Modern Biology* (Moon & Mann, 1933; Moon, Mann, & Otto 1947). All these versions essentially used a phylogenetic approach using the two-kingdom organization. This included coverage of human ancestry, which by 1956 was deleted in response to objections that it did not agree with the *Bible*. In 1960, Al Towle was added as author and some

student activities were added, but they were very cookbook and teacher-directed. Al and I both taught biology in the East Side Union High School District in San Jose, and we did not agree on how students should be learning biology. *Modern Biology* was still the dominant textbook of the time and made the authors and Holt, Rinehart and Winston bundles of money. In the 1970s, Al earned a PhD at Stanford University, taught biology at San Francisco State University, and continued to work on *Modern Biology* for decades. By the 1980s, what was known as the "owl book" by Al and Alexandria Towle was still common in biology classrooms and still encyclopedic in approach, with little modification, although its popularity was much reduced.

After the launching of *Sputnik* in 1957, there was widespread concern that the Russians were beating the United States in educational productivity and, especially, in the production of qualified scientists, mathematicians, and engineers. Because this created a sense of U.S. defense vulnerability, Congress passed the *National Defense Education Act*, which provided massive funding for educational experimentation and wholesale curriculum innovation in many areas of science and mathematics, mostly through the National Science Foundation (NSF). One major result was the development and release of the popular BSCS curricula in the early 1960s. These emphasized inquiry learning and conceptual themes and contained an abundance of engaging activities. For mainstream high school biology, there were three curricula that differed mostly in organization and were marketed by different publishers. BSCS Blue Version had a molecular emphasis, BSCS Green Version (to which I was a contributor) an ecological emphasis, and BSCS Yellow Version a more organismic and phylogenetic approach. The Coral (Red) Version addressed challenged learners, and the Black Version was for advanced biology courses. All but the Green and Blue versions were eventually phased out, with Green selling mostly for

mainstream college prep biology and Blue primarily for advanced biology. I enjoyed using the Green Version with my general biology students for many years during the 1970s; I used Blue Version one summer for a group of very bright AP Biology students in Palo Alto. I also used some of the challenging experiments in Black Version for my advanced biology students. Black Version was clearly aimed at future scientists. Today the Yellow, Black, and Red versions are no longer sold, Blue is used mostly for advanced biology and Green for college prep biology, and none has a large market.

A next generation of high school biology curricula began in the later 1990s to address the perception that most of the BSCS curricula were difficult for the majority of students (and teachers). Some of these curricula were more traditional and developed through authors and publishers rather than through the NSF. Among those still fairly popular today are *Biology* by Miller and Levine and *Biology: The Dynamics of Life* by Alton Biggs and co-authors.

The Miller and Levine text gained quite a bit of popularity after Ken Miller from Brown University testified in the legal case *Kitzmiller v. Dover Board of Education*, tried in 2005 in a Harrisburg, Pennsylvania, Federal District Court. This was the first case to test a school district policy requiring the teaching of “intelligent design,” and the trial attracted national attention. “Intelligent” design was found to be a form of creationism and, therefore, unconstitutional to teach in American public schools because it was religious rather than science-based. This was a major victory for biology education.

Three curricula that were funded by the NSF in the 1990s were inquiry driven, contained a large variety of interesting student activities, and were somewhat novel: *Insights in Biology* (Educational Development Corporation), *Biology: A Community Context* (Leonard and Penick), and *BSCS Biology: A Human Approach*. All of these are quite different in their approach and have somewhat small sales markets today. In 2005, the AAAS Project 2061 did a qualitative analysis of four important content categories from the major biology textbooks available between 1997 and 2000. As expected, the traditional programs were rated poorly, primarily for their lack of inquiry and active learning. Unfortunately, no biology curricula received ratings of “excellent” in any category, and only *BSCS Biology: A Human Approach* and

*Biology: A Community Context* received any ratings of “good.”

The recent Great Recession did much to hurt education in general because funds to schools were reduced. (This occurred in higher education as well as in some state universities, such as Clemson, that became, and remain today, only a small fraction state funded.) The fund reduction to K–12 education included what would have been money for new, innovative textbooks such as those mentioned above. Also reduced were funds for materials needed to support the newer active-learning curricula. The results in many biology classrooms were increased class size, less time spent in laboratory and field activities, more lecture instruction, and a long postponement of the purchase of textbooks. Some schools even gave up using science textbooks because they were too old and/or in very poor condition. Especially hard hit were the large inner city schools that needed these active-learning programs to keep students’ attention. It was rumored that some of the very largest school districts increased class sizes in biology and chemistry to around 40 students. How can a teacher possibly supervise wet lab activities safely in a class of 40 students? Another consequence of the recession was higher sales of traditional textbooks and lower sales of active-learning textbooks.

Concurrent with all the above textbook history, anti-evolution activities began at a national level as early as the Scopes Trial in the 1920s. There have been many notable religious-based challenges to the teaching of evolution at the local, state, and national levels. Fortunately, when many of these challenges eventually make it to court, science-based evolution wins because there is no factual evidence to support alternative notions such as creationism or intelligent design. Sadly, the court decisions seldom change the minds of the anti-evolutionists, still a large segment of our society.

## The Present

Here we are in 2013 and, although there is some progress toward more inquiry and active-learning biology instruction, the dominant mode of instruction in both high school and higher education is still lecture. I think there is a growing sense of the need for more active learning, but there is still the obstacle of insufficient funding to support wide use of inquiry and active learning. To aggravate the current situation even further, some of

the older traditional texts for high school biology, such as *Modern Biology*, are now available on the Internet for just a few dollars each and very tempting to finance-challenged school districts.

## The Future?

There does not seem to be high promise for enlightened biology education in the United States (at least to me). Sure, there is a wider sense among biology teachers that more inquiry and student engagement in the learning process are productive and needed. But lack of resources due to reductions in funding to public education will likely remain a problem for some time.

Also, probably the second-most-persistent public issue in science education will be from the religious right. The sheer ignorance of a vocal fraction of our public is responsible for anti-science and anti-evolution statements in the media. I regard this science-denying segment of our public as the Flat Earth Society because they reject the widely accepted findings of modern science, including on the age of the earth and global warming. There is even unwarranted and ignorant criticism of valuable vaccinations. I think a good analogy to the creationists’ objection to the teaching of evolution is the treatment of Galileo Galilei when he observed, correctly, that the Earth revolves around the Sun as an alternative to the prevailing Ptolemaic belief at his time. After his discovery, he wrote a letter to his astronomer friend Johannes Kepler, saying “My dear Kepler, I wish that we might laugh at the remarkable stupidity of the common herd.” Pope Paul V ordered Galileo to abandon his opinions, recant, and do penance. Galileo did not, and he was dragged to court in 1633. The guilty verdict included (1) being found guilty of heresy contrary to the Holy Scripture; (2) being sentenced to house arrest at his home near Florence, where he remained for the rest of his life; and (3) being forbidden to publish his works. It was not until 1758 that the Catholic Church dropped its general prohibition of books advocating heliocentrism. Ultimately, the scientific community and even the church accepted Galileo’s findings about the Earth and Sun. Fortunately, the Catholic Church supports modern evolution today.

I predict that the battle over the ignorance of creationism will be won, but it may take decades more, as did observable and verifiable scientific discoveries for Galileo. In the meantime, we will still have advocacy of

a 6000-year-old Earth by well-known politicians such as those in Minnesota, Texas, and south Florida. One particular politician from Texas boasted recently that “In Texas we teach both evolution and creationism.” We will probably continue to have deniers of modern science in high political positions, who would just as soon commingle politics and religion. And what I call the “preacher method” of teaching (not necessarily learning) biology will also persist.

Finally, some positive predictions. The reliance on the textbook will decline as our

biology teachers become more aware of the vast array of productive activities available from the Internet and from journals such as this one. Both sources will continue to contribute fun and interesting alternatives to the more traditional activities found in the predominant biology textbooks of the future. The NABT has had and will continue to have a major role in promoting high-quality biology education worldwide. The NABT conferences are widely and internationally attended. *The American Biology Teacher* will continue to be a rich source of biology

content, teaching ideas, and active-learning classroom activities for the middle school, high school, and college. Increased membership by teachers of biology will only help to make biology education a rich and successful experience for all our students.

As for me, at age 72 and in great health, I will continue to be active in the NABT with other initiatives, especially those that focus on increasing membership. You will hear more about that beginning next year.

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