Random Thoughts on Interdisciplinary Science

James H. Stith
Director of Physics Programs
American Institute of Physics
College Park, MD 20740

Teachers in every discipline attempt to identify how they can best get students to understand why their subject is import and how knowledge of it will benefit them and those around them. Faculties worry that students have difficulty seeing the big picture, and don't understand, as they do, that their subject is central to the understanding of science. The inability to see the big picture is due in part to the student view of science subjects as a series of separate facts and ideas, each of which belongs in its own particular compartment. Many students see the high school/college curriculum as an ensemble of subjects to be studied in a given semester or year, and never make the connection of how one course relates to the other.

In recent years, we have begun to examine how faculty can work together to show the interrelateness among our subjects and have begun to talk about the interdisciplinary nature of science. In my view, too often, while we talk about interdisciplinary nature of science, what we are really demonstrating is the multidisciplinary nature. We have assembled courses under the guise of an interdisciplinary curriculum that are nothing more than a series of slices of individual science courses. This conference is an attempt to help us move from the multidisciplinary to the interdisciplinary.

Too often, as we have tried to reform instruction in our own sciences, we have not kept abreast of the changes that are ongoing in those sciences around us. My worry is that each of our respective disciplines will institute reform, assuming that the science base of related disciplines is static; only to find upon completion that the assumed base has been totally changed. Discussions such as those we will have at this conference help to allay those fears.

WHAT DO WE NEED?

There is a growing tendency to look carefully at the courses we teach and ask the questions, "What is really needed?" "What are the fundamental ideas that must be taught that will allow our students to become life-long learners?" While our subjects tend to concentrate on the facts and ideas unique to the particular science, I have come to look at the content as a route to molding and influencing student behavior. In short, I want graduates who can use our subject to: think logically; develop a sense of scale; see mathematics, physics, chemistry, etc as a language they use to describe their physical universe, not as an end in itself.

While I like to think that most of us would agree that the above list is important, my guess is that there is less agreement on how we will know that we have achieved the above stated goals. What gets in the way of our achieving these very important outcomes?

WHAT ARE OUR CONSTRAINTS?

An overriding impediment to achieving our goal is the pressure to cover too much material in too little time. The content matter in each of our fields has grown, and we have all felt the urge to expose students to it all. We have had difficulty making the tough decisions to cut material. We seem to have forgotten that it sometimes took years for us to see the great connections between

certain facts. We seem to believe that if we explain the subject matter well and clearly, our students will see and understand those connections immediately. Reading many of our introductory texts is almost as exciting as reading the dictionary. It contains all the words, has all the definitions, but the context has simply been lost.

Furthermore, it is getting expensive to do practice our craft, in my own case, physics. The cost of the technology and tools continue escalate. Textbooks become more expensive to produce, computers continue to become quickly out of date, software versions change quickly. While we believe that small classes and hands on instruction works best for more students, the pressure continues to find ways to take advantage of the economy of scale. The need to provide some faculty "release time" too often means that class sizes must grow, the student-teacher ratio grows, and less and less of the excitement that naturally exists in each if our disciplines is transmitted or experienced by the student.

Finally, for the student, there is the growing tension between getting an education and getting a job. There is an increasing tendency to blur the distinction between education and training. In fact, many are beginning to use those words interchangeably. Too often, when we speak of the relevance of the subject matter, we mean "What will be its use in the immediate future?" Too often, for our students "future" means within the next year.

Clearly, I have not identified all the constraints we face. I will not even claim to have listed the most important ones. These are only ones that come to mind at the moment.

HOW DO WE COOPERATE?

As we work to show students the interdisciplinary nature of science, there are a number of actions I believe we all can take. A first is to let our students know that we talk to each other. Discuss the natural connections between our disciplines. Physics should be used to show the natural beauty of mathematics. The connections between chemistry and physics are many and the approaches, though sometime different, lead to the same result. We should talk about science more and our own disciplines less. Help our students see the big picture.

At least at the introductory level, lets try to agree on a similar way to introduce topics. For example, too often introductory students don't recognize that the vector cross and scalar products studied in mathematics is the same quantity discussed in physics classes. We should borrow heavily for the courses we support and that support us. For example, physics courses should make explicit connections to the mathematics that students have had in prerequisite courses as well as use examples from follow-on engineering courses. I find it amazing that when I talk explicitly about the math that students have taken (citing the text and referring to examples in those texts), students are less prone to claim they have never been exposed to specific concepts. By using material from courses for which my course is a prerequisite, students tend to have a reason for needing to know and understand the concepts.

Finally, we should continue to evaluate all course requirements. Insure that the courses we teach are relevant and continue to support courses in our own fields and those in our sister sciences.