Science Education in the 21st Century

Striving for Excellence Requires Numerous Changes

By Peter T. Kissinger

Science is hard only for those who are not curious. I believe the most important component of K-12 science education is parents who are curious and educated about science. How things work is an excellent subject of dinner conversation. Parents who are not curious about microwave ovens, cell phones or modern medicines are likely to have children who also lack curiosity.

It is well known that science in Indiana is often not taught by those who majored in a specific science at a university. Taking a chemistry class or two does not make a chemist. While it is true that the most brilliant Ph.D. scientist would likely be clueless about how to manage a class of 14-year-olds, it is equally true that it doesn't do much good to be able to manage a class but not convey excitement for the subject at hand, or not to have adequate knowledge of the subject. Both are needed.

How do we attract the most qualified science teachers? Salary that correlates with their necessary skill level would be the place to start. We need to overcome the apparent fear of differential pay for merit and deal with the fact that our society values some things more than others. Competition is a good thing. We have huge salary differences in many professions, and we ought to consider the same for the classroom. Clearly mistakes will be made and some decisions will be wrong and "unfair." That's how life works. If we don't step up and try for excellence because we fear making a few mistakes, we will never achieve it.

Classroom content and structure

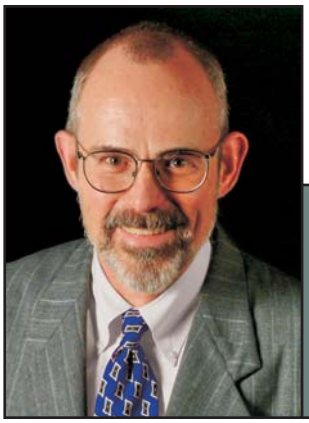
Less is more

The amount of material in modern science textbooks is inconsistent with the time allowed to digest it. This may result from the difficulty of deciding what to include and therefore including everything. I suspect that textbook publishers are co-conspirators. A modular approach using shorter texts with supplemental material provided by individual teachers is much more effective and economical.

If a goal is to convince the majority that science is too hard, too dry and only for "brainiacs," then we are very successful. On the other hand, learning a few basic concepts very well would be better than learning nothing at all. Topics commonly encountered in everyday experience are a good place to start. For beginning students, a feel for acid-base chemistry and the properties of solvents could be judged to be far more important than studies of obscure radioactive elements or the structure of crystals. What is studied is less important than learning how to study.

Big picture topics

In the 1960s there was great excitement about plastics, space exploration, solid-state electronics and more effective drugs. Today, there are global strategic challenges with respect to energy, the environment, basic life sciences and translating research to improved health care. Students like to grasp the important things. They want to believe they can make a difference. Giving students a feel for these big topics can get them thinking about why understanding the details of science will repay society many times over. A recent example is the fad to study forensics. Enrollment in college courses on crime scene investigations matches the excitement created by television shows in this area. If this inspires students to learn some key technologies, so much the better. Whereas memorizing the periodic table of the elements, more than anything else, has probably driven many potential scientists to become lawyers.



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The Science Express van can help educate both secondary teachers and students.

Teach Indiana science

I find that students really enjoy (and can grasp and remember) the commercial science in Indiana. At every opportunity I talk about what DowAgro does for agriculture. I show students the nifty glucose meters from Roche Diagnostics that you can buy at any pharmacy or Wal-Mart. These meters are fabulous teaching tools, and there are not many sophisticated digital chemical instruments that, like them, are available for the price of an IU or Purdue athletic ticket. Do our students really know what diseases Lilly scientists have helped ameliorate? Indiana is a mass spectrometry capital. Do you know what mass spectrometry is and why it's so important? You don't! Why not?

Year-round school

The current school year is archaic. There are many macroscopic factors that make it so, including the rise of women in the workforce, the dramatic reduction of workers devoted to mechanized agriculture and the invention of air conditioning. Year-round school is one of those topics for experiment. We should pioneer it in a few districts and get the bugs worked out.

No more class of 20XX

The very notion that everyone is the same is absurd in a society that espouses the virtues of diversity. Why would we all be expected to get to the same place at the same time? Some of us will go faster. Some will change direction along the way and be inspired to a new course in the middle of it all. High school can easily be a four to six-year experience. I'm encouraged by the notion of a smoother integration of high school with community colleges such as Ivy Tech. Let's give students a choice of speed, location and subject matter.

Adopt the metric system

Indiana could get out front here. While this is a federal issue in a legal sense, we clearly can lead by example. We should just do it! I'm tired of needing two sets of socket wrenches. This is a global economy, and that is here to stay. As with Daylight Saving Time, this is not a topic with which we in Indiana distinguish ourselves by being different from the rest of the world.

Bring science to the students

Most schools in Indiana do not have the scientific equipment necessary to carry out the state-mandated Advanced Placement and Tech Prep programs, as well as Core 40, Academic Honors Diploma and School-to-Work science requirements. Keep in mind that science is not about Bunsen burners and test tubes. Science is about curiosity. It is about electronics and software and spectrometers. Scientists use measurement devices that are not affordable, or even justifiable, to use in a high school two weeks out of the year. The technology advances too rapidly. But when several schools share scarce resources (and spread around the cost for them), we can give the students a more modern experience.

A Scientific Instrument Project has been proposed at six sites throughout the state. This project – Purdue's Science Express science van – would educate high school science teachers in the use of modern instrument technologies for making scientific measurements, plus deliver first-class sets of scientific instruments to their schools for hands-on experimentation in the classroom. This is not a new idea. It has been well established for over 15 years in several states, including Indiana, where it was first prototyped at Purdue. This is smart funding for school science, smart for business and it can fire up the students. Not to have this in place statewide is to shortchange students. The more young people see modern science, the more they will want to participate.

While science vans help a great deal in closing the gap between science history and science in reality, they can't get us all the way there. It makes a huge difference to know where you are heading so you can set your compass. Kids can see the Indiana Pacers play basketball and be motivated to try to do the same. Children who have the opportunity to visit modern factories and laboratories are likewise inspired.

At Bioanalytical Systems, Inc. (BASi), we like nothing better than to show students our research instrumentation and how we make our products so they can get a feel for how things look beyond school in a scientist's or engineer's life. Nothing is more important. My colleagues in business who say, "This is a nuisance" or "It costs too much" or "A kid might get hurt" are shortsighted and may be the first to complain about unprepared new employees. They likewise will say the children in China or India are smarter. Baloney! Stimulating young people to learn is far too important to leave entirely to the schools. Schools cannot do it alone.

Time for action

There are many things that can be done right now to help with science and engineering education. Many of them involve experiments and, thus, change. Until we embrace change instead of fearing it, we will get the same unsatisfactory results year after year. They say the definition of an idiot is a person who does the same thing over and over and expects a different result. I agree with this assessment.

2006 is a year with special focus on science education in Indiana, with the Intel International Science and Engineering Fair in Indianapolis and the Science Olympiad in Bloomington, both in May. Keying off of these events, there are longer-term initiatives such as Project Lead the Way (PLTW), an inquiry-based pre-engineering high school curriculum that has been very successful in terms of academic performance. Indiana

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is a test state for the latter, and the state Department of Workforce Development is enthusiastic.

We also anticipate a science education institute growing out of the science fair effort on which the Science Education Foundation of Indiana (SEFI) took the lead and then brought together an alliance of other science-oriented nonprofits. The University of Indianapolis has a very well financed Center for Excellence and Leadership of Learning (CELL). There are great opportunities for Indiana businesses to participate and share ideas. In science education, as in the Hoosier Lottery, you have to play to win.

INFORMATION LINK

Resources: Peter T. Kissinger founded the drug development company Bioanalytical Systems, Inc. and is a professor of analytical chemistry at Purdue University. He is also the chairman and CEO of Improtero, an industry-university consortium formed to develop and commercialize proteomics tools. He can be contacted at pete@bioanalytical.com