TIME, SPACE, TURF, AND TRADITION:
PUSHING THE BOUNDARIES IN BIOLOGY EDUCATION

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Time. Space. Turf. Tradition. These are but some of the boundaries that appear to exist in the teaching of our biology classes. We teach certain courses because they have always been a part of our curriculum. How can a biology department not offer such essential courses? We teach them in a series of three or four lectures and an accompanying three hour laboratory period because that is the time that we are given by the registrar. We teach them in certain classrooms because that is what we are allotted. We teach them repeatedly, perhaps modifying them slightly from year to year, but with little outside input because they are "our" courses. We hear cries for reform in science education, but they are ignored because these are the limits that we face and we can't change. There isn't sufficient time, money, or space.

At the same time as we face these seemingly rigid boundaries, we see statements in our college literature that encourage students to challenge ideas, to look for different interpretations, and to seek new directions. How can we expect our students to do this if we are not willing to do so ourselves?

In the last year I have attended several conferences that have addressed the teaching of introductory biology. The thrust of those conferences was that we can and must do more to help students to learn biology in the beginning. However, many of the presentations have been about slight changes to the large lecture sections. I have heard and seen many examples of how we can introduce brief periods of discussion time. While this is a step in the right directions, I believe that it is not sufficient.

The National Academy of Sciences Science Education Standards (National Academy Press, 1996, p. 2.) says, "The Standards call for more than "science as process," in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills." If we only look for new tricks to bring to our lectures we are not meeting these goals. Moreover, we are not modeling what we teach, namely science, and we are not truly pushing the boundaries.

Why does a course need to consist of three lectures and a laboratory? It is often argued by my colleagues that carefully crafted lectures convey a wealth of important information. When these lectures are coupled with exciting laboratory investigations the students are exposed to the beauty and complexity of biology. This is the way that we have always taught, and it is good. Or is it? In this model, the professor disseminates information that the students dutifully write down, memorize, and in some way return to us in examinations, quizzes, and papers. The students who work particularly hard will retain much of the information, perhaps even long enough to use it on standardized exams in their junior and senior years. However, in this model they are only learning about science, they are not practicing science. Just as we should not trust a furnace repairer who has only read about furnace repair to fix our broken furnace, we should not allow our future scientists to only read about science. Even those students who will never become scientists need to be scientifically literate. They need to know and understand how to think scientifically and how to do science.
To help our future scientists become scientists, we need to push the boundaries that have limited our teaching of biology. We need to consider how we can help those students to learn important information as well as to practice science. We need to think about the shape and content of our classrooms.

Two Alternative Models
There are many models that we can consider in changing our teaching. One idea is to take one or two of the traditional lecture slots and use it for another purpose. This time slot could be used for discussion of critical issues. Alternatively, it could be used for sessions utilizing computer simulations, for brainstorming sessions in planning laboratory investigations, or for shorter laboratory or field investigations. In alternate weeks the time could be used for student presentations where the students present posters or oral descriptions of their work. Yes, in this model we give up lecture time, but we are giving the students the opportunity to inquire, to observe, to discuss, to learn from each other and to practice science. While this model pushes the boundaries of tradition, and perhaps space, it does not push other boundaries. Another model pushes the boundaries of space, tradition, time and turf. This model is the workshop model. Originally developed as Workshop Physics by Priscilla Laws at Dickinson College, the model has also been used in chemistry and biology classes. At Beloit College, our Chemistry Department adopted the workshop approach in 1992. George Lisensky, Laura Parmentier, and Brock Spencer designed a course in which the students were in the laboratory every day doing what chemists do. Laboratory investigations were coupled with in-class small-group problem-solving exercises on challenging problems, discussions and occasional mini-lectures of 15 minutes or less. Students learned chemistry by doing chemistry.

In 1995, Marion Fass, Ken Yasukawa and I brought this model to our introductory human biology class. Students meet for two hours, three times a week. Each class period is a mixture of investigative activities, usually done in groups, and discussion. Throughout the semester the students present their work in a variety of formats including poster sessions, oral presentations, models of biological phenomena, and written assignments. The professors are not disseminators of information. Rather, they are guides who help the students to understand biology. In addition, the course belongs to all the teachers. We worked collaboratively to design the course and we meet throughout the semester to discuss upcoming class periods. We frequently visited each other’s classes. There is no turf.

Conclusions
These two models are just two ideas of how we can push the boundaries in our thinking about how we educate students in biology classes. They will not necessarily work in all institutions and probably can’t be transplanted directly to any other institution. However, they illustrate ways in which we can change our teaching. In each of these models that I have offered, we make trade-offs. We give up time on our soapboxes, and we give up some control on the direction of the learning. These models are often more labor and time intensive. However, we are giving students some control. We are encouraging them to think, observe, question, hypothesize, experiment, think again, and convince others. We are meeting the goals stated by the National Academy Standards. In pushing the boundaries, we are helping students to understand science to become scientists. Isn’t this what science education is really about?